Dear Participants,

We cordially welcome you in the heart of Antwerp, the former cultural capital of Europe. Its splendid renaissance, baroque and rococo architecture together with contemporary museums are an excellent and inspiring environment for the conference theme "Innovation built on history".

The International conferences on Cochlear Implants and other Implantable Auditory Technologies are the most comprehensive, innovative and inclusive events of their kind. The 800 abstracts included in this Volume of the Journal of Hearing Science are the emanation of the comprehensive nature and multidisciplinary approach by over 1500 otologists, audiologists and speech pathologists, scientists, educators and industrial partners.

This 15th edition of the conference aims to realize a next step forward in the field, relying on evidence-based experience and fueled by cutting-edge technologies and the latest scientific developments, without losing sight on confirming or contradicting formerly formulated hypotheses.

The abstract book provides valuable information at hand to prepare and support you during lectures and to remain as lasting documentation appraising the whole field of auditory implants from basic science to surgery, from guidelines to rehabilitation, from children to auditory cognitive impairment, from auditory brainstem implants to vestibular implants and from cochlear implantation to middle ear implants.

Through all the abstracts, it is clear that the ambition of this Conference is the introduction and implementation of Personalized Medicine for each patient than can benefit from an auditory implant.

We are very much looking forward to meeting you both as fellow professionals with a shared passion for helping people with hearing problems through implantable technologies and, especially, as friends.

The support of the Journal of Hearing Science to realize this Abstract book is very much appreciated.

Prof. Paul Van de Heyning, President

Prof. Marc De Bodt, Prof. Vincent Van Rompaey, Vice-Presidents

Prof. Griet Mertens, Chief Program Director

Wednesday 27 June 2018

Keynote Lecture

Global hearing health care: new findings and perspectives

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In 2015, approximately half a billion people had disabling hearing loss, about 6·8% of the world's population. These numbers are substantially higher than estimates published before 2013, and point to the growing importance of hearing loss and global hearing health care. In this Review, we describe the burden of hearing loss and offer our and others' recommendations for halting and then reversing the continuing increases in this burden. Low-cost possibilities exist for prevention of hearing loss, as do unprecedented opportunities to reduce the generally high treatment costs. These possibilities and opportunities could and should be exploited. Additionally, a comprehensive worldwide initiative like VISION 2020 but for hearing could provide a focus for support and also enable and facilitate the increased efforts that are needed to reduce the burden. Success would produce major personal and societal gains, including gains that would help to fulfil the „healthy lives" and „disability inclusive" goals in the UN's new 2030 Agenda for Sustainable Development.

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Thursday 28 June 2018

Keynote Lectures

Gene delivery to the inner ear: hair cell regeneration and cochlear implantation

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The last several years have seen the first human trials of inner ear gene therapy and cell therapy launching a range of therapeutic interventions that we will need to incorporate into cochlear implant practice. We will review the rationale for generating human auditory hair cells and the implications of molecular therapeutics for cochlear implantation. We will discuss how to choose patients for high-risk clinical trials, review the clinical safety data from current trials and discuss means to optimize gene delivery into the inner ear. Challenges in moving therapy for forward include identifying the molecular and cellular causes of hearing loss, identifying optimal times for delivery of medications to the cochlea and most importantly managing the patient's expectations of outcomes. The next 10 years should show continued improvement and refinement of cochlear implant technology and the beginnings of hybrid device/molecular therapeutic interventions. Hearing preservation cochlear implantation in particular presents the opportunity to potentially improve low-frequency hearing, thereby improving EAS outcomes, as well as identifying patients with progressive ski slope hearing losses whose progressive hearing loss could be halted through gene therapy and their high-frequency hearing rehabilitated through electrical stimulation. These ideas will be further discussed in the subsequent panel.

A Three Dimensional Percept in the Absence of Fusion: What Cochlear Implants in Children Have taught us About the Developing Auditory System

Papsin B.[1,2,3]

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This presentation explores what we have learned about the central processing of poor fidelity auditory stimuli such as those provided by current cochlear implants in children with severe to profound sensorineural hearing loss. Our group has been fascinated by the implanted human's ability to use this incomplete primary source data to reassemble the auditory environment reasonably correctly. Even more fascinating is the finding that bilateral auditory inputs in these children fuse incompletely if at all yet they are able to lateralize sounds correctly. This capacity is undoubtedly related to the importance of correct sensory reassembly for survival and the study of children with cochlear implants has allowed us a wonderful opportunity to study the developmental processes which underlie this ability.

The contributions of the auditory brainstem and central auditory centres in addition to the other non-auditory cortical processors will be discussed and a model of sensory reassembly presented.

Diagnosing congenital hearing loss: the first step towards cochlear implantation

Boudeweyns A.

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Bilateral sensorineural hearing loss > 40dBHL affects 1.3 per 1000 newborns in developed countries. A bilateral severe to profound hearing loss (71-95dBHL) is confirmed in about 35%. The introduction of universal neonatal hearing screening (UNHS) programs allows early detection of newborns with congenital hearing loss (HL) and is the first step along the pathway towards cochlear implantantion for those receiving limited benefit from amplification with conventional hearing aids.

Confrimation of hearing loss upon a referral from UNHS is followed by audiological rehabilitation and a search for an underlying etiology. In the past, several protocols (stepwise or simultaneous) have been proposed including genetic testing, screening for congenital infections and imaging. Comprehensive genetic testing using targeted genomic enrichment with massively parallel DNA sequencing has changed the diagnostic algorithm. The American College on Human Genetics recommends the use of gene panels. Using this approach, the need for complementary examinations can be guided by the suspected diagnosis and the results of comprehensive genetic testing.

Identifying an etiology for congenital hearing loss may direct rehabilitation strategies, allow monitoring of disease progression and associated disabilities and allow accurate and personalised genetic counselling.

The Evolution of Cochlear Implantation Candidacy Criteria

Pillsbury H.

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The cochlear implant is a revolutionary technology that has restored the hearing of hundreds of thousands of hearing loss patients – improving their speech understanding and quality of life. The first candidates for cochlear implantation had bilateral profound hearing loss with little

to no speech understanding. The success of the cochlear implant in these patients raised the question of who else could benefit from this technology. Multiple clinical trials have investigated and demonstrated the benefit of cochlear implantation under expanded indications, and it is a question we continue to investigate today.

The cochlear implant program at the University of North Carolina at Chapel Hill has been at the forefront of clinical research investigating expanded indications for cochlear implantation in children and adults. Findings from these studies have and continue to contribute to the expanding indications for cochlear implantation in the US. This report will review the findings from three clinical trials: 1) simultaneous bilateral cochlear implantation, 2) Electric-Acoustic Stimulation (EAS), and 3) unilateral and asymmetric hearing loss. The success of bilateral cochlear implantation revealed that patients with moderate-to-profound sensorineural hearing loss could combine the stimulation from each ear for improved speech perception in noise over listening with one ear alone. The EAS clinical trial revealed that patients with preserved low-to-mid frequency hearing could combine acoustic information with electric stimulation for greater speech perception in noise as compared to either stimulation modality alone. Emerging data from the clinical trial investigating cochlear implantation in cases of unilateral and asymmetric hearing loss demonstrate that patients with normal hearing in one ear experience significant gains on speech perception in noise and localization with the use of a cochlear implant. Initial data from expanded indication studies in children, including EAS and cases of UHL, supports the benefit of this technology in children who present more hearing than current candidacy criteria. Further, these cochlear implant recipients report an improvement in quality of life – beyond what can be measured in the sound booth.

Cochlear implantation is a beneficial treatment than initially thought possible for children and adults presenting with more residual hearing. Clinical research continues to realize additional benefits, including localization and ease of listening. These findings challenge us to continue to question who else could benefit from this technology

Complex Language and School Performance of CI Students

De Raeve L.

ONICI, Zonhoven, Belgium

Objectives: The aim of the study was to find out the most important factors influencing complex language development and school performance in uni and bilateral implanted deaf children.

Materials and Methods: We started up a retrospective study on 37 early screened (< 3 months) and early implanted (< age 3 y) deaf children: 12 are bilateral CI users, 9 are bimodal users (CI+HA) and 16 are unilateral CI-users. All children received support and habilitation from the same centre. Two groups of children (unilateral and bilateral device users) were compared (on the short and long term) concerning vocabulary, speech perception in quit and in complex listening situations, verbal cognition and school performance (on literacy).

Results:A significant effect of speech perception abilities in complex listening situations (perception of soft speech at 45 dB SPL and of speech in noise) on verbal intelligence and on literacy performance was found. This suggests that bilateral input and the possibility to come to incidental language learning was the underlying reason for improved speech perception. These abilities enable at least some of the children to develop age-equivalent verbal cognition skills and school performance.

Conclusion: Deaf children who use bilateral devices have the opportunity to develop good speech perception skills in complex listening conditions which enables at least some of the children to develop age-equivalent verbal cognition skills and school performance. But there is huge variability in outcomes, and in our presentation we will focus on how we have to adapt our habilitation and education to these outcomes.

In vitro and in vivo models to test the effects of electrical stimulation on the inner ear

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Objectives: While there is a trend to implant patients with residual hearing, we know that cochlear implantation may cause some loss of this residual hearing. The direct effect of implantation of the electrode in macroscopic structures of the inner ear is well described, however, the effect of the electrical field generated by the implant has not been investigated to date. Some recent data suggests that the electrical stimulation can have a negative effect on hair cells. The objective of this study was to determine the effect of electrical stimulation on hair cells employing in vitro and in vivo models of cochlear implantation.

Materials and Methods: A custom stimulator circuit that allows to study several parameters, including stimulation amplitude, pulse width, and total stimulation duration was designed. For the in vitro work, organs of Corti explant cultures from P3 rats were used. For in vivo work, the adult guinea pigs were implanted with a cochlear implant and subjected to a number of periods of electrical stimulation via constant activation of the implant. Stimulation was applied with varying parameters to determine the effects of the stimulation on the survival of hair cells. Survival was quantified by counting hair cells in organ of Corti explants using confocal microscopy. Auditory Brainstem Recordings (ABR) were performed to determine hearing thresholds in the guinea pig model.

Results: In the present study, a compact and easily-adjustable stimulator circuit was developed. It has sufficient flexibility to imitate a wide range of cochlear implant settings.

By varying the amplitude, pulse width, and time parameters, we are able to achieve the simulation required for the electrical effects similar to a cochlear implant. There was a decrease in hair cell count in the explants exposed to higher duration of stimulation. In vivo testing revealed the possibility of testing the effects of changing various stimulation parameters on hair cell survival. We also observed that electrical stimulation induces greater oxidative stress in the cochlea of animals subjected to stimulation compared to implanted unstimulated animals. Experiments are in progress where we are determining the effects of drugs to prevent the auditory damage as well as the generation of oxidative stress in response to electrical stimulation.

Conclusions: In summary, the electrical stimulator developed in this study can be used to understand the effect of electrical field on inner ear sensory cells. The models developed in this study using electrical stimulation can be used as a powerful tool to screen future otoprotective drugs for the preservation of residual hearing post-cochlear implantation.

Intra-cochlear trauma-bone and tissue formation-importance of atraumatic electrodes

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Objective: To evaluate the histopathology of human temporal bones with a history of cochlear implant to determine the localization of fibrosis and damage to cochlea.

Background: This study addresses the histopathological findings of cochlear implantation in order to better guide the design of electrodes for cochlear implant and surgical approaches.

Material and methods: Sixty celloidin embedded archival human temporal bone pairs from patients with unilateral cochlear implants were studied to understand the mechanism of cochlear damage following surgery and long-term implantation. The histopathological findings were compared between the implanted side and the contralateral unimplanted side.

Results : The insertion of a cochlear implant electrode through the round window approach was associated with a significantly lesser degree of fibrosis compared with cochleostomy insertion. The temporal bone surrounding perilymphatic and endolymphatic compartments contained fibrous tissue that was in some cases, localized, and in other cases, widespread and ossified in proximity to the cochleostomy. There was fibrosis in areas where the electrodes encountered the anterior bend of the first cochlear segment and this was commonly present. Overall, the anatomy of the apical turns were better spared compared to the other areas. None of the specimen where the straight electrode was inserted through the round window demonstrated translocation. Seven temporal bones demonstrated erosive changes of the lateral wall consistent with secondary degeneration due to long term use of the electrode.

Conclusion: The temporal bone histopathology findings implicate that the round window electrode insertion method is preferred over cochleostomy due to the apparent inciting of fibrosis and in severe cases, ossification near the cochleostomy site. In addition, the findings implicate that the midscala electrode design is recommended to avoid secondary changes to the lateral wall for long term use.

Percutaneous bone conduction Implants

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Background: Bone anchored earing devices have developed over the years and today more than 250 000 persons in the world benefit from these devices. A review of the development will be given.

Recent studies show a greater impact on hearing, learning and in social life than earlier recognized when suffering from single sided ear canal atresia especially during development. Persons with single sided conductive hearing loss have earlier not been habilitated.

Objective: Central hearing pathways in humans and in an animal model with single sided conductive hearing loss due to ear canal closure has been studied.

Material and Methods: Children and adults with single sided conductive loss due to ear canal atresia have been tested using functional Magnetic Resonance Imaging and Diffusion Weighted Imaging. An experimental model has been established in Sprague Dawley rats where one ear canal was sutured and closed at birth to mirror the human congenital malformation of ear canal atresia. MRI testing were performed at 1,3,6 and 12 months of age.

Results: White tissue in the human brain is statistically shown to be thinner on the affected side. Software developed for human data could be transformed and used on images of rats. The developed method handles formatting issues, artefact corrections, diffusion metrics calculations and statistical group comparisons of magnetic resonance diffusion weighted images. Three month old rat brains have been investigated and found to have special patterns and connection between the central hearing nuclei.

Conclusion: Investigation with MRI has made it possible to map regions of interest in humans and to find connectivity between different hearing nuclei in the brain in a rat model with single sided ear canal closure.

Main Sessions

MS 02: Bilateral Pediatric Cochlear Implantation

BalanCI: head referenced cochlear implant stimulation improves balance in children with bilateral cochleovestibular loss

Cushing S.L.[1,2,3], Wolter N.E.[1], Gordon K.A.[1,2,3,4], Campos J.[6,7], Vilchez Madrigal L.[1], Pothier D.D.[8], Hughes C.O.[8], Papsin B.C.[1,2,3]

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Objectives:

1) To determine the impact of a head referenced cochlear implant stimulation system BalanCI on balance in children with bilateral cochleovestibular loss (BCVL) in a simulated "real world" environment using the balance subset of the Bruininks-Oseretsky Test of Motor Proficiency 2 (BOT-2).

2) To examine the impact of BalanCI on postural control in children with BCVL using the Wii Balance Board a validated clinical measure postural control.

Study design:Prospective, blinded case-control study

Setting: Balance testing occurred in two settings: a quiet clinical setting and an immersive virtual environment at the Challenging Environmental Assessment Laboratory in the Toronto Rehabilitation Institute's iDAPT Centre.

Patients: Balance was assessed in 16 patients with bilateral cochlear implants and total bilateral vestibular loss. Patients with neuromotor, cognitive, or visual deficits that would prevent them from performing the tests were excluded from participating.

Interventions: Children wore the BalanCI system which is a head mounted device to restore head-referenced spatial information.

Main outcome measures: Postural control measured by center of pressure (COP) and balance measured by the BOT2.

Results: In the virtual environment, children demonstrated better balance when using BalanCI as measured by an improvement in BOT-2 scores. Similarly, in a quiet clinical setting, the use of BalanCI led to better postural control as demonstrated by a significant reductions in COP root mean square (RMS) and velocity. The number of falls was significantly reduced with the use of BalanCI.

Conclusions: BalanCI is a simple and effective means of improving postural control and balance in children with congenital bilateral vestibular loss and bilateral cochlear implants. Use of this device could potentially improve the safety of these children and allow them to take part in more complex balance tasks where sensory information may be limited.

What is the sensitive period to initiate auditory stimulation for the second ear in sequential cochlear implantation?

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Objectives: Bilateral cochlear implants (CI) are the standard treatment for bilaterally deaf children, but it is unclear how much the second CI can be delayed in sequential bilateral CI. We investigated the performances of sequential CI to answer this question.

Study Design: Retrospective case series review.

Setting: Tertiary referral center.

Methods: We studied a cohort of congenitally deaf children (n = 73) who underwent sequential CI without any inner ear anomaly or combined disabilities. Hearing threshold levels and speech perception were evaluated by aided pure tone audiometry and Asan-Samsung Korean word recognition test. The scores were analyzed by the ages at surgery and compared among the different age groups.

Results: When the second CI was performed before 3.5 years (the optimal period for the first CI), the second CI scores (96.9%) were comparable to the first CI scores. Although the first CI scores were ≥80% when the first CI was implanted before the age of 7 years, the second CI scores were ≥80% when the second CI was implanted before the age of 12-13 years. The hearing threshold levels were not different regardless of the ages and between the first and second CIs.

Conclusion: Our cohort demonstrated that the second CI showed comparable results to the first CI when implanted before 3.5 years, suggesting that optimal periods for the first CI and the second CI are same. However, the sensitive period (12-13 years) for the second CI with good scores (≥80%) was much longer than that (7 years) of the first CI, suggesting that the first CI

prolongs the sensitive period for the second CI. The second CI should be implanted early, but considered even at a later age.

MS 03: Advancing Molecular Therapeutics in the Inner Ear

Challenges in molecular therapeutics for autosomal dominant disorders / gain-of-function disorders

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Hearing loss has a significant impact on quality of life, cognition and society in general, affecting 360 million people worldwide. As a model for late-onset sensorineural hearing loss (SNHL), we will discuss DFNA9 (DeaFNess Autosomal 9), an autosomal dominant disorder that leads to late-onset (3th-5th decade) progressive SNHL and deafness. The age of hearing loss onset varies depending on the mutation though the average onset age lies around 3rd-5th decade. It typically starts as downsloping of the audiogram at the age of onset and evolution towards deafness and vestibular failure.

DFNA9 is caused by heterozygote mutations in the COCH gene (Coagulation Factor C Homology), which is located on chromosome 14q12-13 and encoding a 550 amino acid protein, cochlin. Over twenty different mutations have been identified in several regions, including North America, Japan, Australia, Korea, China and Belgium/Netherlands. Currently, no treatment is available to prevent hearing loss or balance loss in DFNA9 patients.

Local gene therapy to restore hearing or prevent hearing loss has been studied in neonatal mouse models for several years. Currently, a clinical study is ongoing in adult patients with profound hearing loss to restore hair cells by injecting virus-based vectors -carrying correcting genetic information- directly into the inner ear, while local gene therapy has reached the clinical setting in disorders of the retina (eye) for blindness.

DFNA9 has a unique potential because it involves an increasing number of patients that are aware of their family history and can ask for routine genetic evaluation in the pre-symptomatic stage. In the case of DFNA9, therapeutic strategies to correct genetic information may prevent or slow down the pathophysiologal process. Challenges that will need to be addressed in a preclinical stage will be discussed.

MS 04: Cost-efficacy in Auditory Implants

CI candidacy and coverage disparities in US health insurance

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Objectives: Health insurance for cochlear implantation in the US is covered by a range of options. Type of health insurance citizens have varies by age, work status, and family income. The four main types of health insurance coverage are private employer plans held by a working adult family members, Medicare (for people 65 and older), Medicaid (for those whose income is insufficient to pay for healthcare), and military (for veterans or active duty military families). The Affordable Care Act (ACA) marketplace (known as Obama Care) was initiated in 2010 and enrolled 8.8 million Americans in 2018. How does insurance type affect access?

Methods: Data was collected on individuals covered by each insurance type, utilization, and barriers. Most CI surgeries are covered by private employer plans followed by Medicaid, Medicare, military related, and ACA. Programs were queried about challenges faced in providing services to low income families under Medicaid. BarrAlso evaluated was degree to which adults covered by private insurance, Medicare, or VA experience barriers. The impacts of governmental policies was evaluated.

Results: Based on the survey of 33 cochlear implant centers, 58% of pediatric surgeries and 20% of adult surgeries were covered by Medicaid-the program for low income Americans. Adult coverage under Medicaid is relatively low though is the most common form of insurance for children at many centers. Employer plans were utilized by most adults. The Veterans Administration appears to be the most restrictive with only 477 Ci surgeries in 2016, or 1/10 of 1% of the estimated number of veterans who could benefit from a CI.

Lean thinking for intraoperative surgical management and the use of the intra operative remote assistant (Cochlear CR220)

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Introduction: Up until 2009 in the UK, all CI surgery was unilaterally performed bar bilateral for meningitis or dual sensory impairment. Since then, NICE approved bilateral simultaneous surgery for children. National audit of approximately 1000 consecutive paediatric cases in 2011 showed no additional risk of complication with simultaneous surgery compared with sequential or unilateral procedures. With increasing workload, practices were reviewed to improve efficiency and identify potential costs savings.

Methodology: Surgical practice was reviewed as to how some units managed with simultaneous surgeries. In our practice audiological scientists perform intra-operative telemetry and reflex thresholds. This would typically involve the scientist visiting the operation room for each CI surgery. Forty children (simultaneous) and 65 adults (unilateral) were performed at YAIS in 2016/17

Results: The theatre board approved that the same drill and surgical tray could be used for bilateral surgeries. Nearly £500 per simultaneous surgery could be saved by not duplicating trays and disposables. To improve efficiency of audiological support a simple telephone contact and a 'remote me access' to the programming computer in theatre worked well but still involved audiological expertise. With the introduction of the Wireless Intraoperative Remote Assistant, Cochlear Nucleus CR220, this has freed up the audiologist from the operating theatre and they can now see extra patients. For single sided surgery, downtime and two visits would be a saving of approximately £45 and for bilateral simultaneous £100

With a work load of 40 children, the equipment savings are over £25K. Taking into account audiological savings through the use of the CR220 for both children and adults this equates to nearly £10K of additional savings.

Conclusion: Simultaneous surgery continuing with the same surgical equipment is safe and cost effective. The CR220 produces significant savings and releases the audiologist to see more patients.

Conclusions: A range of patterns exist on Medicaid coverage for children. Major areas of difference include policies on bilateral CI, processor replacements, habilitation, and candidacy. Reimbursement amounts by Medicaid vary. Veterans programs appear to be the most limited, apparently as a consequence of restrictive candidacy evaluations.

MS 05: CI in Otosclerosis and Postmeningitic Ossified Cochlea

Our experience in management of cochlea basal turn ossification

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In far the most cases spiral canal ossification primarily affects the descending part of the basal turn. In this paper the method of atraumatic drilling of the ossified spiral canal is proposed.

In the experimental procedure on 25 cadaveric temporal bones we revealed that the distance between round window membrane and basal turn curvature equals 8.0 mm; the width of labyrinthine capsule which borders spiral canal and internal auditory canal amounts to 0.36 mm and its width between spiral canal and internal carotid artery accounts for 0.77 mm.

The original method, which is based on atraumatic drilling out of the ossification, was put forward. The drilling starts from the ossified round window membrane and proceeds till the basal turn curvature. Notable color difference between otic capsule and ossified tissue is observed: labyrinth capsule tends to look greyish and ossified tissue – whitish. This enables gradual drilling out of the ossification along the descending part of the cochlea basal turn and preservation of modiolus. Taking into consideration close adjacency of the internal auditory canal and internal carotid artery lateral basal turn wall should always be kept in mind the landmark.

The above-described surgical technique was applied in 62 patients with the ossification of the basal turn descending part. In 22 cases the length of the ossified spiral canal varied from 1 to 3 mm, in 40 patients it was in the interval of 4-6 mm and proceeded till the basal turn curvature.

In all the 62 patients the proposed method enabled adequate approach to the cochlea spiral canal and full CONCERTO (MED-EL, Innsbruck, Austria) standard electrode insertion. In these cases only straight rigid electrode can be used to make its way through the drilled out spiral canal lumen.

Postoperative audiological performance of the implanted patients correlated with the ones without ossification.

Cochlear implantation outcomes in cases of cochlear ossification

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Objective: To evaluate the results of cochlear implantation (CI) in cases of ossified cochlea

Patients and Methods: 25 patients with cochlear ossification underwent simultaneous bilateral CI. Bony occlusion spread to the ascending segment of the basal turn in 11 cases (unilateral). We performed an electrode insertion trough round window after gentle drilling ossification of the inferior segment of the basal turn in 39 cases. The superior cochleostoma was perform and the electrode was insert though the second turn in other 11 cases. Using the cochleariform process as a landmark, the second cochleostomy was perform 1 mm inward to the anterior margin of the oval window niche on the line proceeding from the pyramidal process parallel to the stapes crura. A remain electrodes placed in exposed basal turn after removal of the part promontory wall separating the basal and the second turn. The follow-up period varied from 6 months to 1 year

Results: Most electrodes has an impedance in the normal range. A postoperative CT scan showed in all cases. The

subjects' audiological performances correlated with those of cochlear implant users without cochlear ossification. No complications were reveal postoperatively.

Conclusion: Bilateral CI with using the described surgical tactic allows patients with ossified cochlea after meningitis to achieve high levels of audio-verbal assessment. The risk of total ossification of the cochlea and the ability to maximize the using of no ossified cochlea areas for auditory stimulation in the early period after meningitis justifies the indications for simultaneous bilateral cochlear implantation. Applying the described approach to the second cochlear turn in patients with cochlear ossification enables maximal spiral ganglion cell and modiolus preservation and full electrode insertion, and, therefore, improves postoperative auditory performance.

Cochlear implantation in cases of cochlear otosclerosis

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Federal Scientific and Clinical Center of Otorhinolaryngology, Moscow, Russia

Objective: to increase effectiveness of speech and hearing rehabilitation for patients with cochlear otosclerosis accompanied by profound hearing loss

Materials and methods: 12 patients with cochlea otosclerosis were diagnosed and underwent surgery.

Patients underwent cochlear implantation with insertion of straight electrode arrays. 8 patients from had undergone previous procedures of piston-type stapedoplasty, which caused profound hearing loss. During the pre-surgical examination of these patients were diagnosed enlargement of internal auditory canal and endolymphatic duct (according to CT-scan). Evaluation of audiological results was perform according to free-field speech audiometry in 3 months after surgery.

Results: Full insertion of electrode array through round window was performed in all cases. 50% threshold of speech discrimination was reached in all patients' cases using the intensity of sound 31,5 dB in average

Conclusion: Cochlear implantation performed in cases of cochlear otosclerosis provides good results of hearing and speech rehabilitation under the condition of minimal trauma of inner ear.

Labyrinthitis ossificans as it relates to cochlear implantation

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Introduction: Labyrinthitis ossificans may add to the difficulty of cochlear implantation by rendering electrode insertion difficult. The etiology encompasses various pathological conditions including infection, vascular compromise, temporal bone trauma, autoimmune inner ear disease, otosclerosis, leukemia, and tumors of the temporal bone. In all cases, the pathology virtually results in profound sensorineural hearing loss, making cochlear implantation an important treatment option.

Objective: Based on histopathological observations, the chronological pattern of intracochlear ossification is speculated, and the pathogenesis discussed.

Results: The surgical significance of chronological evolution and distribution of intracochlear ossification helps to plan ahead the choice of a suitable electrode type and length and the approach to place the cochleostomy opening.

Some surgical tips related to cochlear implant surgery in the ossified cochlea are explained.

MS 06: CI by Telemedicine

Scaling up telemedicine for adults with cochlear implants

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Objectives:

1. Roll out telemedicine tools to adults using any cochlear implant device in the UK

2. Commission a formal evaluation to establish whether the new care model improves:
- patient empowerment
- equity of access
- patient and staff experience
- clinic efficiency

Methods We will introduce a remote care pathway choice to adults using cochlear implants in participating centres in the UK. Benefits will be available to users of any device. This is a complex intervention comprising four components successfully trialled together previously:
- personalised responsive web app (hearing rehabilitation, music, advice, troubleshooting, training, ordering spares, goal setting, questionnaires, reminders, monitoring of implant site photos)
- home hearing test
- self device adjustment at home (with appropriate device)
- upgrading of sound processors at home

Clinicians will access an online dashboard to monitor their patients, and will receive alerts if patients are not interacting with the tools or other indicators are achieved.

Conclusions : We previously completed an RCT of remote care tools. We examined patient preference using conjoint analysis; the main outcome evaluated was patient empowerment. The remote care group had a significant increase in empowerment after using the telemedicine tools. Their hearing improved, suggesting better ability to take action to keep hearing stable. Patients and clinicians were very positive about remote care and wanted to continue. We need high quality evidence that a remote care pathway delivers our aims. An independent evaluation will be done to establish if the new care model improves:
1. patients' confidence to self-manage
2. stability of hearing as a result of self-initiated monitoring and action
3. equity of access to follow-up care
4. patients' experience of care
5. staff experience
6. use of resources

Longitudinal use of telepractice as a model of clinical service delivery: factors impacting sustainability

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Introduction : Longitudinal use of telepractice as a model for service delivery is reliant on integration of new technologies and practices whilst adhering to basic principles underpinning quality standards of care. This paper will focus on innovations that have made the longevity of the telepractice model possible for all aspects of CI management, with particular focus on an APP that has been designed and verified for use in measuring speech discrimination in enabling self efficacy of clients with ongoing evaluation and monitoring of performance.

Method: A model to evaluate effectiveness and efficiencies of telepractice in clinical service delivery was used to evaluate evaluation, mapping and rehabilitation of CI recipients using telepractice. Clients, clinicians and facilitators in the telepractice process completed survey's questionnaires and outcomes measured to provide this information.

Results :Effectiveness of speech discrimination measures were not impacted by the service model. This is consistent with longitudinal findings from the implementation of telepractice in other aspects of cochlear implant management including counselling, device mapping, and rehabilitation. Efficiencies in timeliness of service and reductions in travel time were reported.

Satisfaction ratings revealed that most of the clients felt more integrated into their device management and reported a deeper understanding of their technology and the processes involved.

Conclusion : Longitudinal implementation of telepractice model must readily adapt to new technologies and the evolving landscape within the field of CI. Evidence is required to ensure that any changes to the model are efficient and effective. Telepractice models will continue to evolve for all aspects of management for CI and can provide a service delivery model that can benefit a range of clients.

Geographically distributed cochlear implant centre model to improve access, patient experience, and program viability

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Objective: To determine whether distributing assessment and programming to community audiologists would improve access for cochlear implants with equivalent outcomes and patient experience measurements.

Materials/Methods: In 2002, we started the Alaska CI Network to extend care to patients without the need for repetitive travel to Seattle (4 hours by plane). ACIN, with over 250 patients implanted, activates 25 new patients per year. In 2015, using the principles of ACIN, The Puget Sound CI Network (PSCIN) was founded. Community-based audiologists determine candidacy then refer to an experienced CI surgeon for implantation. Programming and long-term care returns to the regional audiologist. Patients journey to Seattle only for surgery. Working with industry input and automated CI programming tools, local audiology centres assumed the CI care spectrum progressively at a pace consistent with their confidence level. They together developed standard protocols for pre and post-implant assessment and programming. Network members meet monthly by on-line video-conferencing to discuss difficult cases. Tele-medicine and internet-based support is available as needed in difficult cases. Standard quality metrics and patient satisfaction data have been compared to other industry data.

Results: Clinical outcomes mirror those at our tertiary CI centre while patient experience is superior in the local settings. Patients cite easy access to their local audiologist and less travel as the main drivers of their increased satisfaction. With this shared-risk model for the cost of care each regional centre remains viable. Increased numbers of patients are now being implanted in the geographic regions with satellite programs in place.

Conclusion: We believe this model further extends CI care to local communities and has the potential to increase market penetration in other parts of the world.

The role of web-based implant platform in raising of the implantee`s quality of life

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Aim: to maintain a reliable and permanently accessible platform for providing and exchanging information from well-educated implantees, minor family members and professional from an implantation team to the implantees or candidates.Peer-to-peer and peer-to-pro contact raise the accessibleness of the key-level information by reducing the level of possible inaccuracies of various type of hearing rehabilitation.Materials: The study included 137 implantees, parents of the minors, as well as the members of the implantation team who were contacted for specific questions, in order to reach an answer.Regular contributors, implanted with cochlear or bone-conduction implants, participated.Provided information was broadened and structured by a cochlear implantee with an engineering background who provide advice in the area of the implant connectivity with various devices, e.g. multimedia up to amplified stethoscopes.We have also examined a small, but significant part of the implant community who work in the healthcare field specifically precluded and discriminated to pursue a further career.The collecting method was specifically designed questionnaire where participants were examined in general and focused categories.Results: Of 113 implantees or candidates, the great majority marked the key idea of the platform with highest grades (89%) in the area of accessibility with the members of the implant team (93%), experienced peers (91%) or parents of the implanted children (78%).A share of the novel practices (78%), providing the connectivity tips&tricks (94%), general support and professional instructions regarding the overall rehabilitation outcomes (96%).Conclusions: Nowadays, amount of the accessible information shared through the Internet is unbounded.Well-informed candidates for a hearing implant has scored and greeted a type of the platform which would be consisted of diversified members of a community in order to provide interdisciplinary knowledge with a specific accent.

Is there a future for self-assessment and self-fitting?

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Objectives: To explore the feasibility of autonomous CI fitting by CI recipients

Material and Methods: in the context of our target-driven computer-assisted CI fitting, we have developed (1) self-tests for the audiological assessment of a CI recipient, (2) a wired/wireless connection between the computer and the CP900/CP1000 processor (Cochlear) for administering calibrated sounds in fully controlled conditions and (3) FOX, a decision support application to analyze the results and propose MAP-changes. A feasibility study has been set up to have 6 CI recipients undergo the second fitting session after surgery in their home town by means of a ‚simulated' self-fitting procedure. The term ‚simulated' is used because this session was held in a hospital under remote supervision of our audiologists.

Results: Pure tone audiometry and a spectral discrimination test were developed as self-tests and administered to CP900/CP1000 processors through the Coala-Link. The working principles will be explained. Two weeks after switching on the processor, these self-tests are executed, and FOX is requested to recommend a MAP change. The audiologist judges the new MAP remotely and decides whether it can be written to the processor. By the time of the presentation, three cases will have been enrolled in the feasibility study.

Conclusion: methods are being developed to allow audiological self-assessment and autonomous computer-assisted CI fitting. The introduction of such methods requires a stepwise approach to understand which CI recipients are capable of mastering the procedure and to assure the validity and equality with manual procedures by competent audiologists.

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MS 08: Cochlear Implant Criteria Revisited

Evidence-based inclusion criteria for cochlear implantation in patients with post-lingual deafness

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Background: This study determined the relationship between pre-operative phoneme and word scores and the gain in speech perception after cochlear implantation in a large cohort of patients. We aimed to define evidence-based selection criteria for cochlear implantations in adults with post-lingual deafness.

Methods: This retrospective study included 364 adults with post-lingual deafness that received a cochlear implant between 2000 and 2013 at the Leiden University Medical Center. The gain in speech perception observed post-implantation was compared to pre-operative aided/binaural speech perception scores, measured at 65 dB SPL in quiet. Patients that showed pre-operative phoneme scores on monosyllabic words above 50 percent were also tested for

speech perception in the presence of speech-shaped background noise, at a +5 dB signal to noise ratio.

Results: Speech perception in quiet improved after implantation in all except 7 patients. Average scores in quiet continued to improve, up to approximately one year after implantation. When participants were divided into 5 groups, based on pre-operative speech perception scores, all groups showed gains in speech perception, except for the group with aided pre-operative phoneme scores above 80 percent. However, all patients that were tested pre-operatively with the addition of background noise showed improvements in speech perception in noise after the cochlear implantation.

Conclusion: Although the decision to implant should consider individual ear differences and other factors that might apply to a particular case, based on our data, all patients with pre-operative scores of either 80 percent (phonemes correct) or 60 percent (words correct) and lower in an optimal-aided situation are potential candidates for a cochlear implant, provided that their pre-operative speech perception score decreases below 50 percent (phonemes correct) or 20 percent (words correct), when background noise is added at a +5 dB signal-to-noise ratio.

Better cochlear implant outcomes in severe hearing loss compared with profound hearing loss: we shouldn't wait

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Objectives: The aim of the study was to compare the speech perception outcomes for patients with preoperative severe compared with profound hearing loss range.

Method: The Sydney Cochlear Implant Centre data base was searched (years 2009- 2016) for patients with pre-operative 4 frequency pure tone average- profound hearing loss (90dBHL+) and severe hearing loss (70-89dBHL). Patients with congenital deafness were included who had worn hearing aids since childhood. Outcomes were measures with CUNY sentences and CNC/CVC word scores preoperatively, at 3, 6 and 12 months postoperatively. Mann Whitney U test was performed to compare outcomes of the two groups.

Results: There was a significant difference in speech perception for CUNY sentences between the severe and profound groups with better speech perception in the severe group preoperatively ($p<0.001$), at 6 months ($p<0.001$), and at 12 months ($p<0.01$) At 3 months there was no significant difference. Numbers in each group at the different time points ranged from 92 - 367 patients.

For CUNY matched patient outcomes (severe n=50, profound n=98) more than 97% of patients had improved outcomes, with a few poorer performers having identifiable reasons.

There was a significant difference in speech perception for CNC/CVC word scores between the severe and profound groups with better speech perception in the severe group preoperatively ($p<0.001$), 6 months ($p<0.001$), and 12 months ($p<0.001$). At 3 months there was no significant difference. Numbers in each group at the different time points ranged from 52 - 216 patients.

For CNC matched patient outcomes (severe n=28 and profound n= 46) more than 95% of patients improved, with the few poorer performers having identifiable reasons.

Conclusion: Patients with severe hearing loss have significantly improved outcomes compared with patients with profound hearing loss. It is reassuring for patients that virtually all patients improved on their preoperative scores.

Our experience with cochlear implantation in post-lingually deafened adults who exceed current candidacy criteria

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Objective: Traditional cochlear implantation (CI) candidacy criteria has excluded a significant number of patients who are deriving minimal benefit from their hearing aid. Our objective is to quantify the hearing outcomes and improvement in quality of life (QOL) of post-lingually deafened adults who underwent CI despite exceeding current criteria.

Study Design: Retrospective case series in a tertiary, academic centre.

Methods: Subjects were identified through a search of our prospectively maintained cochlear implant database. All post-lingually deafened adults who were implanted in the year 2014 to 2016, and had a pre-implantation HINT score of 60% of greater in best-aided conditions were enrolled in our study. Speech recognition scores were repeated 1 year after implantation. In addition, health-related QOL was measured using standardized questionnaires (HHQ and HUI3) preoperatively and at 1 year post-implantation. This data was collected and analyzed.

Results: 116 patients were included in our study. There were 56 females and 60 males, with an average age of 61.2 years. Their monosyllabic word, HINT, and AzBio sentence recognition scores demonstrated a significant improvement (all $p<0.05$). The improvement in their hearing-related and overall QOL was also significant.

Conclusion: Our results suggest that patients who exceed current CI candidacy criteria do derive significant benefit from CI. As such, it would be timely to redefine these criteria.

Expanding cochlear implantation criteria for adults with bilateral acquired severe sensorineural hearing loss?

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[3] University Hospital of Ghent, department of Otorhinolaryngology, Head and Neck Surgery, Belgium Objectives: In the Netherlands, a relatively broad inclusion criterion for CI is applied. Patients are considered for CI if the phoneme score, obtained with a well-fitted conventional hearing aid, is <70%. Other countries hold on to a more a conservative approach (e.g <30% phoneme scores in Belgium or an unaided hearing loss >90 dBHL at frequencies of 2 and 4 kHz in England, see the BCIG website).

Material and Methods: In this study, speech perception and quality of life were studied in a Dutch cohort of 164 CI users, divided in two subgroups; those fulfilling the conservative criteria (PTA3 >85dBHL and a phoneme score <30%, group A, n=112) and those with a broader inclusion criterion (PTA3 <70dBHL and a phoneme score >30%; group B, n=52).

Results: The results showed a better phoneme score after one year CI use in the expanded criteria group B compared to the more conservative group A (84% versus 79% respectively; $p<0.05$). Concerning Quality of life (NCIQ), similar benefit was found regarding psychosocial wellbeing, irrespective of group.

Conclusion: We concluded that CI candidates satisfying the group B inclusion criteria might have better speech recognition and similar improvement in quality of life with a CI than group A CI users.

Changing indications for cochlear implants in the United Kingdom

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Objectives: Guidelines for cochlear implant (CI) criteria in the UK are derived by the National Institute of Health and Care Excellence (NICE). The current criteria are some of the strictest in the world and are based on data published in 2004. The British CI Group established a working group on candidacy to review and develop evidence to inform recommendations for changes in candidacy. Current speech perception candidacy threshold is a score <50% on the BKB sentences presented in quiet (70 dBSPL). A National Service Evaluation on speech perception criteria for adult candidates was conducted to determine the most appropriate speech perception measure and cut-off scores for CI indications in adults.

Methods: Speech perception data were prospectively collected from pre-implant to 12 months post-implant from adult recipients. Ten UK CI programmes participated. BKBs in quiet, and in noise, and monosyllable tests (AB words) scored by phoneme and word were used. Cut-off scores were calculated as the pre-operative score corresponding to a 4:1 odds of achieving a higher score post-operatively.

Results and conclusions: Complete data was available for 118 patients on BKBs in quiet, 93 patients on BKBs in noise, 100 patients on AB phonemes and 70 patients on AB words. All measures were sensitive to change, and performance had improved since the 2004 analysis. The BKB test in quiet was prone to ceiling effects. Cut-off scores corresponding to odds of 4:1 were 62% and 50% for the BKB tests in quiet and noise, and 49% and 20% for the AB phonemes and AB words, respectively. Preliminary analyses suggest that the AB word test scored by phoneme is the most appropriate measure to use. Further analyses of the data will be conducted. Recommendations to NICE for expansion in CI indications will be outlined.

MS 09: Experiences with CI Re-Implantation

Surgical finding for re-implanted cochlear implant pediatric patients

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Objective : To have a correlation between the surgical findings before and during explantation of cochlear implant and the root cause of the implants failure. Methods: 5 cochlear implanted patients all with MED-EL implants (Synchrony, Concerto) were included in this study .Their ages between (4 – 7 years) and all were implanted between the years 2013 and 2017. Their surgical data for the first implant were collected and the patients feedback after implant failure and compared to each other and compared to their investigation reports from the manufacturer. Results: There is a direct correlation between the distance from the mastoid side of the implant and the edge of the mastoidectomy and the risk of having an implant failure with any trauma. Also a correlation between the positions of the implant housing and the risk of having an electrode fatigue by time which leads to implant failure. Conclusion : The surgical factor is an important factor for implant reliability as it is directly affect the implant functionality which includes the position of the implant housing and a prober implant bed and electrode channel.

An expanded classification approach for revision cochlear implant surgery: rates and speech perception outcomes

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Objectives: With the continuous increase in the number of cochlear implant (CI) recipients, together with the increase in life expectancy, the prevalence of revision cochlear implant (RCI) surgery is growing. The goals of the current study were threefold: 1) to examine RCI indications using a new approach for classification; 2) to quantify RCI rates in the Sheba Medical Center; 3) to test the effect of RCI on speech perception performance outcomes by means of a within-subject analysis.

Materials and methods: Analyses of data extracted from the medical records of all patients that underwent RCIs, since the initiation of the Sheba CI program in 1989, through 2016. Data included background variables, surgical reports, medical follow-up, and audiological evaluations.

Results: During the study period, 1,297 CI surgeries in 889 patients were performed (65% children, 35% adults). Of these, 150 surgeries (11.6%) in 134 patients (78% children, 22% adults) were RCI. The indications for RCI were classified into the four traditional categories – device failure (41% soft, 24% hard), medical (7%), and surgical (6%), with the addition of two new categories – pain (12%) and trauma (9%). Group mean speech perception performance was similar before and after RCI for open set monosyllabic words, phonemes, and SRTs. Within-subject analysis of 117 patients with full datasets revealed that post RCI speech perception performance was unchanged in 67.5%, improved in 17%, and deteriorated in 15.5% of patients, based on a clinically significant change criterion.

Conclusions: The Sheba RCI rate is similar to previously reported rates. As pain and trauma amounted to 21% of RCI indications, we suggest an expanded classification approach including these two distinct categories. Detailed within-subject comparisons and use of clinically-based criteria indicated that speech perception performance was unchanged or improved in the majority of cases.

Cochlear reimplantation: evaluation of implant failure and postoperative speech perception

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Introduction: Cochlear implantation is a surgical treatment for patients with severe-to-profound sensorineural hearing loss. In the course of time, eventually explantation and reimplantation will be an issue in our patients for various reasons. The implant may fail to function (hard failure), or needs to be removed because for example medical problems (e.g. wound infections). Frequently, patients will be reimplanted with a technically superior device.

Materials and methods: In this study, we reviewed the rate of explantation and reimplantation in two cohorts of consecutively implanted children and adults. One cohort (Radboudumc, Nijmegen) consisted of 1800 patients, implanted between 1987 and 2017. In this cohort, there were 56 reimplantations (3.1%). In the second cohort (St. Augustinus hospital Wilrijk), consisting of 771patients implanted between 1987 and 2017, there were 21 re-implantations (2.7%).

The evaluated data were: demographic information, type of implant (old and new), reason for explantation, type of implant failure (soft versus hard failure), speech coding strategy before and after explantation and audiometric results (speech recognition measured with NVA phoneme scores).

Results: Reimplantation was feasible in all subjects. Speech recognition scores after reimplantation were comparable to the highest speech recognition scores assessed with the previous cochlear implant. If implant type and speech strategy did not change (N=27), the mean phoneme scores improved with 9.6% (SD=19.8%). In case of a reimplantation with a technically improved type of cochlear implant (N=23), the mean phoneme improvement was 8.6% (SD=16.9%). In case the reimplantation implied both a technically improved cochlear implant type and speech coding strategy (N=9), the mean phoneme improvement was 15.2% (SD=20.2%) Because of the large variations, these differences were not significant (p=0.086).

Conclusion: Cochlear reimplantation is surgically feasible on the short as well as on the long term after explantation of a previous device. Devices upgrade, technically and/or in speech coding strategy, showed a positive trend towards improved speech recognition scores.

Outcomes of cochlear reimplantation in children

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Objective: To determine the indications for, and auditory outcomes, following cochlear reimplantation (CIri) in children and investigate factors influencing outcome.

Methods: Retrospective case series.Patients: 36 children (42 ears).

Main Outcome Measure: Pre- and post-reimplantation aided thresholds (AT).

Results: Device failure was the most common indication. 4/36 had 2 re-implants and 1/36 had 3 re-implants. Best AT levels improved by 10.9% (p = 0.102) after reimplantation (n = 21). Improvement seen in 13/21 (61.9%) cases and either declined (19%) or stayed the same (19%) in the remaining eight. Mean time to CIri was 2.3 years. Factors influencing outcome included difficulty of insertion at surgery and the use of certain device models.

Conclusion: It is inevitable that as lifespan increases children will need at least one CIri. CIri does not adversely affect auditory outcomes in the majority of cases. Imperative that surgical technique modification ('hearing preservation') used in all cases to facilitate easy replacement, irrespective of initial hearing status.

Revision surgery in cochlear implants – Indication, performance and surgical challenges

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Introduction: Due to the extension of indication range for the use of cochlear implants (CIs) and the growing number of patients using these devices over the last 30 years, the demand for revision surgery will increase in the future. Possible reasons for revision surgery after a successful use of CI technology may be device failures (hard and soft failures) medical reasons and poor performance. Especially patients with poor speech perception using older devices question if a technical upgrade may improve their performance and quality of sound perception or if another trauma to the cochlea during reopening will harm more than improve. There are many questions still in need to be answered regarding this topic, especially surgical complications after CI revision surgery and the risk of incomplete electrode insertion are discussed in the literature.

Methods: To analyse our experience and outcome after CI revision surgery, we reviewed more than 1300 CI operations we performed in our centre and identified almost 100 cases of revision surgery. We will present and discuss reasons for revision surgery in our patients as well as intraoperative findings and the postoperative outcome in these patients.

Results & Conclusion: Our patient cohort which received revision surgery is widely heterogenous regarding the indication for performing revision surgery, but the number of patients who used implants for more than 10 years happily and who are affected by technical failure is increasing. Despite surgical challenges, speech perception improves in almost all cases significantly.

In summary, revision CI surgery is a safe and effective surgery in most patients. The best choice of electrodes in these cases (e.g. shorter and thinner to avoid an incomplete insertion vs. possible loss in performance) needs to be further analysed in multi-centre studies.

MS 10: ABI Application in NF2

Binaural benefit after sequential bilateral auditory brainstem implantation

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Objectives: Patients with neurofibromatosis type 2 (NF2) considered for auditory brainstem implantation usually have bilateral vestibular schwannoma, which often results in deafness.

Most of these patients receive one auditory implant system (ABI) and obtain various levels of functional benefit. The study objective is to present the binaural benefit in the case of bilateral ABI patient.

Material and method: In 2006, after surgical removal of the tumour on the right side, 27-year-old man with NF2 was implanted with C40+ ABI system, manufactured by Med-El, Innsbruck, Austria. The vestibular schwannoma on the left side was removed and the second C40+ was implanted on March 28, 2008. Three binaural effects – redundancy, head shadow, and squelch – were evaluated with a monosyllabic word test and various spatial arrangements of loudspeakers for presenting the words with competing noise after long term experience with ABI. Moreover localisation test was performed

Results and Concusions: The benefit of cochlear implantation was 5 % for redundancy, 20% for head shadow, 20% for squelch. Localisation errors on the right side, the left side and bilaterally were 41°, 46° and 27°.

Results of the current study demonstrated that bilateral electrical stimulation from ABIs can provide some binaural benefit. Further prospective studies are needed to confirm this case observation.

Cochlear implants in patients with neurofibromatosis type 2

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Objective: To investigate cochlear implantation performance in patients with neurofibromatosis type 2 (NF2).

Methods: Medical records of patients with NF2 treated with cochlear implantation (CI) by the same medical team at out center between 2012 and 2016 were retrospectively reviewed. Treatment strategies, pre-operative hearing status, electric promontory stimulation (EPS), and auditory performances after CI were evaluated.

Results: Twelve patients were included. Seven patients had surgical tumor removal prior to CI. 4 of them were implanted simultaneously with tumor removal and 3 were implanted after the failure of hearing preservation surgery. Five patients were implanted with tumor in situ, 2 of them received gamma knife prior to CI, and 3 were implanted without any treatment. 10 of the 12 patients obtain pleasing speech recognition; the effective rate was 83%. One patient whose EPS was negative and another patient who had good contralateral hearing got limited benefits. The mean pure tone audiometry (PTA) with CI was 44dB (range 25-80dB). The mean sentence speech discrimination score in quiet without lip-reading was 62% (range 0-97%).

Conclusion: Cochlear implantation is an effective option and should be considered primarily in auditory rehabilitation for NF2 patients with intact cochlear nerve. EPS might be a predictor for CI performance. Simultaneous implantation could avoid cochlear ossification that decreases the effect. Good contralateral hearing may also decrease the performance.

MS 11: School Performance in CI Population

School attainments of cochlear implant users evaluated at the end of primary education – The role of implantation age

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Objectives: The aim of the study was to investigate the effect of the age at cochlear implantation at the school attainments of children with prelingual hearing loss – deafness and profound hearing loss as well as partial deafness evaluated at the end of primary school education.

Material and method: In to the study group were included 160 children with cochlear implants. From the study group had been excluded children with multiple disabilities.The measure adopted in this study for the evaluation of school achievements were the results of the standardized test carried out at the end of primary school education.

Results: For the needs of this study the material had been divided into 4 groups according to the age of a child at the moment of implantation: 1) 1.5 - 2.4 years, 2) 2.5 – 4.4 years, 3) 4.5 – 6.9 years and 4) 7 - 13.4 years. The analyses have shown the statistically significant effect of age at the moment of cochlear implantation on the overall score and on the score in the category reading. Post-hoc analysis has shown that children implanted between 1.5 and 2.4 years of age have obtained better overall scores and scores in the category reading compared to children who had been implanted at the age between 4.5 and 6.7 years. No differences between other groups had been observed.

Conclusions: The age at the moment of cochlear implantation has a significant influence on the level of school achievements at the end of primary school education. The positive effects of cochlear implantation up to the 2 years of age on the school attainments, which had been demonstrated substantiates the need of early medical intervention with cochlear implant in children with the prelingual profound hearing loss of total deafness. The children with partial deafness implanted after 7 years of age can obtain good academic results in spite of the relatively late implantation.

Multi-centre study investigating foreign language acquisition at school in children, adolescents and young adults with uni-or bilat-eral cochlear implants in the Swiss German population

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Objectives: This Multi Centre study is performed in order to evaluate foreign language acquisition at school in cochlear implant patients in the German speaking part of Switzerland.

Material and Methods: In October 2016, 125 CI patients (10-18 years) were registered in the na-tional CI Database. CI non-users and mentally retarded patients were excluded. Additional data (type of schooling, foreign language learning and bilingualism) were obtained with questionnaires. German-speaking children with foreign language tuition (English and/or French) in mainstream were enrolled for further testing (n=31). The normal-hearing control group consisted of matched-pairs.

Results: Hundred returned questionnaires were available for analysis. Forty-eight were in main-stream and 52% attained special schools. 88% of CI users attended foreign language tuition. The 12 CI users without foreign language learning were all enrolled in special schools. CI users with foreign language education had better German speech comprehension (89% vs. 51%; $p < 0.05$). Thirty-one patients were further tested. The 10 students in 6th grade had all reached the school norms in English reading and listening. For French, 3 out of 7 CI students (44%) reached the school norm for French reading and one (14%) in French listening. The normal hearing group had higher scores (83.6 vs. 76.4%) which was statistical significant for English reading. Those with bi-modal fitting also had higher test-scores (on average 84% vs. 71%; $p<0.05$).

Conclusion: Almost 90% of our CI children attain foreign language tuition. Those without foreign language learning were all in special schools. Overall, most of the tested patients reached the cur-rent school norm for English reading and listening, whereas the French school norms appeared to be more difficult to reach. A trend for better test scores was found in the normal hearing group. Also CI users with bimodal fitting seem to perform better than bilateral implantation.

Assessment of capability in children with a cochlear implant

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The main thesis of our study is that impairments such as deafness are morally relevant to the extent that they lead to deprivation of the freedom that people have to do or be what they have reason to value, or capability, as defined by the Noble prize laureate, Amartya Sen. Likewise, the impact of healthcare services such as cochlear implants (CI) and subsequent rehabilitation, should be inferred from the extent that they protect or restore capability of those affected. Although there is wide and increasing interest in the concept as a measure of well-being, its measurement is still considered a challenge. In this study, we developed a questionnaire attempting to assess the capabilities of deaf children with CI. The study group comprised 19 children with CI between 8 and 12 years old and their parents. A control group of 23 normal hearing children was recruited at primary schools. Results show that children with CI seem to be more disadvantaged in certain capability related areas than normal hearing children. This concerned areas of accessing information, communication, social participation, and participation in school.

Capability in those areas was not directly related to outcome measures such as speech perception and vocabulary. Low capabilities did occur in children with high auditory and language levels. More interesting, some children with poor auditory and language levels obtained high capability levels.

This study strengthens the notion that the capability approach is a useful perspective, with added value for well-being.

A bucket list full of challenges for deaf and hearing impaired teenagers

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Purpose of the study: "We will never be famous….Why??... Because do you know a single celebrity with a CI??' These are the kind of questions and concerns we hear from the deaf and hearing impaired teenagers who visit our centre.

These teen groups initiated a multidisciplinary team effort to create a resource that helps those deaf and hearing impaired teenagers to support their independence and help them feel more comfortable in the hearing society. The platform we're developing will allow them to share their

experiences and knowledge with peers, challenge them to step out of their comfort zone and help them believe in their own capabilities.

Materials and methods used: a group of therapists together with the teenagers made an inventory of what their thoughts, feelings, challenges, interests and needs are. We reached a group of 25 teenagers between 12 and 18 years old, all wearing either hearing aids or cochlear implants. Based on their feedback, we started to create together with the teens, a digital, easy accessible and age appropriate online platform.

Results: The resource responds to the teenagers' ever growing interest in social media and expanding digital world. There is space for tips and tricks, their own stories and stories of real successful role models, bucket lists, daily survival kits and advice.

Conclusion: This website can be a support for teenagers in their daily life, but can also give parents, therapists and even hearing peers a better insight in how to interact, coach and support these deaf and hearing impaired teenagers.

School performance of children with cochlear implants in mainstream education in Flanders

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Objectives: Although the majority of the early implanted CI children in Flanders are being educated in mainstream schools little is known about their school performance.

The aim of this study was to determine whether children, who were implanted before the age of 2, perform within the normal range of their hearing peers in their last year of elementary school and after transition into secondary schools.

Method: Nineteen early implanted CI students were included in this study, all of them enrolled in mainstream education. Their academic outcomes were obtained from two tests that are annually developed by the school groups (OVSG and IDP tests, last year of elementary school). Of the 19 CI students 10 IDP and 2 OVSG tests could be obtained.

Their performance in secondary schools was further analysed by documenting their school choice (ASO, TSO, BSO) and their subjective (LIFE-NL questionnaire; N = 19) and objective listening skills (realistic class-like speech audiometry, Sound-C; N = 15).

Results: Results show that the average academic outcomes of the CI students were within the normal range of NH students, except for one test, i.e. the listening test.

Correspondingly, CI students reported significantly more listening difficulties at school on the LIFE-NL (71,8±13,3 (NH) vs. 57,7±12,6% (CI)). Results on the Sound-C confirmed this difference with SRT scores of CI students representing only 5 to 61% (mean = 34,3±17,2%) of the average speech understanding of NH peers.

Conclusion: To our knowledge this is the first time that a group of early implanted children was examined on their school performance in Belgium and that the reported results fell within the normal range of NH peers.

Nevertheless, they do experience significantly more listening difficulties than their peers in mainstream education. Further research is necessary to determine how this may affect their further academic career.

MS 12: Management of Difficult Inner Ear Malformations

Cochlear nerve aplasia and hypoplasia: predictors of cochlear implant success

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Objective. To identify factors predicting performance outcomes following cochlear implantation in patients with cochlear nerve aplasia or hypoplasia. Data Sources. Individual patient data extracted from published case series and reports.

Methods. The MEDLINE database, Cochrane Library, Embase, Web of Science, and Google Scholar were queried for "cochlear implant" in conjunction with "aplasia" or "hypoplasia" between 1985 and 2015. Eighteen studies were included describing 97 subjects with individual postimplant auditory data. Postimplant performance was categorized as follows: level 1, nonstimulation/minimal detection; level 2, improved detection; level 3, closed-set speech perception; or level 4, open-set speech perception. The subjects achieving speech perception (levels 3 and 4) were descriptively compared with those who did not.

Results. Subjects with a hypoplastic cochlear nerve on magnetic resonance imaging had higher reported rates of achieving speech perception than those with an aplastic nerve. Subjects with syndromic medical comorbidities had higher reported rates of nonstimulation than nonsyndromic subjects. The data showed that some children with an aplastic cochlear nerve or those with partial electrode insertion could obtain levels of speech discrimination. Reporting of patient characteristics and auditory outcomes was extremely variable across studies.

Conclusion. As previously shown, cochlear implant in patients with cochlear nerve aplasia or hypoplasia can provide meaningful hearing for select patients. The current study suggests that presence of a cochlear nerve on magnetic resonance imaging and lack of comorbid medical

syndrome are associated with better auditory outcomes in such patients. Future efforts to report individual data in a consistent manner may allow better determination of predictive factors.

Auditory brainstem implantation in patients with severe cochlear malformation

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Objectives: To discuss the outcomes and decision making process for hearing rehabilitation in children with severe cochlear malformations.

Material and Methods: Outcomes with cochlear implantation and auditory brainstem implantation will be discussed with a number of illustrative case examples. Pre and post operative results after CI and after ABI, including children with CI on one side and ABI on the other are presented.

Results: Patients with severe cochlear malformation can receive good benefit from a cochlear implant. Those with thresholds and limited speech perception can also benefit from an ABI on the opposite side and bimodal us. The decision to implant with an ABI initially or later is difficult.

Conclusion: Auditory Brainstem Implantation and Cochlear Implantation are both possible is children with severe cochlear malformations and cochlear nerve deficiency. It is our feeling that cochlear implantation early in life is the best first option followed by ABI on the opposite ear. Children with this bimodal means of rehabilitation seem to be our best performers.

Auditory and imaging features to predict outcomes of cochlear implant in patients with cochlear nerve deficiency

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Objective: to access cochlea implant outcomes, and factors affecting outcomes, for children with aplasia/hypoplasia of cochlea nerve. We also developed a more advanced preoperative accessing system, based on nerves in the IAC ,diameter of IAC and auditory features

Material and Method: Demographic data, preoperative audiological data , imaging data measured on 3D-MRI and HRCT of 60 children with CND were collected. We divided all subjects into 5 groups(CND 0-4) according to the number of nerves observed on MRI. For the subjects with only one nerve in the IAC, the diameter of nerve has also been measured. Categoties of auditory performance(CAP) scores, Speech Intelligibility Rating (SIR), Meaningful Use of Speech Scale (MUSS) and meaningful auditory integration scale (MAIS) were used to access CI outcomes 1 year after surgery. Quantitative data for IAC and CNC diameters, as well as questionnaire scores across subjects groups were compared. The relationship between imaging data and CI outcomes and influence of age, preoperative residual hearing were analyzed as well.

Result: Diameters of IAC, CAP,SIR,MUSS,MAIS/IT-MAIS were significantly different among CN groups($P<0.05$). CND0 group showed poorer performance than other groups, while CND4 group showed best performance. Number of nerves were significantly correlated with CAP, SIR,MUSS,MAIS for all subjects. IAC diameters was significantly correlated with MAIS for subjects in CND1 group($P<0.01$ r2=0.763). There was no significant correlation among CI outcomes and age. Patients with inner ear malformation and with no residual hearing benefit less, but there was no significant difference.

Conclusion: Even patients with no nerves observed in IAC can benefit from CI. Both of auditory features and image data should be considered carefully when giving a CI advice . The diameters of IAC may be needed to assist decision-making for patients with one nerve observed in IAC.

MS 14: Cochlear Implantation under Local or General Anesthesia

Cochlear implantation under local anesthesia: Saint Petersburg experience

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Objectives: Cochlear implantation (CI) has become the standard treatment for severe-to-profound sensorineural deafness in the last 30 ears.

It is well known that some patients are denied from the surgery due to surgical reasons (ossification, severe malformations) and anesthesiology related reasons (severe comorbidities).

Material and Method: Twelve adult (aged 21 – 64 years) subjects underwent unilateral CI under LA in our institution between October 2014 and August 2017. All subjects had an American Society of Anesthesiologists (ASA) Physical Status classification of 4, corresponding with significant comorbidity.

In comparison with some other studies no conscious sedation was used at our institution due to the potential risk of adverse side effects.

Result and Conclusion: Total operating time was calculated as time from incision to dressing placement, the mean time was 27 ± 5.2 min. The time included electrode impedances testing and our new developed electrically evoked pure tone audiometry (ePTA).

Subjects' pain was assessed intraoperatively, in 6 and 24 h after surgery with the Numeric Pain Rating Scale (NRS-11). The NRS-11 is 11-point scale in which a score of 0 means "no pain" and 10 means "worst pain imaginable."

Ten subjects did not experience any pain during surgery and reported the NRS score was 0. One subject reported some pain during the drilling of the antrotomy and his intraoperative NRS score was 2. And one subject experienced pain during round window overhang removal (NRS score 3).

NRS scores varied from 0 to 3 in the postoperative period (6 and 24 h) and analgesics were administered when the LA had worn off.

CI surgery under local anesthesia was found to be safe in patients with significant comorbidities where general anesthesia is contraindicated.

Patient experience of cochlear implantation using local anaesthesia

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Objectives :Cochlear implantation (CI) under local anaesthetic (LA) has become established practice for many implant teams when considering certain cohorts of patients (e.g. elderly, co-morbidity). However, there is a paucity of information available regarding patient experience that can be used in the pre-operative period. We aim to discuss our series and demonstrate qualitative information about patient experience of CI under LA at the Yorkshire Auditory Implant Service (YAIS).

Methods: Chart review of all patients who received a CI under LA at YAIS. Data to include demographics, co-morbidities and physiological parameters were recorded and used to calculate P-POSSUM (Portsmouth Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity) scores. The Iowa Satisfaction with Anaesthesia Scale (ISAS) questionnaire was distributed to all patients who received CI under LA and responses were subsequently analysed.

Results: Fourteen patients received CI under LA at YAIS. Male to female ratio was 9:5. The mean age was 77.5 years (range 26 to 93). The mean P-POSSUM mortality and morbidity for this cohort was 1.9% and 28.6% respectively. The average ISAS score was +2.05 (where range of -3 is completely dissatisfied and +3 is completely satisfied).

Conclusion: Our study has shown patients to have a favourable experience with implantation using LA. The data regarding validated patient experience obtained from this work can be used to help counsel patients that may be offered CI under LA in the future.

Assessment of the effect of age at surgery and anesthesia maintenance medication on anesthetic and surgical adverse events during pediatric cochlear implantation

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Objectives: Pediatric cochlear implantation is performed during early childhood to prevent auditory deprivation during the sensitive period and, herewith, to optimize cognitive development. However, anesthesia at younger age is associated with more side effects. Studying the anesthetic risks of this procedure can provide crucial information to define the safest age to undergo surgery. Therefore, we assessed the safety of this procedure and the effect of anesthetic management on the clinical outcome.

Methods: We performed a retrospective cohort study in a tertiary specialized pediatric academic center assessing surgeries performed between 2008 and 2015. Children were classified according to age at cochlear implantation. We evaluated anesthetic and surgical adverse events following cochlear implantation performed before the age of 24 months.

Results: Forty-six cochlear implantations performed in 43 children were studied. Nineteen procedures (41.3%) were performed in children implanted before 12 months. The maintenance agent was either sevoflurane (n=22) or propofol (n=24). None of the children encountered major anesthetic adverse events, whereas minor adverse events occurred during 34 procedures. Those attributed to surgery occurred following 15 procedures. Neither the age at implantation or the anesthetic maintenance agent was significantly related to adverse event occurrence.

Conclusion: This study supports the concept that cochlear implant surgery can be performed safely during infancy (<12 months) in ASA 1 or 2 patients. Moreover, the type of anesthetic maintenance agent did not influence its outcome. A rather high rate of anesthesia-related adverse events favors at least a one-day hospitalization instead of day case surgery in infants.

Postoperative cognitive dysfunction after cochlear implantation

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Objective: Postoperative cognitive dysfunction (PCD) is a subtle, prolonged deterioration in cognition after surgery. This complication has been frequently investigated, mainly after major (cardiac) surgery. However, the incidence after cochlear implantation is unknown. Therefore, the aim of the study was to investigate the incidence and possible risk factors of PCD in severely hearing-impaired older adults after cochlear implantation.

Methods: In a prospective cohort study, 26 older participants (mean age: 70 (8) years), scheduled for cochlear implantation, were assessed prior to and one week after implantation by means of the Montreal Cognitive Assessment (MoCA). The incidence of PCD was calculated. In addition, the following possible risk factors were recorded: age, sex, education, duration of hearing impairment, preoperative signs of depression and anxiety, duration of anesthesia, anesthetic and surgical events and postoperative complications.

Results: The incidence of PCD was 11.5%, defined by a Z-score of change in MoCA scores 1.96 (i.e. a decrease of 4 MoCA points, in the present study). The incidence of PCD was corrected for practice effects by incorporating data from a reference group. Besides an effect of age on the postoperative cognitive performance, no significant risk factors were identified.

Conclusion: Given the considerably high incidence of PCD after cochlear implantation, routine cognitive screening before and after implantation is recommended to identify patients with PCD and to provide additional care for these patients.

MS 15: Role of CI in Vestibular and Intralabyrinthine Schwannoma Management

Cochlear implantation after surgical removal of intralabyrinthine schwannomas: techniques and audiological outcome

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Objectives: Intralabyrinthine schwannomas (ILS) are a rare differential diagnosis of sudden hearing loss and vertigo.

The common managment of these tumors is often a „wait-and-test-and-scan (W&T&S)" strategy. We here describe the audiological outcome of cochlear implantation (CI) after surgical removal of these tumors through subtotal or partial cochleoectomy and/or labyrinthectomy.

Methods: In an own case series of 24 patients, 11 tumors showed an intracochlear, 3 an intravestibular, 3 an intravestibulocochlear, 3 a transmodiolar, 1 a transmodiolar with CPA, 1 a transotic with CPA and 2 a multilocular location. 16 patients received surgery for tumor removal, 4 patients are scheduled for surgery and 8 patients decided for a „W&T&S"-strategy or.

Results: The 3 intravestibular tumors were removed via labyrinthectomy and patients received a CI in a single stage procedure. Nine intracochlear tumors were surgically removed via an extended cochleostomy with single stage CI (x1), via partial or subtotal cochleoectomy and partial cochlear reconstruction with CI (x6) or implantation of an electrode dummy for follow up with MRI and possible later CI (x2), or via labyrinthectomy and partial cochleoectomy (x2). The transotic and the transmodiolar tumors were removed via a translabyrinthine approach.

In all but one case, hearing rehabilitation with CI was successful (WRS up to 95% monosyllables at 65 dB SPL in quiet).

Conclusions: Surgical removal of ILS is recommended before tumor growth leads to a complete filling of the cochlea or before a transmodiolar or transmacular growth complicates surgical removal and prevents cochlear implantation. Radiotherapy of ILS may lead to destruction of the spiral ganglion cells hindering hearing rehabilitation with CI. If done early enough, cochlear implantation after surgical removal of ILS is an option for auditory rehabilitation and an alternative to a „W&T&S" strategy.

Confirmation of cochlear nerve preservation during acoustic neuroma resection with MED-EL cochlear test electrode

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Background/Objectives: Some patients with Acoustic neuroma (AN) desire a hearing solution that requires cochlear implantation(CI). Some patients with AN would like their tumour surgically removed and desire cochlear implantation for the subsequent single sided deafness (SSD). In certain cases it is possible to remove an AN and preserve the cochlear nerve. If the cochlear nerve can be confirmed to be electrophysiologically intact by electrically evoked auditory brainstem response(EABR) at the completion of tumour surgery then the cochlea can be safely implanted in the one surgery. The MED-EL cochlear test electrode has never been used for this clinical situation before.

Methods: The full range of treatment options for AN and the full range of treatment options for hearing loss were discussed with all patients. All patients were offered surveillance and a radiotherapy second opinion. All patients were informed of the possibility the cochlear nerve could be damaged at surgery preventing CI. Patients underwent translabyrinthine tumour resection with facial nerve monitoring and EABR monitoring utilising the MED-EL cochlear test electrode. CI was undertaken only after confident confirmation of cochlear nerve electrophysiological integrity. Patients underwent standard CI rehabilitation and were followed up with speech discrimination testing.

Results: Technique and results of electrophysiologic monitoring and evaluation will be presented and discussed in both cases in which the cochlear nerve was able and cases in which it was unable to be preserved.

Conclusion: The possibility of cochlear implantation being performed simultaneously with AN tumour surgery has wide ranging implications for individualisation of AN management. The ability to confidently assess cochlear nerve electrophysiological integrity is critical to successful CI after tumour surgery. The MED-EL cochlear test electrode is the most reliable technology we have found to achieve this.

Simultaneous translabyrinthine vestibular schwannoma resection and cochlear implantation with intraoperative electrical auditory brainstem response

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Objectives: Long-time hearing preservation in vestibular schwannoma patients is below 50% independent of treatment modality. Due to this fact, the improvement of surgical procedures and the MRI safety of modern cochlear implants there is an increasing interest in hearing rehabilitation in vestibular schwannoma patients. Sparing the cochlear nerve and determining nerve conduction after tumor removal is one of the most challenging steps.

Material and Methods: Four patients with vestibular schwannoma and functional deafness were included in the study. Preoperatively MRI and CT scans were carried out as well as audiometric testing. All patients were operated by translabyrinthine approach. Intraoperatively eABR was performed with an intracochlear test electrode before, during and after tumor removal. All four patients received a cochlear implant and were followed up currently at least for 6 months.

Results: Complete tumor removal was achieved in all four patients. MRI scans 6 months after surgery showed sufficient visualization of the IAC, no residual or recurrent tumor. Preliminary results show promising predictive value of eABR measurements. Conclusions: Simultaneous resection of vestibular schwannoma and cochlear implantation is a good option for patients with functional deafness. Evaluation of sufficient nerve conduction remains the next challenge. Intraoperative eABR measurements show promising results.

Cochlear implantation in patients with single-sided deafness after the resection of vestibular schwannomas

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Objective: One of the problems facing the treatment of tumors in the inner ear canal and cerebellopontine angle through resection is a possible subsequent deafness in the surgically treated ear. Most patients consider single-sided deafness (SSD) as a significant drop in their quality of life. Nowadays aural rehabilitation in cases of SSD has become a part of cochlear implant (CI) programs. We demonstrate the potential success of cochlear implants to aid SSD rehabilitation following the translabyrinthine approach.

Methods: A retrospective case analysis was performed. Patients were evaluated with SSD after resection of an acoustic neuroma with an anatomical preserved cochlear nerve and a consecutive cochlear implantation on the same ear in a period between 2009 – 2017. Individual clinical outcome and speech understanding were analysed.

Results: 13 patients have been provided with a CI. In one case, the CI was implanted simultaneously. The follow-up interval is 2 years in most cases. In 9 of 13 cases, the implanted ear was able to understand and discriminate monosyllabic words at 65 dB after 6 months. A speech understanding over 50% at 65dB was possible for half of the patients in the observed period. Personal feedback with regard to hearing in daily life situations is very positive in nearly all patients.

Discussion: Compared to other methods like bone-anchored and CROS hearing aids, only a CI is able to restore bilateral hearing. Furthermore, progressive obliteration of the cochlea is possible following labyrinthectomy. However, so far no method is available to guarantee the functional integrity of the hearing nerve and, by extension, the success of aural rehabilitation. This should be taken into account to provide patients with adequate information during the consultation process.

Conclusion: In certain circumstances, cochlear implantation can be a good solution to restore hearing in cases of SSD following translabyrinthine access to the skull base.

Cochlear implantation in patients with a vestibular schwannoma

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Objectives: There is increasing evidence in the literature that cochlear implantation (CI) in patients with a vestibular schwannoma is a reasonable extended indication of C.I and should be given the preference over an ABI. It can be performed simultaneouslu with the tumor removal (during translabyrinthine surgery) or in a staged procedure (after retro-sigmoïd or middle fossa surgery) and when the auditory could be anatomically preserved but not the hearing function.

Material and methods: We report our first experience in 10 vestibular schwannoma patients: 7 solitary schwannomas and three NF2 cases.

Results and conclusions: Three patients had an intralabyrinthine schwannoma removed with simultaneous CI implantation, one patient had a CI one year after VS removal and space holder implantation. Four patients had a space holder implantation after tumor removal. One patient had a CI implantation while leaving the tumor in place. Two patients had a combined ABI and CI implantation (called ABCI).

The auditory results after cochlear implantation vary widely from excellent open set speech perception to no auditory benefit at all (non-user). The individual results will be presented and compared with data from the literature. This expanded indication for CI could profoundly influence our management of vestibular schwannomas in the future.

MS 16: CI Fitting: Time for Artificial Intelligence?

Preliminary results: clinical evaluation of novel evaluation and cochlear implant fitting techniques with experienced cochlear implant recipients

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Introduction: Results of a multicenter study evaluating a new clinical decision assisted software that utilizes Artificial Intelligence (AI) and evaluation measures through a direct connect testing system in the United States will be presented. Audiqueen is a software package developed by Otoconsult (Antwerp, Belgium) which introduces a novel psychoacoustic test battery to evaluate cochlear implant recipients. It is used in tandem with the Fitting Outcomes Expert (FOX) software which utilizes artificial intelligence to provide programming parameter recommendations to the audiologist during an appointment. The main goal of this technology is to maximize cochlear implant outcomes and introduce a standard of care in cochlear implant evaluation and programming.

Objective: The objective of this study is to evaluate speech perception performance using standard of care and novel evaluation metrics through a direct connect testing system, in addition to satisfaction measures in experienced cochlear implant recipients.

Methods: 55 experienced cochlear implant subjects are included in the study across 8 cochlear implant centers in the United States. These experienced recipients are one arm of a larger study. Preliminary data from at least 35 subjects will be presented. Test metrics for this within subject, repeated measures design included: CNC Words, AzBio Sentences in noise (+10dBSNR), and a psychoacoustic battery (including audiometry, loudness scaling, phoneme discrimination, and speech audiometry) and subjective measures of patient satisfaction.

Conclusion: Utilization of a direct connect testing system and clinical decision assisted software that uses (AI) provides a data driven approach to programming experienced cochlear implant users. Results indicate these evaluation metrics and programming methodology can be successfully implemented with experienced cochlear implant recipients.

MS 17: What did we learn? Cochlear Implantation in Single-Sided Deafness

Benefits of cochlear implantation for single sided deafness: data from the House Clinic-USC-UCLA FDA trial

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Objectives: Evaluate safety and efficacy of cochlear implantation for single-sided deafness (SSD) patients.

Methods: Data are reported for 10 patients who completed the FDA-approved study. Audiological thresholds, localization, speech perception in quiet and in noise, tinnitus severity, dizziness severity, and quality of life (QoL) were measured before implantation and during the six-month period after activation of the cochlear implant (CI). All patients were implanted with the Med-El Flex 28 device.

Results: Data reported is six months post-activation of the CI, relative to baseline. Mean pure-tone average thresholds with the CI-only improved from 91.9 to 38.4 dB HL. Mean word and sentence recognition in quiet with the CI-only improved by 51.1 and 84.4 percentage points, respectively. Mean error in localization was reduced by 11.5 degrees. Mean speech reception thresholds in noise (measured with speech presented in front) improved by 0.8 dB when noise was presented to the CI ear, by 2.8 dB when noise was presented in front, and by 2.6 dB when noise was presented to the normal-hearing ear. Mean tinnitus severity according to a visual analog scale was reduced by 1.9 points (scale: 0-10). The mean Tinnitus Functional Index score was reduced by 22.9 points (scale: 0-100). The mean Dizziness Handicap Inventory score was reduced by 4.6 points (scale: 0-100). For the Glasgow Hearing Aid Benefit Profile, mean difficulty was reduced by 0.9 points with the CI on (scale: 0-5); patients generally found the CI to be helpful. For the Speech, Spatial, and Quality of hearing questionnaire (scale: 0-10), mean scores improved by 2.3, 3.0, and 1.0 points for the Speech, Spatial, and Quality categories, respectively. These data suggest that cochlear implantation can improve SSD patients' sound awareness, sound source localization, speech understanding in quiet and in noise, and QoL, while reducing tinnitus and dizziness severity.

Cochlear implantation in cases of unilateral and asymmetric hearing loss

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Objectives: Patients with substantial unilateral hearing loss (UHL) or asymmetric hearing loss (AHL) experience poor speech perception in noise and limited localization as compared to normal-hearers. Unfortunately, approved treatment options for UHL and AHL do not provide significant improvements on these tasks. Cochlear implantation has been explored as a potential treatment option for cases of UHL and AHL. The present report reviews the preoperative and post-initial activation speech perception and localization of CI recipients with UHL and AHL to assess its effectiveness as a treatment option.

Methods: Twenty (20) subjects with UHL and 15 subjects with AHL underwent preoperative testing, cochlear implantation, and follow-up assessment as part of a single-site clinical trial. Subjects were assessed preoperatively in the unaided condition (normal/better hearing ear alone) and with a bone-conduction hearing aid (BCHA+contra). Subjects were assessed in the unaided condition and with the cochlear implant plus the contralateral ear (CI+contra) condition at 1, 3, 6, 9 and 12 months post-initial activation. The test battery included measures of speech perception in spatially-separated noise and localization.

Results: Preoperatively, speech perception was similar or poorer in the BCHA+contra condition as compared to the unaided condition. Localization was significantly worse in the BCHA+contra condition as compared to the unaided condition. Subjects demonstrated a significant improvement on speech perception and localization in the CI+contra condition. Early performance on these tasks differed between groups, however, the performance gap narrowed with listening experience.

Conclusions: Subjects with UHL and AHL experienced a significant improvement with the CI+contra on measures of speech perception in noise and localization. Performance with the CI+contra exceeded that of the BCHA+contra condition. The rate of performance growth differed between groups, though this difference decreased over time. These results support the idea of expanding cochlear implantation candidacy criteria to include those with UHL and AHL.

A prospective longitudinal study in adult cochlear implant recipients with asymmetric hearing loss

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Objectives: Functioning with asymmetric hearing (severe to profound hearing loss in one ear and better hearing in the other) requires considerable effort and is detrimental for understanding speech in noise and sound localization. The present study evaluated longitudinal performance outcomes in a relatively large group of adults with asymmetric hearing who received a cochlear implant in the poor ear.

Design: Participants were 47 post-lingual adults. Test materials were selected that reveal communication challenges encountered by those with asymmetric hearing and included objective and subjective measures. Evaluation intervals were at pre-implant, and 6 and 12 months post-implant.

Results: Compared to the pre-implant listening condition, group mean results in the post-implant bimodal condition showed significantly improved sentence scores at soft levels and in noise, improved localization, and higher communication function ratings by 6 months post-implant. Group mean, 6-month post-implant results were significantly better in the bimodal condition versus either ear alone. Audibility and speech recognition for the poor ear alone improved significantly with a CI compared to pre-implant. To understand the impact of better-ear hearing on bimodal performance, study participants were grouped by hearing thresholds in the better ear: 1) ≤ 40 dB HL, 2) 41-55 dB HL, 3) 56-70 dB HL. All groups showed bimodal benefit on speech recognition measures in quiet and in noise; however, only Group 3 obtained benefit when noise was toward the implanted ear. All groups showed improved localization and perceived communication ratings.

Conclusion: Receiving a cochlear implant for the poor ear was an effective treatment for these participants. Test batteries should consider quality-of-life measures, sound localization and adaptive speech recognition measures with spatially separated noise to capture the deficits of asymmetric hearing and the treatment benefits reported by this patient population.

One year update on a multicenter study on cochlear implantation in single sided deafness

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Objectives: Cochlear implantation (CI) in adult subjects with acquired single sided deafness (SSD) or asymmetric hearing loss (AHL) is investigated prospectively. Audiological performance is evaluated, as well as potential improvements of tinnitus and anxiety/depression.

Materials and Methods: A multinational, multicenter, prospective study design was implemented with participating centers in Germany, Austria, and Belgium. Speech discrimination was tested in quiet, and in noise using an adaptive paradigm with the speech coming from the front and the noise from three different locations (either from the front, or the implant side, or the contralateral side). Tinnitus was evaluated by Visual Analogue Scale (VAS) and questionnaire, anxiety and depression by the Hospital Anxiety and Depression Scale (HAS). A pitch matching task was performed by some clinics, and localization abilities were also tested.

Results and Conclusions: To date, 36 subjects from 7 clinics were included in the data analysis (mean age 53, range 18-81 years). No adverse events have been noted. After 3 months of CI use, a significant speech intelligibility benefit with the implant (noise on the contralateral side) was observed: 0.3 dB (N=23). The significant speech intelligibility benefit was maintained at 6 months (N=20) and increased to 1.75 dB (N=18) at 12 months. The tinnitus impairment decreased significantly by 2.5 points on the VAS after 3 months (N=26). A significant decrease of 2 points was maintained by 12 months (N=19). The tinnitus questionnaire was in line with this improvement.

CI in subjects with SSD and AHL is able to improve speech discrimination in quiet and noise. Impairment by tinnitus decreased significantly. These benefits were apparent as short as 3 months after implantation and persisted with time. As CI is a safe procedure, it should continue to be considered in subjects with unilateral or asymmetric hearing loss.

Is CI indicated for all SSD patients? Learning from the failures

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Objectives: There is strong evidence demonstrating that cochlear implantation (CI) is the only treatment option that may provide the benefits of binaural hearing in single-sided deafness (SSD) and treat tinnitus, if present. Compared to other treatment modalities, CI shows superior performance in speech understanding in noise scores and localisation ability and this has been demonstrated by several research groups. However, these research findings may not be always replicated in the clinical setting resulting in skeptical clinicians and unsatisfied patients.

Results and Conclusions: A review of hearing outcomes took place in a tertiary hospital with a large number of SSD CI recipients. The focus was to identify those patients who (1) did not demonstrate objective and/or objective improvement in hearing outcomes, (2) and/or became a non-user. A comprehensive discussion of the possible causes for the "failure" for such patients may offer guidance for clinicians recommending CI for SSD patients.

MS 18: Is there a Future for Percutaneus Bone Conductive Devices?

BAHA attract vs ADHEAR

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Background: There are cases of hearing loss, where air conduction prostheses either cannot be used at all or there are significant limitations as to their use. For this group of patients, an alternative can be bone conduction systems. Currently in clinical practice there are several systems of this type – some of them do not require surgical intervention, but others are partially implantable. The aim of this paper is the compare modern bone conduction systems, i.e. BAHA Attract and ADHEAR. Although both devices are not percutaneous, the former one requires screw and magnate implantation, the latter one is non-implantable. The systems differ in the method of mounting the processor and transmission of bone vibrations. Those differences influence the range of indications, application possibilities and comfort of use.

Material and Methods **:** The study involved a group of 5 adult patients from the Institute of Physiology and Pathology of Hearing with unilateral or bilateral conductive hearing loss, who use BAHA Attract system in one ear. Audiometric tests in free field – audiometry, speech audiometry in quiet and noise both unaided and aided with BAHA Attract and ADHEAR system – were performed in all patients.

Results: The obtained results indicate a statistically significant improvements both in audiometry and word tests in free field after the BAHA Attract and ADHEAR systems had been used. In both solutions comparable results were obtained in terms of increasing both the sensitivity of hearing and speech discrimination.

Conclusions: Those preliminary results indicate a comparable effectiveness of the presented solutions, however, due to a small group of patients, it is recommended to continue studies. The analysis of the history of the development of bone conduction systems shows a clear tendency to use transcutaneous devices, thus minimalizing dermatological complications. Manufacturers of those devices, trying to meet patients' needs, create more and more modern systems, which not only are characterised by a higher degree of technological sophistication but also the location and nature of the transmission of vibrations allows safer and more comfortable use of the prosthesis.

Audiological evaluation of the novel bone conduction hearing device ADHEAR in patients with conductive hearing loss

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Objective(s): The ADHEAR is a novel non-implantable bone conduction hearing system, in which audio processor is connected directly to the skin via a special Adhesive Adapter that is placed behind the ear. It is intended for treatment of patients with conductive hearing loss. The ojbective of this acute clinical study was to assess the audiological efficacy with this hearing.

Material and Methods: Material of this study consists of five native Polish adults with uni- or bilateral conductive hearing loss. Unaided and two aided conditions with the ADHEAR and the BC device on softband will be compared using the following tests: (1) Sound field audiometry with warble tones. (2) Speech in quiet by determining the word recognition score and speech reception threshold (SRT50) in sound field with Polish monosyllables. (3) Speech in noise by determining the SRT50 in sound field using the Polish Matrix Test with speech and noise coming from the front.

Results and Conclusions: Preliminary results of pilot tests showed comparable performance between the ADHEAR

and a bone conduction hearing device on a softband. The new bone conduction hearing device ADHEAR as a non-implantable solution could be a good alternative to the other bone conduction hearing devices and shows comparable audiological benefit in patients with pure conductive hearing loss. It seems that the ADHEAR can be a good solution for patients with small mastoids, especially for babies and children, who are waiting for surgical procedure or are not suitable for it.

MS 19: State of the Art of ABI in Small Children

Results of a safety and feasibility study of auditory brainstem implantation in congenitally deaf children

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Objective: To determine the safety and feasibility of the auditory brainstem implant (ABI) in congenitally deaf children with cochlear aplasia and/or cochlear nerve deficiency.

Study Design: National Institutes of Health-Funded Phase I feasibility clinical trial of surgery in 10 children, ages 2 to 5 years, over a 3-year period.

Intervention(s): ABI implantation and postsurgical programming.

Main Outcome Measure(s): The primary outcome measure is the number and type of adverse events during ABI surgery and postsurgical follow-up, including behavioral mapping of the device. The secondary outcome measure is access to and early integration of sound.

Results: To date, 6 children have successfully undergone ABI surgery and postoperative behavioral programming. Three of the implanted children have been followed up for 36 months, 1 for 24 months and another for 12 months, and one has just been activated. Expected adverse events have been documented in three of the six children who received the ABI. One child experienced a cerebral spinal fluid leak, which resolved with lumbar drainage. One child demonstrated vestibular side effects during device programming, which resolved by deactivating one electrode. One child experienced postoperative vomiting resulting in an abdominal radiograph. The first five children all have speech detection threshold of 40dB or less, with 4 at 25dB or less. Scores on the IT-MAIS/MAIS range from 10 to 32 (out of a total of 40), and the children are demonstrating some ability to discriminate between closed-set words that differ by number of syllables (pattern perception), with one child able to discriminate with open-set ability with auditory stimulation only.

Conclusion: ABI surgery and device activation seem to be safe and feasible in this preliminary cohort. Speech detection, particularly pattern perception and word discrimination, develops slowly and long-term followup and rehabilitation is necessary with an experienced team.

Technical modifications to ABI surgery in children

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Cerebrospinal fluid (CSF) leak is the most frequently reported significant complication in pediatric ABI surgery, occurring in up to 8.5% of patients. Surgical protocols frequently call for a watertight dural closure followed by use of a mastoid/temporal pressure dressing to minimize the risk of CSF fistula and fluid collections.

Evidence from cerebellopontine angle surgery confirms that intracranial CSF pressure rises immediately after posterior fossa surgery and normalizes after 48 hours, with impaired absorption the believed cause. This can result in CSF egress around the tract of the ABI electrode cable into the subgaleal space. Complications of pseudomeningocele include skin wound breakdown, meningitis, and need for further surgery. Multiple case reports describe revision surgery on pediatric ABI patients to place fat and other tissue grafts and plating systems to address these issues.

Pressure dressing use is also problematic and may provide a false sense of assurance to the operating surgeon. Surgeons have been shown to be unable to accurately assess pressure to prevent magnet migration with dressings during MRI. It is therefore difficult to support the routine use of tight pressure dressings over an implanted device in a thin-scalped child when this could result in a pressure ulcer and devastating wound complication.

At our pediatric ABI program, we have begun to perform lumbar subarachnoid drainage routinely for 48 hours postoperatively after retrosigmoid (RS) ABI placement in children as we routinely do in adults having acoustic neuroma surgery. We use dressings for only 24 hours to provide initial counterpressure to prevent pseudomeningocele as the lumbar drain is begun. There have been no complications related to lumbar drain use, and at our pediatric hospital lumbar drains are managed on the regular ward. We believe the combination of lumbar drainage and short pressure dressing use allows for the best risk-benefit profile in these patients.

MS 20: Place pitch: Does Adaptation Correct Perceptual Misalignments

Place dependent stimulation rates improve pitch perception in cochlear implantees with single-sided deafness

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Objectives: Pitch perception in cochlear implant users is mainly depending on place of stimulation. The perceived place pitch evoked of the electrical stimulation differs mostly with the stimulating rate and the corresponding rate pitch in the cochlear.

Method: A group of eleven unilateral implanted experienced CI users with acquired single-singled deafness and normal hearing in the contralateral ear were recruited in the present study. All uses implant devices manufactured by MED-EL with deep insertion (FLEXSOFT or FLEX28) electrode arrays. The task of the subjects was to adjust the frequency of a sinusoid presented at the non-implanted ear by means of an adjusting knob until they perceived the same pitch that was elicited by a reference stimulus at the implanted ear for the six most apical electrodes. Six pitch matching trials per electrode were collected for each subject. A new method for improved (electrical) pitch perception was developed: The electrical stimulation rate for bilateral pitch comparisons was calculated by means of insertion angle assigned by postoperative imaging of the cochlea.

Results: The pitch-function with place dependent stimulation rates shows in contrast to previous findings with fixed rates that the median of matched acoustic frequency is in line with the exponential predictions according to Greenwood for normal hearing. Collapsed data of matched pitch frequencies as a function of calculated electrical stimulation rate were well fitted by linear regression (R^2=0.878).

Conclusion: These findings give the possibility to affect the preciseness of perceived pitch evoked by electrical stimulation in single-sided deafness patients. Sound processing strategies incorporating place dependent stimulation rates are expected to improve pitch perception in CI users.

Development of electric-acoustic pitch comparisons in single-sided-deaf cochlear implant users

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Objectives: 6 cochlear implant (CI) users with near-normal hearing in their non-implanted ear compared pitch percepts for pulsatile electric and acoustic pure-tone or harmonic tone stimuli presented to the two ears. 3 CI users were implanted with the 28mm MED-EL FLEX, 2 with the Cochlear CI24RE and 1 with the AB MidScala electrode. The experiments were performed right after activation of the CI for the first time and 2 or 3 months afterwards.

Material and Method: After loudness balance the electric and acoustic stimuli, comparisons were performed between a 1000 pps pulse train and pure tones or between 12 pps electric pulse trains and bandpass-filtered acoustic pulse trains of the same rate.

Electrode positions for 2 subjects were taken from Cone Beam Computer Tomography data pre- and post- CI implantation. The cochlea length of each individual CI user was estimated pre- implantation. The longitudinal and angular positions of the intracochlear electrode contacts were determined postoperatively. The cochlear length and the electrode position estimations were then used to estimate the frequency corresponding to each CI user's electrode using Greenwood equation. Next the acoustic pitches matched to the electric pulse trains were compared to the Greenwood function estimations.

Results and Conclusions: We observed that the 3 MedEL CI users matched the apical electrodes to lower frequencies than the Cochlear and AB CI users. The reason might be that the MedEl electrode array is inserted deeper in the cochlea. In two MedEl CI users we observed that the 12-pps electric pulse train was matched to the same frequencies than the 1000-pps right after implantation, however after 2 months of CI use the 12-pps electric pulse train was matched to lower frequencies than the 1000-pps pulse train. In general the pitch elicited through electric stimulation deviated less than an octave with respect to Greenwood's estimate.

MS 21: Cortical Auditory Evoked Potentials in CI Patients: Past, Present and Future

The utility of EASSRs for CI fitting: from threshold determination to the assessment of modulation encoding

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The electrically evoked auditory steady-state response (EASSR) is a phase-locked electrophysiological response that can be evoked with modulated pulse trains. It originates, depending on the modulation frequency used, from different regions of the auditory pathway. The EASSR is ideal as an objective measure to assess the responsiveness of different regions of the auditory pathway to temporal envelope modulations in cochlear implant (CI) users. EASSRs evoked with high-rate pulse trains, as used in conventional CIs, allow the determination of the pulse-rate dependent and electrode specific threshold levels in CI users.

Measuring EASSRs from CI users is challenging, mainly due to stimulation artifacts corrupting the EEG recordings used to record the EASSRs from the scalp. Artifact removal signal processing methods are able to eliminate the stimulation artifacts from the EEG recording, enabling the assessment of the phase-locking ability of the auditory pathway to amplitude modulated high-rate pulse trains. We will discuss recent published and unpublished work from our lab focusing on the clinical applicability of EASSRs for the determination of stimulation levels in CI users and its future perspectives for CI fitting.

Crossmodal cortical reorganization and CI outcome

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Postlingually deaf Cochlear Implant (CI) users show better lip reading skills compared to normal hearing individuals even after several years of CI experience. A neuronal component of this enhanced performance could be cortical cross-modal reorganization of the auditory cortex. A higher auditory cortex activity in response to visual stimuli in CI users has been related to better face recognition as well as enhanced lip reading performance. On the other hand, a residual pattern of cross-modal cortical reorganization in experienced CI users may limit auditory speech perception. To what extend these changes are deprivation-induced or related to sensory recovery is still debated. Evidence for a deprivation-induced onset of reorganization comes from recent studies with individuals showing only a moderate hearing loss. However, the amount of sensory deprivation that is required for the initiation of cortical reorganization remains poorly understood. Investigations with normal hearing, moderately and severely hearing-impaired individuals (CI users) are therefore needed to better understand the role of cross-modal reorganization for auditory rehabilitation.

Prediction and objective evaluation of therapetic effects of CI in subjects with SSD and debilitating tinnitus using qEEG

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Notwithstanding successful reduction of tinnitus after cochlear implantation (CI) in patients with single-sided deafness (SSD) in recent studies, neither the exact mechanism of suppression nor the predictors of the amount of improvement are fully understood yet. In this regard, the first part of this talk will address the possibility of preoperative cortical oscillations measured by quantitative electroencephalography (qEEG) as a predictor of post-CI tinnitus reduction in patients with SSD. Also, in the second part of this talk, cortical changes relevant to tinnitus improvement in subjects with SSD after CI will be shown by comparing pre- and post-CI qEEGs. In short, CI alleviates tinnitus due to overall decreased cortical activity and functional connectivity. However, CI decrease tinnitus not by cortical plastic changes, but by suppressing tinnitus-related cortical regions by dynamic peripheral reafferentation.

MS22: Family Involvement in Cochlear Implantation

How to manage immigrant children with cochlear implants? Our experience in Brussels, a multicultural city

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Objectives: The aim of this study was to highlight the particularities of a cochlear implant (CI) rehabilitation program in the multicultural pediatric population of Brussels.

Material and methods: We analyzed a cohort of 125 implanted children, amongst whom 59 were from immigrant families mostly from North Africa and Eastern European countries. Thirteen families had a very low French language level and 12 families did not know French at all.

Monolingual and bilingual children were compared in terms of age at screening, age at diagnosis, age at the first and second CI, rehabilitation, schooling, presence of associated handicaps and family involvement. Language

development was tested for lexicon and morphosyntax (EVALO, ELO, L2MA, NELL, E.CO.S.S.E, EVIP, BALE, …).

Results: Although the age at implantation was similar for monolingual and bilingual children, most French-speaking implanted children in our cohort were attending ordinary schools whereas most bilingual implanted children were attending specialized schools for the deaf (> 75%). Furthermore, their score on the Marry Pat Moeller Test was lower and they presented language development delays.

Multidisciplinary and psychosocial teams were involved earlier on. French-speaking speech therapists added the verbo-tonal method to help children getting accustomed to the French phonology. Social translators were involved as well, as we highly valorize the transmission of the mother tongue.

Conclusion: Bilingual implanted children tend to have more language development delays than French-speaking implanted children and more frequently need to attend specialized schools for the deaf.

The management of multicultural and multilingual implanted children is challenging and requires a specific and more individualized approach in order to allow these children to thrive despite unfavorable circumstances.

Tutorials

Genetic testing for hearing loss: from one or two genes to over one hundred in just a few years time

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Genetic testing is one of the most important tests in patient care of genetic diseases today. DNA sequencing is one of the main techniques used for testing. Until a couple of years ago, Sanger (dideoxy) sequencing was used, but the high cost limited testing to just a few genes. For hearing loss this became inadequate, as over 100 responsible genes have gradually been discovered over the last 20 years. However, Next-Generation Sequencing (NGS) provided a major breakthrough in molecular diagnostics for genetic heterogeneous disease, as it allowed cost effective analysis of dozens or even hundreds of genes. Over the last couple of years, NGS-based testing has become the standard in molecular diagnostics for hearing loss in most laboratories.

In this tutorial the different possible methods for NGS genetic testing for hearing loss will be explained, and their advantages and disadvantages will be discussed. In addition, the experience and results of several years of NGS testing in Antwerp will be discussed.

http://hereditaryhearingloss.org

Cochlear implantation after subtotal cochleoectomy for removal of intracochlear schwannoma

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Objective: The frequent management of intralabyrinthine schwannomas (ILS), which are a rare differential diagnosis of sudden hearing loss and vertigo, is a ‚wait-and-test-and-scan (W&T&S)' strategy. This video describes the technique for surgical tumor removal, cochlear implant (CI) electrode placement and reconstruction of the surgical defect in patients with intracochlear schwannomas.

Method: By the means of a video demonstration a didactically valuable example is provided, illustrating the surgical technique for removal of an intracochlear schwannoma through a subtotal cochleoectomy, placement of a cochlear implant electrode carrier and reconstruction of the surgical cochlear defect. The example is selected from an own case series of 17 patients with surgical therapy of an intralabyrinthine schwannoma with or without CI.

Results: The tumor was successfully removed without macroscopic (operation microscope and endoscope) tumor remnants. The surgical defect can be reconstructed with cartilage, perichondrium or temporal muscle fascia, and bone paté. At follow-up, good hearing results with the cochlear implant was obtained despite of subtotal cochleoectomy.

Conclusions: Depending on the extension, intralabyrinthine schwannomas with intracochlear location or extension can be removed through an extended round window approach, partial or subtotal cochleoectomy with or without labyrinthectomy. The surgical tumor removal and cochlear implantation is a promising treatment strategy in the management of intralabyrinthine schwannoma with intracochlear location, further extending the indication range for cochlear implantation. It is, however, of importance to observe the long-term outcome in these patients and to address challenges like follow up with magnetic resonance imaging.

Focus Sessions

FS 01: CI Aspects of Cochlear Histology and Temporal Bone Anatomy

Telmesani radiological classification of the location of the vertical segment of the facial nerve: impact on surgical approach in cochlear implant surgery

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Objective: This study was conducted to establish a radiological classification of the location of the vertical segment of the facial nerve (VSFN) and to see if this has implications on the surgical technique needed to access the round window niche (RWN) in cochlear implant (CI) surgery.

Patients: One hundred twenty seven patients underwent CI surgery, and high resolution computed tomography (HRCT) of 140 temporal bones was studied.

Main Outcome Measures: The radiologic location of the VSFN in relation to the lateral semicircular canal in the coronal plane of HRCT and its implication on the surgical approach used to access the RWN in CI surgery.

Results: A statistically significant association is present between the radiological location of the VSFN and the surgical approach used ($p<0.001$).

There was insignificant correlation between the locations of the VSFN and the patient's age, sex, and IEM as the $p>0.05$.

Conclusions: On HRCT (0.6mm) in the coronal plane, the position of the VSFN in relation to the lateral semicircular

canal is correlated with the alternative approaches that must be taken during CI surgery.

The role of preoperative computerized tomography in a safe posterior tympanostomy for cochlear implant surgery

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Introduction: A posterior tympanostomy is a technique performed to access round window area in order to insert cochlear implant electrode into round window membrane or through relationships between the facial nerve (FN) (vertical part), chorda tympani Nerve(CHTN), and facial recess (FR) pneumatization and airations in an axial temporal bone computerized tomography (CT) to be more accurate and safe in performing mastoid surgery with posterior Tympanostomy act.

Patient and methods: Retrospective analytic study was established on temporal bone computerized tomography (CT scan)51 patients in a cohort research study, who underwent cochlear implantation with classical mastoidectomy with posterior tympanostomy in our inclusions.

Results: 51 patients had a diagnostic CT preoperatively for the temporal bone in-between the period of January 2014 until the end of the study in November 2015. we classified the correlation in the anatomy according to several parameters and factors including the FN protrusion inside mastoid antrum, FR pneumatization, And the status of FN bonny canal. Anatomical relationships between the vertical Part and PT were classified into 3 categories: type 1, the FN has no protrusion with a regular bonny FN canal with pneumatized FR; type 2, the FN is protruded into the mastoid antrum with a regular bonny facial canal and/or poorly pneumatized FR; and type 3, the FN has sclerotic mastoid with no FR pneumatization.

Conclusion; These results enable preoperative evaluation of the FN's status and difficulty while performing posterior tympanotomy, providing basic knowledge to prevent injury to the FN while performing a posterior tympanotomy.

Usefulness of temporal bone prototype for drilling training: a prospective study

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Objectives: Dissection of cadaveric temporal bones (TBs) is considered the gold standard for surgical training in otology. For many reasons, access to the anatomical laboratory and cadaveric TBs is difficult for some facilities. The aim of this prospective and comparative study was to evaluate the usefulness of a physical TB prototype for drilling training in residency.

Design: Prospective study.

Setting: Tertiary referral centre.

Participants: Thirty-four residents were included. Seventeen residents (mean age 26.7±1.6) drilled on only cadaveric TBs („traditional" group), in the traditional training method, while seventeen residents (mean age 26.5±1.7) drilled first on a prototype and then on a cadaveric TB („prototype" group).

Main Outcome measures: Drilling performance was assessed using a validated scale. Residents completed a mastoid image before and after each drilling to enable evaluation of mental representations of the mastoidectomy.

Results: No differences were observed between the groups with respect to age, drilling experience and level of residency. Regarding drilling performance, we found a significant difference across the groups, with a better score in the prototype group (P=.0007). For mental representation, the score was statistically improved (P=.0003) after drilling in both groups, suggesting that TB drilling improves the mental representation of the mastoidectomy whether prototype or cadaveric TB is used.

Conclusion: The TB prototype improves the drilling performance and mental representation of the mastoidectomy in the young resident population. A drilling simulation with virtual or physical systems seems to be a beneficial tool to improve TB drilling.

RW visualization during cochlear implantation

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Introduction: The clear visualization of the round window region through the facial recess is a prime requisite for the

surgeon when inserting the electrode into the cochlea. Variations in the position of the round window can pose difficulty in the visualization of the round window niche by the surgeon. The variations in the position of the round window niche are caused by rotation of the cochlea in the horizontal and vertical axes, as well as the relation of the surrounding structures, namely the facial nerve. Various surrounding anatomical landmarks are very useful in accurate localization of the round window during cochlear implantation.

Objectives: We hereby present 5 important landmarks for the easy and accurate localization of the round window niche and membrane. Results: The first is the relation between the round window and oval window, the second is the pyramid and the third is the fustis. The round window membrane itself should be seen in all cases and is considered the fourth landmark. Finally, as the aim is the proper positioning of the electrode inside the cochlea, the identification of the inside of the cochlea is considered the fifth landmark. We describe the detailed surgical techniques to identify these landmarks easily and in the most difficult situations of cochlear implantations.

Round window visibility in pediatric cochlear implant patients: posterior tympanotomy versus transcanal approach

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Learning Objective: To assess the visibility of the round window (RW) during cochlear implant (CI) surgery in pediatric patients through posterior tympanotomy versus trans canal route.

Methodology: 80 prelingual pediatric patients prepared for CI were divided in randomized manner into two groups. Group (A): 40 patients underwent CI through classic mastiodectomy posterior tympanotomy approach (MPTA). Group (B): 40 patients underwent CI using endoscopic assisted combined approach technique (CAT) with limited posterior tympanotomy. Intraoperative evaluation of RW visibility through wide posterior tympanotomy after blue lining of the facial nerve (FN) and chorda tympani nerve (CTN) in group (A) patients and compared to RW visibility through trans canal using oto-microscopy and oto-endoscopy in group (B) patients.

Results: Out of 40 patients in group (A), RW was fully visible in 20 patients through wide posterior tympanotomy, more than 50% of RW was visible in 10 patients, less than 50% of RW was visible in 8 patients and in 2 patients the RW could not bee seen with maximum surgical effort. For group (B), RW was fully visible in 24 patients through trans canal, more than 50% of RW was visible in 12 patients and in 4 patients less than 50% of RW was visible when using the oto-microscopy. In group (B) patients, the RW was fully visible in all patients when 00 endoscope was used.

Conclusion: Endoscopic assisted CI surgery improves the RW visibility which is an important issue during CI surgery.

FS 02: Cochlear Implantation and Music Perception

Musical milestones for hearing children, does this correlate with children who have cochlear implants?

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Music is an evidence based, integral element for improving outcomes in children's listening, communication, spoken language and global development (Welch, 2006,Patel 2010, Sakkalou 2012, Kraus 2015).

When setting goals, selecting a musical activity and monitoring outcomes it is important to know what constitutes musical development for hearing children. How do we know if the musical activity or goal correlates with linguistic goals? Is the musical expectation an age appropriate expectation in terms of the child's hearing age and musical age?

Method: Instrumental and vocal activities were designed as part of an app, to focus on musical behaviours aligned with musical milestones for hearing babies, toddlers and children. Observational evidence was recorded on the ability of the child to sing and play, in relation to a targeted, age appropriate milestone, specifically for rhythm and pitch.

Results: 20 Parents completed an observational quantitative questionnaire with professionals, which enabled outcomes to be collated across the set of activities and the level to which the child executed the activity in relation to musical milestones.

Discussion: Through developing a standardised series of musical milestones through a further multi-centre study , therapists will have a greater ability to guide and provide strategies for all parents to select and confidently use music in their homes to maximum benefit for their child. This will enable therapists to use music effectively and appropriately to support optimal early intervention.

Music in rehabilitation and development of pediatric patients after cochlear implantation – Study on active and passive music therapy

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Objectives: Main aim of the cochlear implantation in congenital or acquired total and partial deafness is provision of

development of hearing, speech and communicaton skills. Excellent results of rehabilitation in a group of implanted patients made the development of artistic skills of patients a measure of progress in therapy. Results of active and passive music therapy indicate that children rehabilitated with music have accelerated auditory development have as well as developed their cognition.

The best results were obtained in patients rehabilitated with active music therapy (systematic music training. Aim of this paper is to present a study of implanted patients whose hearing development was supported with acvtive and passive music therapy.

Material and methods: Material includes a group of CI patients presenting musical skills. All patients were operated according to the 6 step Skarzynski's precedure. Patients using active and passive music therapy accelerated the process of hearing rehabilitation. In addition, they have developed other skills, including linguistic, communication, cognitive and general development skills.

Results and conclusions: In all operated patients, the standard-shaped, and personalized post-operative rehabilitation program was supplemented with musical activities. Inclusion of musical activities contributed to the intensification of the rehabilitation program and quick acquisition of auditory, linguistic and additionally musical skills. At the same time, in the group of teenage and adult patients, the positive influence of music contributed to the reduction or elimination of tinnitus.

Results: Supplementing the traditional post-operative rehabilitation program after cochlear implantation in various types of deafness and profound sensorineural hearing loss with properly selected musical elements has a significant impact on the acquisition of auditory, linguistic, musical and general development skills. It also reduces tinnitus.

Music perception of adult hearing aid users, compared to cochlear implant recipients

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Objectives: This study investigated music listening/appreciation from adult HA users with different levels of hearing loss (HL) ('mild' vs. 'moderate' vs. 'moderately-severe or worse'). This data is important for the CI field, as i) many potential adult recipients are existing HA users, and ii) many current and future recipients are/will be bimodal users. This was then compared to data collected using the same questionnaire, from adult CI recipients.

Methods: A published questionnaire developed for CI recipients was modified for this study. It had 51 questions covering music listening, sound quality of instruments/styles, listening preferences, and factors impacting on listening. The questionnaire was posted out to HA users with a i) mild HL; ii) moderate HL, and iii) moderately-severe or worse HL.

Results: 111 questionnaires were completed; 51 participants had a mild HL, 42 a moderate loss, and 18 a moderately-severe or worse loss. Overall, some significant differences were noted, predominantly between the Mild and Moderately-severe group, with fewer differences between the Mild and Moderate groups. There were significant differences between the three groups for the music styles which sounded best with HA(s), as well as between the ratings on more specific timbre rating scales used to rate each style.

A comparison of this HA cohort to the CI users from a published study using the same questionnaire provides interesting observations. The two groups spent a similar amount of time listening to music prior to their HL (HA users – Mean: 74; CI users - 72; scale 0-100 where 100 is the highest), but the HA users listen to music more now with their HAs (Mean: 70) than the CI users with their CI (Mean: 46). Music enjoyment ratings were also similar pre-HL (HA users – Mean: 79; CI users – 84; scale 0-100), but HA users rated music more enjoyable with HAs (Mean: 77) than CI users with their CI (Mean: 52). The CI recipients' overall scores for music was lower than the HA participants in this study, although pre-HL ratings and scores were similar for the two cohorts.

Conclusions: Overall results indicated little difference in music appreciation between those with a mild vs. moderate loss, however poorer scores for those with a moderately-severe or worse HL. This would suggest that HAs and/or HL negatively impact on music listening, particularly when the HL becomes more significant. When compared to CI users, HA users tended to provide higher ratings and listened to music more.

Music and speech perception outcomes after 12 weeks of music training for children with prelingual hearing loss

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Music training has been proposed as a complementary means of (re)habilitation for children with hearing loss, and although the number of studies investigating this is modest, there have been positive and significant results indicating improvement to music perception, music appreciation, and elements of speech perception—most notably prosody. This study aims to explore which aspects of music perception are improved from music training, and if additional transfer effects generalise to other auditory domains such as speech perception.

13 children aged between 5.9 and 9.0 years (M=7.3, SD=1.0) with moderate to profound prelingual hearing loss (6 bilateral CIs, 4 bimodal, 3 bilateral HAs) participated in this study. The design was a pseudo-randomised, longitudinal study with a delayed/waitlisted control group. Music training was 12 weeks, consisting of weekly music therapy sessions and online music apps 3 times a week. Testing occurred at pre, mid, post, and follow-up sessions. The test battery measured: music perception (pitch and timbre), speech perception (SIN, emotional and question/statement prosody), and spectral resolution.

After training and relative to the control group, the music group significantly improved their perception of timbre by 14.2%, F(1,14)=4.658, p=.049 and spectral resolution by 1.6 ripples/octave, F(1,14)=7.403, p=.017. Pitch, F(1,14)=.238, p=.238 and SIN perception, F(1,14)=3.686, p=.075 were not significantly improved, although the music group improved their SRTs by 1.4 dB. Both groups improved significantly in emotional prosody by 7%, F(1,14)=13.177, p=.003 and question/statement prosody by 12%, F(1,14)=11.113, p=.005.

The findings suggest that even a modest amount of music training can improve timbre perception and spectral resolution, though the evidence for speech perception enhancement is weak. As both groups improved in prosody perception, the results suggest that these gains are derived through natural maturation or development.

Evaluation of the music perception abilities in children with cochlear implantation

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Object: The goal of the present study was to evaluate music perception abilities in children after cochlear implantation (CI).

Methods: We aimed to ascertain tree main music perception dimensions: (1) subjective music style appreciation, (2) discrimination between the timbers of different musical instruments and (3) ability to discriminate of different music components such as rhythm, pitch, melody, volume and harmony. There were investigated 54 children using unilateral or bilateral CI and normal hearing (NH) control group of 47 children matched to the CI users regarding sex and age.

Results: The evaluation of enjoyment of music style sections showed that NH children rank electronic and pop music as their preferred styles while CI users ranked rock music as their favorite. CI users consistently show a more diffuse error pattern than NH children identifying instrumental timbers and mistake on instrument for another unrelated to instrument family. Therefore CI subjects show great ability to identify percussive instruments. The NH controls responded with nearly 89.4% accuracy in rhythmic perception task, the result of CI subjects varied from nearly perfect responses to around 74% accuracy. Evaluating pitch perception abilities NH subjects achieved a mean performance of about 78.7% accuracy but CI users' performance varied drastically from 10 % to 90%.

Conclusions: The CI users performed slightly worse in rhythmic perception task than NH children but achieved perfect results in identifying music volume and harmony changes. However comparing to NH participants CI subjects vary widely in their ability to identify pitch and melody changes.

Bimodal benefits in mandarin-speaking cochlear implant users for music perception and tone recognition

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Objective: To measure bimodal benefits for music perception and tone recognition, and probe the influence of bimodal benefits.

Patients: Sixteen Mandarin-speaking bimodal CI patients (7 male and 9 female), with age ranging from 16 to 49 years old, participated in this study. All CI subjects had more than six months of experience with their device at the time of testing.

Materials and Methods: Musical sounds in cochlear implants(Mu.S.I.C.) test battery was undertaken to evaluate music ability. Mandarin Tone Identification in Noise Test(M-TINT) was used to assess lexical tone recognition. All patients are test in CI alone and CI+HA listening conditions.

Results: Relative to the CI-only, mean tone recognition with the CI+HA improved from 77.9% to 87.7% correct in quiet (+9.8 points)($P<0.05$), and from 53.8% to 70.2% correct in noise (+16.4 points) ($P<0.05$). For music test, performance was significantly better with the CI+HA in both C4 and A4 pitch discrimination, melody discrimination and instrument identification ($P<0.05$ in all cases). A significant correlation was found only between duration of deafness and bimodal benefit for A4 pitch discrimination($r=-0.504$; $P=0.047$).

Conclusion: Mandarin-speaking bimodal CI patients have better music perception and tone recognition ability with CI+HA than CI alone listening condition.

FS 03: Speech and Noise Processing Algorithms

Effects of a transient noise reduction algorithm on speech intelligibility in noise, noise tolerance and perceived annoyance in cochlear implant users

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Objective: Most current CI processors have the possibility to apply a noise reduction algorithm in order to improve speech performance in noisy situations. Single-microphone algorithms are mainly effective in reducing stationary background noises. However, many environmental noises are transient. Recently transient noise reduction became available as an extra processing option in CI processors. The objective of this study was to evaluate the validity and efficacy of a transient noise reduction algorithm (TNR) in cochlear implant processing and the interaction of TNR with a continuous noise reduction algorithm (CNR).

Design: We studied the effect of realistic transients in steady-state noise, and the effect of TNR and CNR, using subjective ratings of annoyance, a speech-in-noise test and a noise tolerance test. Each combination of TNR on/off and CNR on/off was tested. Ratings of annoyance were obtained in a paired comparisons experiment

Study sample: Participants were 16 experienced cochlear implant recipients wearing an Advanced Bionics Naida Q70 processor.

Results: CI users rated sounds with transients as moderately annoying. Annoyance was slightly, but significantly reduced by TNR. Transients caused a large decrease in speech intelligibility in noise and a moderate decrease in noise tolerance, measured on the Acceptable Noise Level test. The TNR had no significant effect on noise tolerance or on speech intelligibility in noise. The combined application of TNR and CNR did not result in interactions.

Conclusions: The TNR algorithm was effective in reducing annoyance from transient sounds, but was not able to prevent a decreasing effect of transients on speech understanding in noise and noise tolerance. TNR did not reduce the beneficial effect of CNR on speech intelligibility in noise, but no cumulated improvement was found either.

Revision cochlear implant in adults

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Objective: To identify the incidence of cochlear revision surgeries in adults, the main causes that led to these surgeries and to verify the improvement of the audiological results of these patients after the revision surgeries. Material and Methods: Retrospective study of patients older than 18 submitted to CI surgery from 2004 to 2016 at a Public Hospital in Brazil. The data collected were: age at the time of implantation, sex, etiology of deafness, audiological characteristics of each patient in the pre and postoperative period, and whether there was a need for surgical revision and reason for it. Results: One hundred and fifty-eight CI surgeries were performed in 137 patients. Seven patients underwent bilateral CI and 10 required revision surgery, of which six were female and four were male. Fourteen revision surgeries were necessary in these 10 patients (8.9% of the total surgeries). The most frequent cause that needed for revision surgery was the displacement of the internal unit (three cases) that needed to be repositioned. The mean age at first surgery was 46.9 years and the mean age at revision surgery was 47.3 years. The outcome of the audiometric threshold in the pre-IC phase was 112, 4 dB and post-revision surgery of HF was 33.1 dB. Conclusion: The revision surgery of the IC is infrequent and was effective in most cases.

Nucleus 7 moves forward: a new noise reduction algorithm

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Objectives: Understanding speech in noisy environments is a challenging task for cochlear implant recipients; evident by the rapid degradation of speech scores with increasing noise

(Dorman et al., 1998; Muller-Deile, J., Schmidt, B. J., and Rudert, 1995; Wolfe et al., 2009).

Noise reduction algorithms such as SNR-NR and the newly developed algorithm ForwardFocus are designed to overcome some of the difficulty experienced by CI recipients by improving the overall signal-to-noise ratio (SNR) in noisy environments.

This study investigates speech perception, listening effort and subjective preference with ForwardFocus implemented in Cochlear's Nucleus 7 sound processor. Twenty four experienced adult cochlear implant subjects were enrolled into this investigation.

Material and Method: Speech perception in noise and listening effort was measured during acute in-booth test

sessions, and subjective impressions were collected via a custom questionnaire after real world take home experience. In addition, the 'Speech' domain, and three items on the 'Qualities' domain of the 'Speech, Spatial and Qualities of Hearing Scale' (Gatehouse & Noble, 2004) was completed by subjects at the beginning of the study and again after use of the ForwardFocus algorithm.

Results and Conclusions: Preliminary results show a benefit in speech perception scores when ForwardFocus is activated. Subjects reported a range of preferences and practical considerations when using ForwardFocus.

Fixed and adaptive beamforming improves speech perception in noise in cochlear implant recipients

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Introduction: Even though many cochlear implant users achieve remarkable levels of speech perception in quiet, speech recognition in noise remains a major challenge for these patients. Directional microphones, which are an established approach to improve speech intelligibility in noise in hearing aid users, became available for MED-EL cochlear implant recipients with the new SONNET audio processor. The aim of this study was therefore to determine if the fixed and adaptive beamforming technology improves speech intelligibility in noise.

Methods: 18 adult cochlear implant patients were included in the study. Speech reception thresholds (SRT) were measured with an adaptive speech test (Oldenburger Sentence Test) in continuously present, speech shaped noise. Target sentences were presented in front of the listener, noise sources were placed at -135° and 135°, respectively. Outcome measures were the differences in SRT with microphone settings: omnidirectional, fixed beamformer, and adaptive beamformer.

Results: Analysis revealed that the use of directional microphones improved SRTs as follows: fixed beamformer vs. omnidirectional: -4.27 dB ($p<0.0001$); adaptive beamformer vs. omnidirectional: -6.12 dB ($p<0.0001$); and adaptive beamformer vs. fixed beamformer: -1.84 dB ($p=0.001$).

Conclusion: The fixed and even more the adaptive beamformer of the MED-EL SONNET audio processor significantly improved speech reception thresholds in noise. Cochlear implant users will therefore benefit in difficult listening situations.

Measuring speech recognition abilities in noise in cochlear implant users

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The main purpose of cochlear implants (CI) for postlingually deafened adults is to restore communication abilities. Speech-recognition performance measures are, thus, very relevant to evaluate CI outcome. The results of our studies demonstrated that common Dutch measures of consonant-vowel-consonant (CVC) phoneme recognition in quiet have their limits and that adaptive tests of speech-in-noise recognition provide more and relevant information. In a study with 12 normal-hearing (NH) listeners, 24 hearing-aid users and 24 CI users, the adaptive digits-in-noise (DIN) test was compared to the standard Dutch sentence-in-noise (SIN) test. The DIN test yielded valid and reliable results when measuring speech-in-noise performance in these study groups, and was applicable to a larger range of listeners than the SIN test. The results of two studies, with 72 NH listeners with varying educational levels and language backgrounds and 24 CI users, demonstrated that the DIN test informs primarily about auditory capacity and is less influenced by cognitive and linguistic abilities than the SIN test. The DIN test may, therefore, be used to monitor progress in speech-recognition performance after cochlear implantation. The SIN test, although often too difficult, is more suitable to evaluate auditory functioning in everyday listening situations, because it involves more linguistic and cognitive processing. For listeners that are not able to perform the standard SIN test, keyword scoring can be used as an alternative.

Based on our results the following protocol for the evaluation of CI performance is suggested: start with CVC tests in quiet; when CVC phoneme scores exceed about 40% correct phonemes, the DIN test is suitable to extend the test battery to test and monitor auditory aspects of speech-in-noise recognition; from DIN scores of around -2 dB SNR or more favorable, the SIN test seems a suitable addition to assess everyday performance, and can be repeatedly and reliably measured.

A low rate implementation of the ace strategy aiming to save power

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The development of smaller sound processors for cochlear implants is a great challenge for manufacturers, as the power consumption of these systems is inherently high. Subsequently, the battery occupies a significant amount of space inside the speech processor.

For many years, Cochlear uses 900 Hz as their default stimulation rate, although data from older publications suggest that also lower rates could be used without sacrificing hearing performance. However, the data was not

yet conclusive, so a new study investigating the effect of stimulation rate on speech understanding as well as frequency discrimination was initiated. Frequency discrimination is an important aspect, as lower stimulation rates might hamper the perception of rate pitch, i.e. the perception of the fundamental frequency of different talkers in so called cocktail party scenarios.

The study design consists of a chronic and an acute branch. In the acute part, rates of 1200 Hz and 500 Hz are being compared with regard to frequency discrimination and modulation detection in the frequency range below 500 Hz. In the chronic part, rates of 900 Hz and 500 Hz are compared to each other. During the baseline appointment, speech tests (monosyllabic words and the Oldenburg Sentence Test) as well as frequency discrimination and modulation detection will be examined at the default rate 900 Hz. After the test session, subjects will be sent home with a 500 Hz stimulation rate for three weeks to get accustomed to the new setting. At the next appointment, the full test battery will be repeated at 500 Hz.

Current data indicate similar hearing performance at the different stimulation rates. Speech test data as well as modulation detection thresholds and frequency discrimination abilities were not significantly different between the different rates tested.

Thus, we conclude that lower stimulation rates in the range of 500 Hz are suitable for saving power without compromising hearing performance.

FS 04: Preoperative and Postoperative CT and CBCT in CI

Preoperative CT versus operative finding In CI

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Learning Objective:

- To study the pre-operative CT scan. This will serve as a roadmap to the anatomical layout of the ear to be implanted.

- To study the Key steps which are influenced by anatomical variations? These variations can pose unanticipated technical challenges with respect to obtaining good surgical access.

- To study landmarks which Identify Round window. This is of paramount importance since random drilling on the convexity of the promontory should be avoided because this can result in intracochlear damage.

Methodology:

CT scan findings will be correlated with the operative findings in 50 patients who underwent Cochlear Implantation. The following parameters were studied:

- Mastoid cellularity
- Dura position
- Sigmoid position
- Facial recess cellularity
- Round window niche anatomy
- Round window membrane visibility
- jugular bulb position

Results: Will be presented

Conclusion: The presentation will focus on different parameters which are useful in predicting potential difficulties encountered during the key steps involved in cochlear implant surgery. This will help the surgeon to anticipate technical challenges that may be encountered during the operation.

Three-dimensional visualization of cochlear malformations

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Introduction: Cochlear malformation is no longer a contraindication to cochlear implantation. Accurate identification of the involved abnormality from radiographic studies is important prior to operation. This abstract demonstrates the value of 3D segmentation images in the assessment of cochlear malformations.

Materials & methods: Anonymized preoperative HRCT datasets of temporal bones with a variety of cochlear malformations were made accessible from several clinics across the world with a voxel resolution of 0.5mm. The image data sets were loaded into 3D slicer freeware followed by segmentation of the cochlea along with the IAC (Internal Auditory Canal), vestibular organ, and vestibular aqueduct (VA). Segmentation of these structures were performed in the axial plane as precisely as possible as by setting tight thresholds of the grey scale to avoid capturing un-desired structures.

Results: Enlarged Vestibular Aqueduct Syndrome (EVAS), Incomplete Partition (IP) types I, II & III, Common Cavity (CC), and Cochlear Hypoplasia (CH) were identified in the data set taken for analysis in this study. EVAS showed enlarged VA with a width of 2.76mm. CC and CH cochleae showed a great variation in its size, shape and in the presence and absence of the semicircular canals. IP types on the other hand showed its own characteristics with IP type II with enlarged VA, IP type I with very minimal development of the basal turn and IP type III with a wider IAC connecting the basal turn of the cochlea.

Conclusion: It is difficult for many clinicians to mentally compile a series of 2 dimensional images slices into an accurate 3D representation of any anatomic structure. Yet a clear 3-dimensional understanding of anatomy, especially pathologic anatomy, is an enormous advantage to any surgeon undertaking a complex procedure. 3D segmentation, as demonstrated in this study, improves the clinicians' ability to visualize cochlear anatomy and the nearby structures compared to 2D images and in proper electrode selection.

Cone beam CT postoperative control of the precurved Midscala electrode array

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Objective: The cochlear implant insertion should be the less traumatic as possible in order to preserve the residual hearing and the cochlear structures and to obtain the best postoperative auditory outcomes. The aim of this study is to analyze the postoperative intracochlear position of a precurved electrodes array (Midscala®, AB) and to correlate the insertion characteristics to speech perception score.

Material and Methods: Twenty-one patients, mean age 64.7±13 years implanted with a Midscala® electrode array were included (25 ears) between May 2015 and July 2016; fourteen patients were contralaterally hearing aided. Auditory speech perception scores in quiet were tested at 6 and 12 months after activation. Tests in noise were performed at 12 months with an adaptive test (Matrix) aiming the SRT 50%. Harmonic/Disharmonic Intonation (HI/DI) test to assess the perception of pitch at low frequencies was performed at 12 months post-op. The cone beam CT scan evaluated the following insertion parameters: the distance between round window and reference electrode (insertion depth), the angular depth of insertion, and the electrode array scalar translocation.

Results: Mean speech perception scores in quiet, CI only, were 47±3.8% and 74±2.8 for words and phonemes respectively. The mean SRT 50% was 10.7±1.8 dB, nine patients were not able to complete the Matrix test. The mean just noticeable difference for pitch change on HI/DI test was 13±2.4 Hz and 26±6.8 Hz respectively. The full insertion of the electrodes was obtained in all cases through a pure round window insertion; the AB® insertion tool was used in all cases. A scala translocation occurred in 7/25 ears.

No correlation was found between electrodes array insertion position and auditory outcomes.

Insertion depth was deeper in those ears where a translocation from the tympanic to the vestibular ramp occurred (2.4±0.5 mm vs 1.4±0.2 mm, unpaired t test, p=0.03).

Conclusion: No correlation was found between electrodes position and auditory outcomes. The overinsertion of the array was correlated to the translocation. The correct insertion (i.e. stop the progression of the array when the blue marker reach the round window) would reduce the translocation rate of this precurved array.

Radiographic findings of peristapedial cyst for diagnosing cerebrospinal fluid fistula among cochlear implantation candidates

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Objective: To report high-resolution computed tomography (HRCT) findings of a peristapedial cyst as a specific radiographic manifestation for children with cerebrospinal fluid (CSF) fistula and congenital profound sensorineural hearing loss(SNHL).

Material and Methods: 4 children (2 males and 2 females, aged 2–5 years) in Qilu hospital of Shandong University were retrospectively reviewed. All the patients presented bilateral, congenital profound SNHL and meningitis. One patient complained of vertigo symptom. The patients underwent HRCT of temporal bone. Auditory perception and language development were evaluated postoperatively and postoperatively. Vestibular obliteration and concurrent cochlear implantation were performed and the intraoperative findings were recorded to validate the diagnosis of fistula.

Results: HRCT findings of all patients showed specific manifestations of unilateral peristapedial cyst with mild dehiscence of the footplate, indicating CSF otorrhea. Accompanying radiographic findings include concurrent Mondini dysplasia, defects at the base of the inner ear canal and contralateral Michel dysplasia. Intraoperatively, small translucent bulges could only be detected in the stapedial region, validating the HRCT findings. The fistulous orifice in the stapedial footplate could be observed in one patient. Massive CSF gushes from round window were encountered. After cochlear implant array insertion, the fistula was sealed. Postoperatively, no reoccurrence of meningitis was reported. The sound-field threshold was 56±8 dB HL (mean ± standard deviation) preoperatively with a hearing aid, which dropped to 29±4 dB HL after CI. The closed-set word recognition score improved significantly, from 27±15% preoperatively with a hearing aid, to 77±17% after CI ($p = 0.018$).

Conclusion: For CI candidates, the HRCT findings of peristapedial cyst could be a diagnostic point of CSF fistula, which need further intervention during CI surgery.

Diagnostic imaging for cochlear implantation: a rational checklist

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Cochlear implantation has become a reliable choice for patients with severe to profound sensorineural hearing loss not benefitted by hearing aids. Increased awareness has given rise to increase in the number of Cochlear Implantations being performed. Diagnostic imaging is of primary importance in determining candidacy, assessing potential

intra-operative surgical challenges, for research, and documentation. Three essential information we need to obtain is Cochleo-vestibular Anomalies that Preclude Implantation, evidence of Luminal Obstruction which can complicate the surgery intra-operatively and presence of any additional findings that may complicate the surgery or subsequent patient management. Both Magnetic Resonance Imaging and High resolution computed tomography are essential to obtain clinically relevant pre-operative information. Pre-operative knowledge about the status of the Cochlea and Cochlear lumen can also help in choosing the implant and electrode types. Patients can also be counseled pre-operatively about the procedure, consequences and realistic post-operative results. Most important of all, diagnostic radiology helps us in excluding the patients who are not ideal candidates for Cochlear Implantation.

MRI is used as a preliminary imaging modality for screening. The MRI is assessed with an inside-out approach, starting from the Brain and Auditory cortex to the mastoid. Pathological conditions with potential poor outcomes are identified, counseled and/or such patients are excluded from candidacy. A Computed tomography is done only if potential surgical risks are identified on MRI. With this, we present a rational approach and check-list for radiological diagnostic evaluation for Cochlear Implants.

FS 05: Quality of Life After CI

Measuring changes in quality of life in patients with auditory implants

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Objectives: Hearing implants amplify or restore hearing in individuals with different severities of hearing loss. Clinical outcome measures usually assess speech understanding in quiet and in noise. In recent years, an increased focus has been placed on hearing implant users' subjective assessment of the benefit that they feel that they derive from device use. This study compares the patient-reported quality of life and quality of hearing before hearing implant activation with that at 6 and 12 months after activation.

Material and Methods: The Health Utility Index (HUI) and the Speech, Spatial and Qualities of Hearing Scale (SSQ12) were administered to individuals who received a cochlear implant (CI), BoneBridge, or VIBRANT SoundBridge. The Nijmegen Cochlear Implant Questionnaire (NCIQ) was only completed by the CI subjects. The questionnaires were administered at all three intervals (before first activation and after 6 and 12 months after first activation). Additionally, the subjects' satisfaction with their audio processors was recorded at the 6 and 12-month intervals using the Audio Processor Satisfaction Questionnaire (APSQ).

Results: Preliminary data analyses of 85 CI recipients and 36 VIBRANT recipients showed that quality of life and quality of hearing increased from pre-activation level to the 6-month interval in all measures. The SSQ total scores improved significantly for both the CI ($p < .001$) and the VIBRANT subjects ($p = .009$). From the HUI2 and HUI3 data, the multi-attribute scores were calculated and a "clinically important improvement" was found for both CI and VIBRANT subjects. The NCIQ scores (CI subjects only) improved significantly from the baseline visit to the 6-month interval for all 6 subscales (all $p < .05$). Further, the descriptive analysis of the APSQ revealed a generally highly level of satisfaction with their audio processors (median score of 4.1 for CI subjects and 4.2 for VIBRANT subjects with 5 being the max. score).

Conclusions: The present data show that hearing implant users feel that their quality of life and quality of hearing both significantly benefit from hearing implant use. Overall, these results suggest the importance of hearing implant provision on users' lives beyond simply an increase in speech understanding.

Quality of life outcomes in cochlear-implanted children with partial hearing

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Objectives:
- Data spanning 9 years will be presented, demonstrating long term preservation of hearing in children with partial hearing who have cochlear implants
- Outcome data will be presented with particular focus on quality of life

Method : Since October 2014, our two hearing implant programmes have worked collaboratively to explore outcomes of partially hearing children who have received cochlear implants. 60 children who received their cochlear implants between 2008 and 2018 were included in this review.

The Brief Assessment of Parental Perception (BAPP) is used to define quality of life outcomes for 3 separate patient groups: unilateral, simultaneous bilateral and sequential bilateral users.

A comprehensive analysis of the data will be presented, including rates of hearing preservation, functional outcomes and a particular focus on quality of life

Results : Atraumatic surgical techniques result in hearing preservation in all cases except EVA and hearing continues to be preserved long term – in our cohort, up to 9 years. All families reported improvements in quality of life after cochlear implant surgery.

Conclusions :Long term preservation of hearing is possible for children with partial hearing who have cochlear implants. Additionally, significant improvements in functional outcomes and quality of life are seen across the group.

Working life satisfaction of patients with cochlear implant. Multicentric study

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Objective: The aim is to analyse the CI impact in adults with moderate-severe bilateral sensorineural hearing loss working life.

Material & Methods: A questionnaire was designed and validated in 2015 for measuring working life impact in CI users. A multi-center, retrospective study is carried out. Inclusion criteria are: CI user >18 years old when completing the questionnaire; severe-deep bilateral hearing loss; willingness to participate in the study. 1 year of IC use, and 6 months of active working life.

Results: A total of 119 CI users were included in the retrospective study versus 17 in the prospective study. Some of the aspects studied are: gender, level of studies, work activity, hearing disability, noisy environment, working satisfaction and motivation, phone abilities, work progress, personal relationships, working discrimination etc. 91.8% of the subjects were working actively. 58.8% of the subjects works in noisy enviroments. An improvement in work satisfaction is observed in the retrospective group, in the 88.3% of the subjects. 79-88% of patients did not find specific supports for his hearing loss in the workplace.

Conclusion: This fact, in addition to high noise in the workplace, shows that working conditions were difficult in terms of listening. This is essential in the recognition of the spoken word, specially when we are talking about people with a hearing disability.

Autonomy in adults with Ci

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An important aim of the application of CI's is to improve the quality of life of deaf adults. Personalized rehabilitation aims to enhance wellbeing by removing restrictions that limit participation. However, for the assessment of well-being, the degree to which deaf adults are able to attain freedom of choice in participation is important as well. In QoL studies aspects like autonomy are only indirectly addressed. Autonomy presumes not only self-governance, awareness of one's own goals and the ability to realize them, but also the capacity to initiate and maintain meaningful social relationships. Deafness can be detrimental to both these elements.

This study measures the autonomy of 24 adults who use their CI for at least 5 years. The Autonomy-Connectedness scale (Bekker 2015) was used for assessment. This 30 item questionnaire consists of 3 subscales; Self awareness, Sensitivity to others and Capacity to manage new situations. The subscales consist of balanced mixes of positive or negative statements. Responses are given on a 5 point Likert scale. Data were analyzed for pre- and postlingually deaf adults separately. Average age at testing was 57 years. Mean scores were compared to the norm scores with one-sample T-tests. More participants will be included in this ongoing study.

Self-awareness of the pre- and postlingually deaf groups did not differ from the norm average. Prelingually deaf adults showed a significantly poorer Sensitivity to others, whereas the average of postlingually deaf adults did not differ from the norm average. The Capacity to manage new situations was similar to the norm for both CI groups although we observed a trend for slightly lower scores in the postlingually deaf group. The Sensitivity to others was associated with speech perception and with vocabulary. Furthermore, most participants did not show a harmonious autonomy profile.

Effect of auditory status on recognition of facial expressions by adolescents

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Objective:. Adolescent cochlear implant (CI) users experience signficiantly more peer problems and higher bullying rates than peers with typical hearing (TH), which may stem from deficits in peer social dynamics. Successful social interactions require perception of not only message content, but also integration of sensory input to infer a speaker's emotion from visual (facial expressions) and auditory (prosody) cues. This study examines the effect of auditory status (CI vs. TH) on visual emotion recognition in adolescents. METHODS. Participants included 34 adolescents with CIs and 24 with TH. CI users had a mean age of 13.3 years, mean age at first CI of 2.7 years, and mean duration of CI use of 10.7 years. TH peers had a mean age of 13.7 years. All participants completed an emotion recognition task with static images of 4 individuals expressing 6 emotions (anger, disgust, fear, happy, sad, surprise). Participants labeled the emotion in the image from a closed-set list. We recorded mouse clicks to

examine behavioral accuracy and reaction time, and eye movement patterns via eyetracking.

Results: No significant group differences emerged for behavioral accuracy or reaction time for emotion recognition. However, eye tracking revealed differences relative to areas of the face on which each group fixated, with the CI group fixating longer on the mouth area across emotions compared to TH peers.

Conclusions: Longer fixations on the mouth may represent a compensatory strategy to mitigate effects of a compromised CI signal, but it detracts attention from the eyes, which underscore conversation management and social interaction. Knowledge of the effect of CI on emotion recognition could lead to more effective, efficient therapeutic intervention related to social deficits in adolescents with CI.

Uni *vs* bilateral cochlear implantation and they influence of some quality of life parameters

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Because hearing is essential to everyday life, its loss adversely affects human development and quality of life. Cochlear implantation is a modern medical procedure that allows humans to recover their ability to hear

The purpose of the study is to determine the quality of life in patients with uni- and bilateral cochlear implants

Reporting of results is done in several ways, which detects the patient's well-being, his satisfaction, the situation in society and the determination of the circumstances of implantation.

We sought correlations between the implantation decision, patient and family expectations after implantation.

A prospective observer study was performed on a group of 16 unilateral and bilateral cochlear implant patients between 10 months and 18 years of age.

Cochlear implantation in children brings major benefits in life, but increasing the quality of life differs from one child to another, because hearing recovery does not happen the same. An extremely important determinant of their evolution is support for family and parents.

Life quality in bilateral implants evolves in a positive and remarkable direction in the fields of communication, functioning, well-being and happiness and supporting the child. Significantly increases the speech intelligibility and the ability to locate sounds. Compared to the quality of life at unilateral, we can say that in the case of the bilaterally implanted, in the field of communication is the greatest evolution, because there has been a major improvement in the communication, conversation and the use of the spoken language.

Promoting social well being in adults following cochlear implantation

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Introduction: There are many rehabilitation tools and programs available for adults receiving cochlear implants, with a strong emphasis on self management. Recipient suitability of technology based tools varies, hence the CI clinician must identify the most appropriate methodology for their client. Further, these tools, do not provide the opportunities to develop the social wellbeing that many recipients seek following CI. This paper will identify methods of supporting adult CI recipients through the use of available resources as well as identifying the role of direct traditional 1:1 therapy and the use of volunteers in the rehabilitation process.

Method: Two to four weeks post device activation clients were screened to determine and review preoperative goals to determine rehabilitation approaches to be used. Outcomes were measured following a series of individual sessions; therapy supported through self management with support from a volunteer or a combination of both.

Results : One or more of the client goals were achieved in all conditions within the period of intervention following device activation. Subjective data and self rating scores showed no significant difference regardless of the type of intervention provided. A longer term rehabilitation program was required in most of the cases which was readily accommodated through ongoing self management and volunteer support.

Conclusion : A blend of post operative auditory training approaches in the acute phase following device activation was recommended for clients requiring support in their rehabilitation process. Generalisation of skills was facilitated through the use of volunteers and through self management following a period of individual sessions whereby the recipient gained confidence in their skills and abilities. This study provided a template for managing newly implanted CI recipients across the organisation to ensure that immediate and longitudinal training needs were met.

FS 06: From Neonatal Screening to Follow-up

Genetic profiles and their impact on cochlear implant outcomes in Egypt

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Objectives :
- Assessment the type of gene mutation in patients presented with sensorineural hearing loss who are candidate for cochlear implants.
- Determine the occurrence of gene mutations.
- Correlate type and site of mutation with clinical severity and occurrence of complications in cases with sensorineural hearing loss (genotype phenotype correlation).

Patients and Methods:

One hundred children undergoing cochlear implantation underwent : history, audiological evaluation, radiological evaluation,Genetic GJB2 mutation screening using Invitrogen PCR mix and ApaI restriction enzyme (North America,CA,10572-014),

Positive patients' parents were subjected for genetic analysis by the same way to clarify the pattern of inheritance.
- The geographical distribution of cases within the country was determined.
- Postoperative outcome results obtained by aided audiogram an word discrimination score.

Results: There were 64 males and 36 females, aged 1.6-7 years (m=3.72). Consanguinity was found in 60% of the cases.

35delG mutations were detected in exon2 in 31% of the children. All of them showed a heterozygous pattern of inheritance (35delG/non-35delG).

Positive mutation in mothers was found in 18/31(58.06%) and in fathers in 13/31(41.93%). Symptomatic parents with mild to moderate SNHL were found in 8/31 (25.8%) evident by audiological evaluation.

Parents are carrier to that mutations in 23/31 (74.19%).

Radiologically there were no differences in the mean cochlear dimensions suggesting normal cochlear growth with absence of gross cochlear malformations in patients with positive 35delG mutation.

Speech and hearing comparison between positive 35delG mutations and negative children was done at 6 months and one year post cochlear implant. Children positive for 35delG mutation showed better and earlier outcomes than negative children for mutation with good follow up to one year.

Genetic predisposition of sporadic congenital hearing loss in South Korea

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Objectives: Genetic hearing loss is extremely genetically heterogeneous. Although congenital hearing loss is likely attributable to genetic disposing factors, it is hard to distinguish inherited cases from non-inherited cases of sporadic hearing loss. Herein, we delineated the genetic inheritance in the simplex cases of severe-to-profound congenital hearing loss in Korean infants.

Methods: Among the children with bilateral severe-to-profound hearing loss (auditory hearing threshold more than 70dB HL or nHL), 31 cases of nonsyndromic hearing loss without familial history were selected. SLC26A4 and GJB2 were screened with Sanger sequencing. We applied whole exome sequencing (WES) to the genetic analyses of the individuals without causative mutations in SLC26A4 and GJB2.

Results: Fifteen children (47%) and three (9%) had biallelic mutations in SLC26A4 and GJB2, respectively. 13 affected individuals negative of mutations in SLC26A4 and GJB2 were analyzed with WES data. Compound heterozygous mutations in MYO15A and CDH23 were detected in 2 (6%) and 1 (3%) of 13 families, respectively. All of the identified mutations of SLC26A4, GJB2, MYO15A, and CDH23 are homozygous or compound heterozygous biallelic. This finding indicates that the inheritance pattern of sporadic cases of severe-to-profound hearing loss is autosomal recessive. In 10 families, in whom mutations in known monogenic genes were excluded, we analyzed WES data and identified novel candidate genes for NSHL.

Conclusion: With successful diagnostic applications of combined Sanger sequencing and WES, we found that about 65% of sporadic cases of severe-to-profound hearing loss had genetic predisposing biallelic mutations. Given that there are still unveiled genes causing hearing loss, the genetic contribution to sporadic congenital hearing loss would be much more than we investigated here and WES allows identification of novel candidate genes.

Retrospective view to the newborn hearing screening in Turkye based on the published data

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Background: NHS in Turkey has been started as hospital-based programs in 1996, and following a pilot NHS study from 2004, in 2008, national NHS program of Directorate General for Maternal and Child Health and Family Planning has been started. At the end of 2016, 1000 screening centers were established all over the country and the

coverage ratio was around 93,9 % of live births , which were 1309771.

Objective: Our purpose is to review the published data about NHS in Turkey to evaluate impact of the program.

Material & Methods: Forty-six published researches presenting the data of NHS programs in Turkey were reviewed, and the data about fails, referral rates, missed cases, the screening methods, and rate of the hearing loss were analyzed.

Results: It was seen that 44 studies presented the data of separate hospitals including 418530 newborns . Rates of the first-test fail, referals and hearing loss were 15,7%, 0,88% and 0,35% respectively. Rate of bilateral hearing loss was 81%.

Conclusion: The Turkish NHS data appears that bilateral congenital hearing loss is more common in Turkiye than European countries. Besides, in respect to data of the clinical studies, severe cases constitute more than half of the subjects. Therefore, it is clear that Turkiye needs a well-established audiologic program not only for early diagnosis but also for fitting and (re)habilitation, which should be supported by special education system throughout the country. Not only increase in number of the audiologic centers and cochlear implant surgeries during the last 5 years, but also apparent decrease in number of the children in the deaf schools point out that governmental policies closely follow the requirements, although the ultimate data presenting improvement in their speech and language development and success rates in the general stream schools are not available yet.

Intrauterine hearing testing

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Objectives: To make criteria for intrauterine testing for hearing

Material and methods: 1000 pregnant woman to be tested for intrauterine hearing of foetus in a period of 1 year from april 2017 to march 2018

Audiometer headphone cup to be placed on the abdomen after checking the position of foetal ear and movement assessed at different frequencies

Movement criteria to be fixed and assessment done

Results: Out of 1000 tests done it was found that 20 foetus did not respond to sound at all frequencies

On correlation it was found that on birth they were profoundly deaf

Conclusion: Intrauterine hearing testing is a useful predictor of hearing loss before birth Can lead to intrauterine cochlear implantation in the future

Program for audiological/psychological follow up for children with hearing aids and cochlear implants. Part I – program overview

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Objectives: Hearing rehabilitation programs aim at establishing the diagnosis of a hearing loss and begin of the therapy as early as possible. Since new born hearing screening has been established, it became possible to reach these aims very early in life. During the last few years the average age of hearing aid fitting ranged within 3 to 8 months of life. The number of children receiving a cochlear implant at/under the age of one year has been continuously increasing.

Goals of therapy (HA or CI) extend beyond just improving the hearing abilities. The final goal of the therapy is to reach an optimal speech and language development. The latter will be affected by other factors such as the general development, presence of other handicaps and psychosocial factors. Parents counselling and support remains is an important issue that has to be maintained throughout the therapy.

Material and Methods: Since 2010 we began a follow up program for hearing impaired children. Every child is included in this program as soon as the diagnosis of hearing loss is established. The program includes information material for the parents as well as multi-disciplinary evaluation of the children and counselling of the parents at regular intervals. The results of evaluation are documented in a child booklet.

Conclusions: Thus, allowing an easy flow of information among the different care takers (Paediatricians, education specialists etc). Moreover, analysis the data collected help to detect and evaluate factors influencing the development of the children.

Follow-up-program for children with hearing aids and cochlear implants in Würzburg

Part II: evaluating the speech and language development

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Objectives: In order to be able to evaluate the speech and language development of hearing impaired children psychometric data of speech-and language and developmental psychology together with audiological evaluation results are necessary

Speech-and language development does not depend only on auditory perception, but also on general intelligence, more precisely on neuropsychological components such as auditory memory. Similar to children with normal hearing, hearing impaired children, might have so called neuro-functional weaknesses ("neuropsychologische Teilleistungsstörungen") additional to their hearing loss. These neuro-functional weaknesses will influence their speech and language development.

One of the aims of our Follow-Up-Program of hearing impaired children is to give a differential profile of all neuropsychological abilities of a child and to identify underlying neuro-functional weaknesses.

Result and Conclusion: The concept of neuropsychological functions relevant for speech and language development will be presented. First results of the long term data analysis of our hearing impaired children, supported with examples demonstrating the effects of specific neuro-functional weaknesses will be discussed.

FS 07: Auditory Development and Perception

Effect of noise and reverberation on speech intelligibility in cochlear implant recipients considering realistic sound environments

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Recent studies have suggested a strong link between speech intelligibility (SI) in cochlear implant (CI) recipients in quiet rooms, and the reverberation time (RT60). However, in real rooms, variation of RT60 does not occur in isolation, and other acoustic parameters are likely to impact SI. In addition, studies that have investigated the combined effect of reverberation and noise on SI have not examined the effect of reverberation on the temporal fluctuations of the noise. This study aimed at identifying the main factors that drive speech understanding in reverberant conditions in both quiet and noise using realistic acoustic environments. Percent correct sentence recall scores were measured in 12 unilateral CI recipients both in quiet and in noise using a 3D loudspeaker array in an anechoic chamber. Target speech was convolved with room impulse responses (RIRs) recorded at three listener-talker distances in five physical rooms with distinct RT60s. Noise consisted of four two-talker dialogues convolved with RIRs measured at four fixed positions around the listener. Target and noise levels were kept constant at subject-dependent SNRs. Overall, results showed large differences across subjects. Results in quiet revealed that a significant drop in SI occurs mainly at large listener-talker distances, and small reverberant rooms affect SI the most. The results present a strong correlation between SI and the early-to-late reverberation energy ratio as measured by the clarity-50 (C50). This suggests that CI recipients can benefit from early reflections in adverse situations. Results in noise show that the reverberant effects in quiet are combined with the fact that reverberation reduces the fluctuations of the competing speech, leading to a weaker distortion of the target speech envelope. In conclusion, the main drivers of SI in rooms are (1) the subject's own ability, (2) the C50, (3) the SNR, and (4) the modulation of the reverberant noise.

Directional hearing in patients with bilateral cochlear implantation

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Introduction: Bilateral implantation is the standard of care for children in majority of western countries, but for adults it is still the topic of the debate. As hearing is bilateral sence, those who have the single side implantation has to face a some problems.

Methods: We designed a pilot study focused on the directional sound localization and speech discrimination in noise in bilaterally implanted adult CI users. From 2016 to January 2018 we collected data from 6 patients with 1 year follow-up. 4 implants were CP910 (Cochlear) and two Rondo (Medel). Patients were from 18 to 43 years old, all implanted as adults, because of progressive hearing loss. ¨

Results: For all users bilateral stimulation provides improvement of the speech understanding in babble noise, the benefit was from 10% to 55%, 33% in average, in comparison with unilateral stimulation of preferable ear. With bilateral stimulation 4 out of 6 patients were able to differentiate the direction of the noise on the statistical significant level. With only unilateral stimulation neither of them was able to differentiate the direction of the noise.

Conclusion : We can conclude from the results of the small pilot study that bilateral cochlear implantation is beneficial for the adults users and provides improvement of the speech in noise understanding and can restore the directional hearing in majority of the users.

Assessing binaural fusion in bilateral cochlear implant users

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Although in normal hearing listeners, a sound is conveyed to the brain through two ears, it is perceived as one single sound source. This process known as binaural fusion is very important for sounds localization and the perception

of speech in noise. The aim of this experiment was to investigate if bilateral cochlear implant (CI) users can fuse sounds in a similar way. Binaural fusion was tested through a modified version of the scale illusion proposed by Diana Deutsch in 1975. In that experiment, six listeners bilaterally implanted had to detect one deviant note within a stream composed of a repeating melody, while simultaneously being presented with a distractor stream of randomized notes. The experiments included two conditions. In a binaural condition, every second note from the melody and the randomized stream was presented to the other ear. In a monaural condition, both streams were presented to the same ear. Of the six CI users, two could perform the task binaurally, and one only monaurally. The other three could not do the task at all. This result suggests that binaural fusion can be achieved only by a minority of CI listeners. A good alignment between the two sound processors might be critical to achieve good binaural processes.

Neural recovery function of the auditory nerve in cochlear implant surgery: comparison between pre-linguistic and post-linguistic patients

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Objectives: The Auditory Nerve Recovery Function (REC) consists of objective and non-invasive measurements of cochlear nerve function and are drawn from the action potential of the neural fibers of ECAP (Electronically Evoked Compound Action Potential). ECAP can be influenced by the stimulation received by the nerve. The ECAP and REC thresholds may be useful in predicting the minimum and maximum levels that should be used in mapping the electrodes for speech processor programming in pre and postlingual patients. To verify if there is a correlation between REC and pre-lingual and post-lingual patients.

Material and Method: Cross-sectional, descriptive and prospective study. The study included 46 individuals undergoing Cochlear Implant Surgery (CI), divided into two groups. The REC measurements were calculated for a posterior analysis of the relationship with the other data collected.

Results and Conclusion: Data analysis showed no statistically significant correlation between the three measures of ECR, T0, A, TAU in the comparison between the two groups. However, it was possible to observe a difference for Neural Response Telemetry (NRT) in the basal region of the cochlea.We conclued that there was no statistically significant difference in the function of auditory nerve recovery and pre and post-lingual patients.

Academic achievement of children after cochlear implantation

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Objectives: Education and subsequently employment are fundamental for individuals' psychological and socio-economic wellbeing. A hearing impairment is a disability with a particular impact on education and employment opportunities. With application of cochlear implants it is possible to compensate for a hearing loss much more effectively than before thus better counteracting the negative consequences of hearing impairment. Positive effects of rehabilitation of hearing and speech after cochlear implantation allow expecting that these students will achieve similar school education results as children with normal hearing. To date only a few study reports had included an objective record of the issues related to complying with the school education requirements and school scores achieved by children using cochlear implants with the measure of standardized test for hearing children. The aim of the study was to analyze school attainments of CI children at the end of primary education and to compare results with those obtained by hearing peers.

Material and method: The study group consisted of 33 CI children who wrote the test for children with normal hearing at the end of primary school. The raw data of the obligatory, standardized test carried out in Poland at the end of primary education in years 2010-2014 were analyzed.

Results: Test results of CI children were not significant different compared to the population of normal hearing children.

Conclusions: School attainments of a CI child can be at the same level comparing to hearing peers.

Auditory and speech performance in ANSD children with cochlear implant: Saudi Arabia experience

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Auditory neuropathy spectrum disorder (ANSD) is a type of hearing impairment in which outer hair cell function is normal but afferent neural conduction in the auditory system to the brain is abnormal. ANSD can affect different age groups, from infancy through adulthood. Although CI is the mainstay of treatment in ANSD, appropriate response in the form of speech and language outcomes can't be guaranteed since highly variable responses were seen after CI amongst the ANSD patient. Not many studies in

Saudi Arabia have evaluated speech performance in ANSD patients after CI. Owing to this, a retrospective study was conducted to assess the auditory and speech performance among ANSD post cochlear implant (ANSD-CI). We also decided to compare the results obtained from ANSD-CI patients with other cochlear implant candidates.

A retrospective study was carried out using a cohort of 58 patients who had been using a cochlear implant for at least one year. The study group included 18 subjects diagnosed with ANSD. Findings from this group were compared to those of a matched cohort of 40 cochlear implant recipients with SNHL. Our results demonstrated that the values of both tests were higher in control group than that of the other group. However, there was no significant statistical difference in both CAP-II and SIR scores between the two groups, with p-values of (P=0.32) and (P=0.14) respectively. The outcomes of our population suggested that when controlling the age at surgery, patient compliance, inner ear and cochlear nerve integrity, cognitive, behavioral and other medical disorders, children with ANSD who receive cochlear implants will reach almost similar auditory and speech performance as compared to children with SNHL. Further studies with follow up data on a new set of patients should be conducted to independently confirm our findings.

FS 08 Surgery Reflections of Implantable AMEI

Optimal loading of the Carina T2 actuator

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Introduction:

The desired outcome for the implantation of active middle ear implants is maximum coupling efficiency with a minimum of conductive loss. It has not been investigated yet, which forces are correlated with ideal coupling. In this study we performed an investigation of loading forces on actuator coupling efficiency, normal sound transmission via the ossicular chain (i.e. conductive loss), and the electrical impedance of the actuator.

Methods: Experiments were performed on 10 ASTM compliant human cadaveric temporal bones. Actuator output was measured by Laser Doppler Vibrometry of stapes motion between 100 Hz and 10 kHz while the actuator was advanced in steps of 20 µm towards the incus, resulting in loading forces of up to 100 mN. The actuator output was expressed as equivalent SPLat 1 Vrms actuator input. We additionally investigated the occurrence of conductive losses (air-bone-gap) due to high loading forces by measuring changes in stapes motion in response to the acoustic stimulation of the tympanic membrane. Additionally, the electrical impedance was measured over the whole frequency spectrum for each loading force.

Results: Highest coupling efficiency was observed at forces above 10 mN and did not change at higher forces up to 100 mN. Below 1 mN no efficient coupling could be achieved. Conductive losses > 5 dB upon coupling according to manufacturer guidelines, correlating with forces of approx 30mN, were observed in one out of nine TBs for frequencies ≥4 kHz. The magnitude of the impedance resonance peak decreased rapidly upon coupling to the incus and completely vanished at 5-10 mN loading forces.

Conclusion: A minimum coupling force of 10 mN is required for an efficient coupling of the T2 actuator to the incus. No Conductive losses were observed in most of the temporal bones. Impedance measurements via the transducer loading assistant are a simple, yet effective way to indicate coupling.

Surgery information for the Cochlear™ MicroDrive™ Actuator

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Objective: The aim of the Cochlear-Implanted Recipient Observational Study (Cochlear IROS) is to collect information on performance outcomes and surgical details in a systematic, consistent observation of routine clinical practice. Here, we report the surgical details collected for the Cochlear MicroDrive™ Actuator implanted as part of Cochlear's middle ear implant systems by 9 European Tertiary Referral Centers.

Materials and Methods: The observational data was collected in an online database. 33 subjects (21 female and 12 male) implanted with either the Carina system (n=20) or the MET system (n=13) were included in this study. The average age of the subjects was 51 years. 16 subjects were implanted on the right ear and 17 on the left ear.

Results: The average surgery time was 2:17 (range 1:20 – 5:45) for the Carina system while it was 1:47(1:10 – 3:30) for the MET system. In all but one patient the MicroDrive actuator was coupled to the incus. For one patient it was coupled to the stapes head with a CliP prosthesis. The intra-operative test system was used and passed in all subjects. 23 surgeons rated the surgical difficulty as easy or very easy, 9 as medium and 1 as difficult.

Conclusions: The surgical time to implant the Carina system is acceptable. Combined with the fact that 70% of the surgeons rated the surgical difficulty as easy or very easy, this confirms that the surgical procedure is straightforward for incus coupling. Additionally, the surgical procedure is

new for many of the surgeons so that a reduction in surgical time can be expected once they gain more experience with the system and its surgical procedure. The surgical time goes down to 80 minutes for experienced surgeons.

Middle ear implant totally implanted – CARINA

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Objective: The aim of this work is to describe the first outcomes for the active middle ear implant fully implantable Cochlear™ Carina® System.

Study Design: retrospective observational nonrandomized group study.

Methods: from December 2014 to June 2017, 15 patients underwent Carina implantation. All the implants were from the last generation developed by Cochlear® company. Preoperative and postoperative air conduction and bone conduction thresholds were evaluated. Speech perception in silence and in noise, and localization sounds abilities, were also analyzed.

Results: 16 Carina implants were performed. Post-operatively, the mean pure tone audiometry threshold, in the operated ear, was 50,45 dB (± 12,64 SD) in BC and 64,92 dB (± 15,36 SD). The difference between post-operative and pre-operative mean pure tone audiometry threshold in the operated ear was not significant ($p > 0,05$).

The mean post-operative threshold in free field with the Carina™ device switched on was 46,77 dB , 45,75 dB, 43,57 dB and 45,38 dB, at 1 months, 3 months, 6 months and 1 year, respectively. In speech discrimination in silence, the mean post-operative SRT in free field with the Carina™ device switched on and contralateral masking, was 51,7 dB, 48,18 dB, 45 dB and 45dB, at 1 months, 3 months, 6 months and 1 year, respectively. Speech discrimination in noise and localization improve significantly with Carina.

Conclusion: In spite of the small number of patients our results confirm that fully implantable middle ear implant is a viable treatment for patients with moderate to severe sensorineural hearing loss.

Clinical results after implantation of the fully implantable hearing system in patients with chronic otitis media

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Introduction: Especially in patients after multiple middle ear reconstruction surgeries, active middle ear implants represent a promising hearing rehabilitation option. The fully implantable Cochlear™ Carina® System enables hearing rehabilitation in patients with high-grade sensorineural or combined hearing loss.

Material and Methods: We examined ten patients (9 male and 1 female) after implantation of the Cochlear™ Carina® System 2017. All patients had a stable high-grade sensorineural or combined hearing loss. The audiometric performance was determined pre- and postoperatively, analyzing bone and air conduction thresholds as well as speech audiometric parameters in free field condition using the Freiburger monosyllabic speech test. The word recognition score (at 65 dB SPL and 80 dB SPL in quiet) was compared to the unaided condition after occluding the contralateral ear. Additionally, the functional gain was quantified.

Results: The mean preoperative hearing level of all patients was 77,3 ± 17,3 dB (range 45 to 105 dB) with a mean bone conduction level of 49,5 ± 12,1 (range 18 to 61 dB). The actuator was coupled to the stapes suprastructure (n=3), the stapes footplate (n=7) or the round window membrane (n=2) depending on the middle ear pathology. In two patients the Carina hearing device was implanted in an obliterated radical cavity and surrounded by abdominal fatty tissue. All patients had an improved speech comprehension compared with preoperative conventional hearing aid fitting. The word recognition score showed a significant improvement after the second fitting after 3 months in comparison to the first switch-on after 6 weeks. A cochlear depression was not observed in any case.

Conclusion: Because of the alternative coupling methods, the Carina implant allows for a successful hearing rehabilitation in patients with high-grade sensorineural or combined hearing loss. In cases of an obliterated mastoid cavity, the obliteration with abdominal fat has no negative effect on the vibrational output.

ABR measurements via Vibrant Soundbridge® and MiniTek® using optimized chirp stimuli

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The Vibrant-Soundbridge® (VSB) is an active middle ear implant which is coupled to different structures in the middle ear, depending on the type of hearing loss and the individual physiology of the middle ear. Hearing improvement is highly dependent on the coupling efficiency between the floating mass transducer (FMT) and the respective middle ear structure. The measurement of aided thresholds intraoperatively would facilitate a direct control of implant integrity and coupling efficiency. In the postoperative course it might help to perform fitting in children and difficult cases and to determine hearing degradation over time. Currently there is no sufficient method to determine the coupling efficiency intraoperatively.

In order to obtain objective data during surgery auditory brainstem responses (ABRs) were recorded using the implant itself. For this purpose a wireless streamer (Sivantos

MiniTek™) was used to transmit stimuli from the ABR system via the audio processor (Samba™) to the FMT of the implant. The ABRs were evoked by chirp-sounds optimized for the VSB implant system that account the properties of the signal chain of the VSB and MiniTek.

Overall, it is possible to determine ABR thresholds via VSB to determine the coupling efficiency. The study includes a cohort with various couplers and contains the intraoperative measurements and the postoperative hearing results.

FS 09: Organisation of CI Provision

Education of rehabilitation experts from emerging markets & International Rehabilitation Academy

Herrmannova D.

MED-EL, Prague, Czech Republic

Despite of overall difficult economic situation in developing countries there are still various ways to finance cochlear implants (private, charity, governmental programs)

Especially third world countries have poor infrastructure of specialists, awareness about CI and rehabilitation availability

Everybody has the right to hear in spite the economic situation of the potential CI candidate

The lecture will explain the need to work on systematic building up the infrastructure and education of local experts to make it happen

MED-EL supports infrastructure for CI users, making sure they have good services, rehabilitation, education, trained experts . We designed for that reason International Rehab Academy to intensively support emerging markets and applying it in different regions for last 3 years.

International Rehab Academy is an international education and rehab tool supporting experts working with hearing impaired of all age groups and needs. It is structured, continuous and systematic rehab education available in different regions for rehab experts, therapists, students, parents.

Designed are 8 education modules & workshops

All modules follow holistic, natural rehab and education approach.

Set of modules covers the most important rehab topics and goes through the theory to practice.

Whole concept of the trainings and support will be explained during the presentation as well as the results / statistics from last 3 years from different developing countries and regions

Latin America CI actual situation and actions need it

Faletty P.

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Objectives: Caring of people with a disability is complex and requires the involvement of multiple

sectors: health, education, social welfare. Usually, the cost associated with care of people with disabilities.

Latin America Coverage and Costs effective actual situation. Access to coverage which includes early detection actual situation.

Methods: Information extracted from different sources: Country laws, WHO, PAHO, CEPAL, WORLD BANK, others

Results: In this sense, fragmentation of health systems in Latin America generates inequalities when it comes to having access to a quality treatment of the disability when appropriate.

Conclusion: Coverage of specialized services are extended in key countries and limited in others showing movements to expand coverage, there are needs to improve some circles for an early detection. Associated directed with Cost Benefit.

Developing a cochlear implant programme in the world's 7th poorest country

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Malawi is the 7th poorest country in the world however ten implants in post lingually deaf children have now been implanted in the country. The surgery has been carried out without complication and the switch ons, with subsequent audiological programming, have been carried out with the input of local audiological professionals. The details of the 10 patients will be presented but all have made good progress and have now returned to full time education. The development of the service has been possible due to a collaboration between UK & Malawi professionals and charitable support (including a CI manufacturer). Further plans are in place to develop the service including rehabilitation within families and the educational environment.

The rehabilitation of such a small number of patients is, however, simply a 'drop in the ocean' with regard to the need in Sub-Saharan Africa. Our aim however is to show that it is possible to do implants in a poor country and that, with appropriate follow up and support (including long term), they do vastly improve the lives of those who have been fitted

As well as outlining how the Malawian program has come about, including the major challenges arising, the presentation will also highlight the issues facing those looking to treat patients with severe to profound loss in the developing world. It will utilize our experience in detailing lessons learned but also outline how future developments could potentially radically change the outlook for those patients in the poorest countries in the world.

Breaking the barriers for hearing implants: the need to re-think, re-model and rejuvenate hearing implant healthcare in the brave new world

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Over the last decade there have been a number of seismic shifts in the hearing implant landscape. This has been led by marked advances in hearing implant technology, surgery and rehabilitation. The criteria for cochlear implantation has broadened dramatically for all ages. At the same time, there has been heightened clinical expertise in hearing implants demonstrated by clinicians across the industry. People are now more knowledgeable and demanding of independent decision-making so they can actively control their own hearing implant care.

Australia has excellent access to cochlear implant innovation, technology and clinical care, with well qualified medical and allied health professionals. When indicated, hearing implants are available for unilateral and bilateral hearing losses, in children and adults and across all socioeconomic strata.

Despite this rich and ripe environment, we have in Australia the embarrassing statistic that only one in ten adults who could benefit from a cochlear implant eventually accesses the benefit of such technology. Furthermore, those people who eventually do receive a cochlear implant often do so after years of unnecessary and unacceptable delay. This inadequacy is a reflection of a wanting healthcare delivery model for implantable hearing solutions in Australia, particularly in its regional areas.

Presently there are the technological tools to address this, including e-consultation, remote programming and the utilisation of cloud–based technology. This paper will review an innovative new hearing health service established in Australia and take a detailed look at the barriers experienced by people considering hearing implants and how each are being address to improve access to implantable hearing devices. this includes challenging all medical and hearing clinicians to rethink, revisit and re-shape the means of referring people for the hearing implant care they need and deserve.

Multicenter clinical evaluation of data logging in 1366 cochlear implant recipients using automated scene classification technologies

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Currently, there are no studies assessing everyday use of cochlear implant (CI) processors by recipients by means of objective tools. The Cochlear™ Nucleus® 6 System sound processor features a data logging system capable of real-time recording of CI use in different acoustic environments and under various categories of loudness levels. In this study, we report data logged for the different scenes and different loudness levels of 1366 CI patients, as recorded by SCAN, gathered from 30 Italian ENT clinics. Monitoring device use in cochlear implant recipients of all ages provides important information about the listening conditions encountered in recipients' daily lives that may support counseling and assist in the further management of their device settings. The findings for this large cohort of active CI users confirm differences between age groups concerning device use and exposure to various noise environments, especially between the youngest and oldest age groups, while similar levels of loudness were observed. We found that child groups spend more time in noisy environments at high levels of loudness, whereas adult groups spend more daily time in the quiet scene at lower levels of loudness. The data are shown in Percentile of scene and loudness exposure (Speech, Speech in Noise, Quiet, Noise, Music and Wind) on age classes (from 1 to over 75 years old). Our results can provided valuable reference information for clinicians for the purpose of troubleshooting, counseling, program optimization, and therapeutic intervention planning for CI recipients.

FS 10: Next-Generation Electrodes: Pharmalogical Structure Preservation

Effects of steroid application with a cochlear catheter on impedances after cochlea implantation

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Introduction: It is known that systemic and local administered steroids can reduce the insertion trauma and growth of fibrous tissue after cochlea implantation and thus increase the chance for hearing preservation and lower impedances. Several ways of administration have been described, e.g. systemic administration, diffusion via middle ear or drug releasing surface coatings. The motivation for the development of a cochlear catheter was to bring the drug to more apical regions without structural harm of the cochlear microstructure.

Methods: A silicone catheter was developed for drug administration into the inner ear. The Cochlear Catheter (Med-EL, Innsbruck) consists of a 20 mm long electrode dummy with a hollow lumen and an opening at the tip. Patients treated were without relevant residual hearing (> 80dB hearing loss at 250Hz) and received a cochlear flushing with triamcinolone via the catheter before cochlear implantation with a Med-El Flex 28 electrode. A „Low" group (4mg/ml) and a „High" group (20mg/ml) were treated with diluted triamcinolone. Impedances were measured directly after implantation in the OR, on day 3, day 10, day 17, day 24, at first fitting and at 3 month. Results were compared to n=5 recipients of the same electrode without use of the catheter or steroids.

Results: In the Low group impedances are stable until day 10 post-OP and start rising between day 10 and day 24 post-OP. For the high group impedances are stable until first fitting and rise up to the 3M appointment. The effect of delayed increase in impedance can be seen on all electrode contacts in the apical, medial and basal region of the cochlea. During and after the intervention no adverse events were observed.

Conclusions: The procedure introduced is a safe and effective method for drug delivery into all regions of the cochlea.

Hearing preservation after cochlear implantation using different steroid therapy models

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During recent years there was many approaches to have better hearing preservation rate during Cochlear implant surgery with residua hearing (Partial Deafness Treatment). The aim of the study was to assess how different models of steroid therapy influence hearing preservation after cochlear implantation.

Eligibility criteria were: age ≥ 18 years, cochlear duct length ≥ 27.1 mm based on the computed tomography (CT) scan and hearing levels within following limits: 10-120 dB in frequencies 125-250 Hz, 35-120 dB in 500-1000 Hz, 75-120 in 2000-8000 Hz. Exclusion criteria were occurrence of symptoms or diseases with cautious use or contraindication for steroid therapy and taking medicines that increase the steroids effects. Patients included in the study were divided into 3 groups: intravenous steroid administration, intravenous + oral steroid administration and a control group.

Hearing preservation was established based on pure tone audiometry (frequencies 125-8000 Hz, both octaves and semi-octaves) according to ISO 8253-1:2010. Hearing preservation was calculated based on the pre- and postoperative average hearing levels (PTA) according to special formula developed by the Hearring Group.

36 patients were included in the study. In all cases the cochlear implant electrode was inserted via the RW approach with a straight electrode length 28 mm. Patients with prolonged application of steroids had better results than standard steroid application and control group.

The steroid therapy stabilizes hearing thresholds and enables to preserve hearing abilities in adult patients. Combination of intravenous and oral steroid therapy seems to be the most optimal administration model.

Dexamethasone-eluting cochlear implant electrodes in combination with glucocorticoid hydrogels: effects on hearing preservation and impedances

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Background: Cochlear implantation is the first effective treatment for profound deafness in children and adults. The technical advances in the last several decades resulted in the development of hybrid CIs which combine the classic CI with a hearing aid. Therefore, the indication criteria were expanded to patients with more residual hearing. Thus, the preservation of the residual hearing has become a main focus of research.

Objectives: The aim of this study was to investigate for the first time short- and long-term synergetic effects of dexamethasone-eluting electrodes (DexEl) combined with topical administration of a 6% dexamethasone-loaded thermoreversible hydrogel (DexGel) on hearing preservation and impedances after CI in a guinea pig model.

Material and Methods : 40 guinea pigs were intratympanically injected with a Dex-loaded or control hydrogel (cGel) one day prior to CI. Animals were implanted unilaterally with Dex-eluting or control electrodes (cEl) and equally randomized into four groups: I: cGel+cEl+, II: DexGel+cEl, III: cGel+DexEl, IV: DexGel+DexEl). Compound action potential and impedance measurements were performed over a period of 4 months. Furthermore, histological analyses will be performed and correlated with hearing preservation and impedances.

Results: Preliminary results showed a protective effect of Dex-hydrogel (II) on residual hearing between 8 and 32 kHz. This effect could also be observed between 8 and 16 kHz in animals with Dex-eluting electrodes (III). Furthermore, animals treated with Dex-hydrogel (II) showed stable impedance values over the whole study period.

Conclusion: The preliminary results of the current study revealed a protective effect of topical Dex-hydrogel on residual hearing and impedances when applied prior to CI. A synergetic effect of Dex-hydrogel in combination with Dex-eluting electrodes could not be observed yet.

New electrode design: organic biocompatible coating

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Foreign body reaction following cochlea implantation leads to intracochlear chronic inflammation and fibrosis. These events might decrease the levels of the dynamic fitting range of loudness levels, increase the impedance and fibrosis degrades the sound transmission to the auditory nerve. Furthermore implantation can induce chronic inflammatory process in the cochlea and these processes can cause fibrosis. Increasing the biocompatibility of the implant might reduce inflammatory processes and foreign body reaction.

In a previous study an anorganic protein coating resulted in a significant reduction of the chronic inflammatory responses after cochlear implantation. In this study we test another promising coating, an organic protein coating.

We conducted ABR-hearing measurements and impedance analyses on female guinea pigs on different time points. In total 13 animals were bilateral implanted. After 3 months animals were sacrificed and the cochlea was removed and fixed for further analysis. The cochlea was examined for degenerated spiral ganglion using immunofluorescence staining. Moreover the cochlea was stained with Haematoxylin and Eosin to determine the coating effect. Immunofluorescence staining was furthermore used to detect the organic protein coating.

In eleven out of thirteen electrode fibrotic sheaths residuals of the protein were visible. The Immunofluorescence revealed that the implants were only partially still covered with protein. These findings correlate with the ABR and Impedance measurements. There was a significant difference between the two groups regarding the Impedance measurements. The organic protein coating proved to be beneficial by lowering the Impedance.

Nevertheless, as the evaluation of the histological data is still ongoing, this particular biocompatible organic protein coating might still prove to be a promising anti fibrotic coating. Further studies with improved adherence of the coating might lead to more substantial benefits.

Potential for pharmacological protection against loss of residual hearing after cochlear implant surgery using the clinical stage oral otoprotectant SENS-401

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Loss of residual hearing following cochlear implantation is a major concern for patients and constitutes a barrier to implant surgery. Sensory hair cell death is central to loss of residual hearing and concurrent treatment with an effective otoprotectant could potentially address this and enhance cochlear implant surgery outcomes.

SENS-401 is an oral, clinical stage drug candidate with orphan designation for sudden sensorineural hearing loss and platinum-induced ototoxicity.

In animal models, oral doses of 6.6 and 13.2 mg/kg SENS-401 demonstrated significant treatment benefit vs placebo against severe hearing loss induced by acoustic trauma (NIHL: 120 dB octave band noise 8-16 kHz for 2 hrs, mean acute hearing loss of 55+ dB) and cisplatin-induced hearing loss (CIHL: 8 mg/kg iv, 30 min infusion, hearing loss of 30-50 dB at D14). In the NIHL model, SENS-401 demonstrated significant and clinically relevant improvement of ABR threshold recovery (~130-430% enhancement) and DPOAE amplitude recovery (~230-630% enhancement). In the CIHL model, SENS-401 reduced ABR threshold shifts (up to ~79%) and DPOAE amplitude losses (up to ~78%) depending on frequency. In both models, SENS-401 demonstrated significant enhancement of outer hair cell survival.

SENS-401 has demonstrated good inner ear penetration after oral administration in rat with perilymph and inner ear tissue content of respectively 25-30% and 35-50% of plasma levels. In a recent phase 1 clinical trial oral SENS-401 was well tolerated in healthy volunteers, and achieved drug exposure levels well above those needed for efficacy in preclinical models.

Together, the preclinical efficacy data and pharmacokinetic properties consistent with healthy volunteer safety and pharmacokinetic data support the feasibility of effective hearing loss treatment with enhanced sensory hair cell survival in the clinical setting. Such effective otoprotection could potentially reduce loss of residual hearing after cochlear implant surgery.

Results of a double-blinded placebo controlled trial on the efficacy of high-dose systemic steroids for hearing preservation in cochlear implantation

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Aim: To assess whether a single, peri-operative, high dose of methylprednisolone can improve hearing preservation following cochlear implantation (CI).

Methods: Patients with hearing at 85 dB or better at 500 Hz in the ear to be implanted were randomly allocated to either treatment (methylprednisolone, 1g i.v. on induction of anaesthesia) or control (normal saline infusion). All patients received a routine "anaesthetic" dose of dexamethasone (8 mg i.v. on induction of anaesthesia). Implantation was undertaken with Cochlear's Slim Straight electrode via the round window. Audiometry was performed prior to implantation, and again at 3 and 12 months. The primary outcome was the level of residual hearing 12 months following cochlear implantation. Secondary outcomes included audiometry, lectrode impedance, and speech perception scores at 3 and 12 months after surgery.

Results: Forty-six patients were enrolled into the control group and 48 patients received the steroid. There was no statistical difference in hearing at 12 months, nor at 3 months following surgery. Electrode impedances did not differ between the groups.

Conclusions: There is an extensive experimental literature to suggest that steroids can reduce the loss of residual hearing during CI surgery, including when the steroid is given systemically. This paper demonstrates that high-dose local steroid injection at surgery is not effective in preventing a loss of residual hearing. Similarly, electrode impedances are not reduced by the high-dose steroid regime. Recent studies have suggested that steroid treatment may be more effective if used for a period of weeks after implantation. Future studies should explore this approach, or prolonged local steroid delivery via the cochlear implant.

FS 11: Focus on Bilateral Pediatric CI

Sequential bilateral pediatric cochlear implantation – Long-term usage of the second implant and factors predictive for its use

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Objectives: The primary objective of our study was to describe the usage patterns of the 2nd cochlear implant (CI2) in young adults who underwent sequential bilateral CI (SeBCI) as children, and to analyze factors that were predictive of usage. Our secondary objective was to describe the hearing outcomes in users and non-users of CI2.

Study Design: Retrospective cohort study in a tertiary, academic centre.

Methods: Pediatric implant recipients from a single tertiary pediatric centre were identified as they transitioned to a regional adult CI centre after the age of 18 years. Those who underwent SeBCI before the transition were enrolled in this study. Data was collected from a CI database and their clinical notes. This was supplemented by a questionnaire. The current usage of CI2 is described, and its association with other patient and treatment related variables were analyzed. The early speech perception scores under various conditions were also described, for users and non-users of CI2.

Results: Our study included a total of 56 participants. The mean age at the 1st CI was 5.8 years and that at CI2 was 14.7 years. 60% of the participants were users of CI2 and the inter-implant interval was the only significant predictor on multivariate analysis. When stratified based on the inter-implant interval, all participants with an interval of 3 years or shorter were using CI2, as compared to 53.2% of those with a longer interval. The early speech perception scores under quiet, monaural (CI2 only) conditions were significantly better in users of CI2, as compared to non-users.

Conclusions: Our results suggest that a longer inter-implant interval predicts for non-usage of CI2. From a practical standpoint, bilateral CI should be done simultaneously when possible, and if not, no later than 3 years after the 1st CI.

Consistency of using the auditory prosthesis device post sequentially implanted cochlear implant: datalogging Evidence

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Objective: In many studies evaluating the effect of sequential bilateral cochlear implantation in Sensory neural hearing loss, device use is not taken into account. This study aimed to objectively measure daily Cl use and factors influencing consistent device use in patients using one and compare it to two CIs during daily CI uses

Study Design: A retrospective study that looks at and measures the daily Cl use. Subjects will be obtained from users of Cochlear Nucleus 6 speech processors. The sample includes patients who were using Cochlear Nucleus 6 speech processors in their first implant and their sequentially implanted device

Materials and Methods: Daily Cl use, duration, and frequency of coil-offs per day, and the time spent in multiple intensity ranges and environment types were extracted from the data log saved during clinic appointments need to be reviewed and analyzed.

Results: We are still analyzing the logging Data from 15 and it will be ready to be present soon

Long-term development of localisation ability in sequentially implanted cochlear implant recipients.

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The aim of this retrospective study was to investigate how localisation ability develops over time for sequentially implanted paediatric recipients. The trajectory of localisation was assessed by modelling localisation scores over time and identifying factors that influence general ability and the rate at which it improves. The intended application of the model was to use it in clinical practice to inform families on an individual recipients' progress against expectations.

Longitudinal data was collected at routine clinic appointments for a period of up to 10 years after sequential implantation. Five loudspeakers in a semi-circular arc were used to assess localisation. The angle of error was calculated for each response and the mean absolute error (MAE) in degrees was recorded along with time since second implant. All sequentially implanted recipients in Nottingham were eligible for inclusion within the study. Data were available for 138 of 166 recipients.

Analysis of the data showed that localisation ability improves over time following sequential implantation, with an average reduction in MAE of 4.1 degrees per year. Overall localisation performance was influenced by inter implant interval (III), with MAE increasing on average by 1 degree for each additional year between first and second implant, and by age at first implant (AAI), with MAE increasing on average by 2.3 degrees with each additional year before first implantation. Neither factor influenced the rate at which localisation improved over time.

The data show that the development of localisation ability is a complex process in sequentially implanted recipients, affected by several factors. The model can generate predictions to determine whether an individual's localisation ability is developing as would be expected based on their III and AAI. This tool can be used to inform clinical practice and give realistic expectations both pre and post –implant depending on the recipient's AAI and III.

What happens when you offer metachronous contralateral cochlear implantation to children with an existing device? Impact of the introduction of bilateral funding to Nova Scotia. The ‚catch-up cohort' - 2007 and onwards

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Objectives: In 2007 the Provincial Government of Nova Scotia approved funding for bilateral cochlear implantation for children. New candidates were to be offered synchronous bilateral implantation. Existing unilateral users and many whose families were motivated to request a device for the contralateral side were evaluated and counselled carefully before making their decision.

Our experience captures a unique period in the history of cochlear implantation and one that will never be repeated in our programme.

More recently, the number of children suitable for a second-sided metachronous implant has dwindled as all new candidates are offered synchronous bilateral devices from the outset. What remains is a log of prospectively collected data documenting the progress of our own 'catch-up cohort' during this peculiar time.

Method: Of 34 children identified, 21 children proceed while 13 chose not to. Demographic data captures age of first implant, second implant or decision not to proceed and the duration inbetween. Aetiology of deafness, presence of amplification on second side pending implantation and outcomes after both first and second surgeries.

Qualitative data to gauge family and recipient responses to the initial decisional conflict to proceed or refrain and subsequent impressions of the pros and cons of a second device will be presented. We sought to establish whether the patients and their families felt that the effort had been worthwhile.

Results: 5 of the 21 had no problems, 13 struggled requiring many hours of counseling to maintain motivation and use at least for school. 3 children had other issues impeding their general progress.

Conclusions: Our experience is best described as challenging, worthwhile but not overwhelmingly good.

While our findings might resonate with those who have lived through similar times, the lessons learned may also be of assistance to those who are yet to go through this experience and need to plan resources accordingly.

Bilateral vs unilateral cochlear implantation in Mandarin speaking children: Surgical experience and preliminary results

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For children with prelingual deafness, bilateral Cochlear Implant (CI) use is beneficial in terms of sound localization and speech recognition in quiet and in noise when compared to unilateral CI use. However, little is known about the benefits of bilateral CI use in children with prelingual deafness whose mother tongue is Mandarin, a tonal language. Furthermore, sufficient data on surgical approaches are currently lacking.

Objectives: This study aims to collect more evidence on these topics.

Material and Methods: 30 children (aged 12–18 months) with prelingual severe to profound bilateral sensorineural hearing loss were implanted with a CI at the Peking Union Medical College Hospital in Beijing. 10 children were implanted unilaterally, 20 were implanted bilaterally. All children were from Mandarin-speaking families. The surgical approach was documented. The following outcomes are investigated over a period of three years and compared between the unilateral and the bilateral group:

• Auditory development
- LittleEars Auditory Questionnaire (LEAQ)
- Speech, Spatial and Quality of hearing questionnaire (SSQ, parent version)
- Categories of Auditory Perception (CAP)

• Speech perception
- Mandarin Early Speech Perception test (MESP)

• Speaking performance
-Speech Intelligibility Rating (SIR)
-Mandarin Paediatric Speech Intelligibility test (MPSI)

•Spatial hearing
-Reaching For Sound (RFS)

Results and Conclusion: At 1-year post-CI activation, average SSQ, CAP, SIR, and LEAQ scores improved. The bilateral group had better scores in the spatial domain of the SSQ questionnaire than did the unilateral group. Due to the very young age, only a small number of children could be tested for speech recognition and spatial hearing skills.

The data collected so far contribute to the assessment of benefits of bilateral CI use in toddlers and to the study of their auditory skills development.

Simultaneous bilateral cochlear implantation in very young children without preoperative computed tomography

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Bilateral cochlear implantation (CI) is surgical standard in infants and young children suffering from severe to profound hearing loss. Newborn hearing screening allows for an early diagnosis. This resulted in an increasing number of children receiving their CI within the first year of life. Bilateral simultaneous CI offers additional advantages in regard to the acceptance of the implants and the fitting and rehabilitation measures. Moreover, having one surgical session and one hospital stay for both ears may be more convenient and practical for the parents and the child.

Preoperative radiological diagnostics routinely included Computed Tomography (CT) and Magnetic Resonance Imaging (MRI). Recent studies have shown that X radiation and especially CT diagnostics of the brain and the facial bones within the first year of life increases the risk of brain and lymphoid cancer. As a consequence, preoperative imaging diagnostics was limited to MRI, only in cases with suspected malformation CT is performed additionally.

A series of bilaterally simultaneously CI implanted children since 2012 was analyzed. One aim of the study was the evaluation, if single MRI diagnosis preoperatively allows for a safe surgical procedure.

From 2012 - 2016, 26 children with congenital hearing loss have been implanted bilaterally simultaneously. Mean age of the children at the time of implantation was 13.45 months (min: 7.49; max: 34.61). The mean duration of CI operation for both sides was 3:00 (min 2:20; max: 5:36) hours. Neither postoperative complications nor complications related to anaesthesia became evident.

Before July 2013 a CT was performed routinely. Since then, CT was limited to cases with suspicion of a possible malformation of the cochlea, which was the case in only 5 %. Both groups did not differ in operative time and complication rate. All children achieved a remarkable improvement in hearing and speech development, confirmed by various age appropriate evaluation procedures.

The data demonstrate that bilateral simultaneous CI can be performed safely in very young children within a reasonable operative time and without any complications. Bilateral simultaneous fitting from the beginning leads to a better acceptance of both CIs and avoids problems that may occur in the rehabilitation when each ear is implanted separately. This results in a very satisfactory improvement of hearing capability and speech development. Leaving out preoperative CT diagnostics in routine did not affect the safety of the procedure.

FS 12: Experiments in Speech Coding Strategies

Measurement of spectrotemporal modulation perception in infants

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Objectives: Discrimination of acoustic spectrotemporal modulation (SM) patterns is crucial for speech perception and spoken-language development. Tests of SM perception correlate significantly with speech understanding and device efficacy in postlingually-deaf adults and prelingually-deaf children who use cochlear implants. Therefore, SM perception could be used to assess device efficacy in infants with CIs as well. However, SM sensitivity is immature at 7-10 years of age and the earlier developmental trajectory is unknown. The present study examined SM sensitivity in infants.

Materials & Methods: Normal hearing 6-7 month old infants and adults were recruited through a human subjects pool. Infants passed an OAE screen while adults passed behavioral screening in both ears. SM sensitivity was measured using a modified version of the „Spectrotemporal Modulation Ripple Test" (Landsberger et al., 2013). Stimuli were 1s broad-band noises with spectrotemporal modulation sweep rate of 5Hz, peak density from 1 to 16 peaks/octave presented in sound field at 70dB SPL and 2s isi. A single-interval, forced-choice observer-based procedure was used to measure listeners' ability to respond when the ripple density of the stimulus was less than 20 RPO and the density associated with the 0.7 point on the psychometric function was taken as threshold.

Results: Nearly all adults and over half of the infants tested provided thresholds. Adult threshold was better than infants showing that infant SM sensitivity was immature. However, both threshold improved with ripple depth to a similar degree at both ages suggesting that infant frequency resolution of the ripple peaks is mature at 6 months old.

Conclusions: Infant SM sensitivity is immature and will impact measures of SM perception independent from spectral frequency resolution. Implications of these findings for designing clinical tests of SM perception for young CI listeners will be discussed.

Temporal processing and speech recognition performance in patients with cochlear implant

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Aim: Adult users of cochlear implant (CI) demonstrate impressive performance in speech recognition in silence after (CI) surgery. However, problems in central hearing abilities remain, which complicates understanding in certain situations, such as in competitive listening and in the perception of suprasegmental aspects of speech. There are some studies in the literature suggesting that the temporal processing abilities are directly associated with speech perception.The argument supporting this proposition is that many characteristics of hearing information are somehow influenced by temporal aspects. However, there are few studies in the literature evaluating the temporal processing abilities in the population of CI users. Hence, in this study we aimed to assess the temporal processing abilities with gaps in noise test (GIN) and the speech discrimination performance without noise and to investigate the relationship between temporal resolution and speech discrimination scores in patients with CI.

Methods: The study was conducted on 14 cochlear implanted patients with mean age of 36.64 ±15.59. In order to reveal the relationship between speech recognition performance and temporal resolution Pearsons correlation test was used.

Results: The mean values for GIN threshold was 10.78±2.86 ms, percentage of correct response was 39.71±12.37, word discrimination score obtained by recorded materials was 59.71±20.24 percent and word discrimination score obtained by live voice was 53.71±17.09 percent. In the present study we observed that there was no significant correlation between speech discrimination scores and temporal resolution performans in patients with CI. We only found significant correlation between GIN thresholds and total percentage scores.

Conclusion: It was verified that adult users of cochlear implants have significant alterations in temporal processing abilities and speech discrimination performance but temporal speech recognition performance was not related with temporal resolution performance. It was may be explained by there are numerous effective mechanisms on speech recognition.

Dynamic current focusing: a novel approach to loudness coding in cochlear implants

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Objectives: In an attempt to improve spectral resolution and speech intelligibility a novel loudness encoding strategy, called "Dynamic Current Focusing (DCF)", was developed. DCF uses tripolar (TP) stimulation near threshold and gradually broadens the excitation (by decreasing compensation coefficient σ) to increase loudness without the need to increase overall current. In a recent pilot study, DCF showed improved spectral resolution after a few hours of adaptation. However, battery life decreased to 1.5-4 hours. The current take-home trial investigates the long-term effect of an optimized, more energy-efficient, implementation of DCF.

Methods: Speech intelligibility in noise and spectral ripple discrimination was assessed among 20 HiRes90K (Advanced Bionics, Valencia, USA) CI-users. Subjects were using their own clinical program (baseline), the DCF strategy and, again their clinical program (final), to rule out learning effects. The test days were preceded by a 5-week adjustment period.

Results: The improvement with DCF was +0.9 ripples per octave for spectral resolution (65dB) (p=0.012) and -1.4 dB SNR for speech intelligibility in noise (45dB) (p=0.012). When compared to the final measurement, however, this significant improvement disappeared and a significant (p=0.012) decline of +1.9 dB SNR in the speech-in-noise test (65dB) was found. Thus, both measures showed a significant learning effect over time. Battery life with the newly-implemented DCF increased to 9 hours on average.

Conclusion: The DCF strategy has the potential to improve both speech understanding in noise and spectral resolution, although the current results were below expectations based on the pilot study. Moreover, the found learning effects complicated the interpretation of the current results. Unfortunately, the method to increase battery life also caused insufficient levels of current focusing across the dynamic range. Further development of the DCF strategy should focus on finding the right balance between energy efficiency and degree of current focusing.

Sound coder stimulation rate and voice pitch perception in cochlear implant users

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Objectives: We employed the dual filter-bank "STEP" coder to separately control the spectral and temporal modulation resolution of analysis channels. Previously we compared vowel pitch ranking and gender classification with eight subjects using enhanced modulation at F0 - including across-channel synchronised modulation to the ACE coder. There was no significant improvement using modulation enhanced coding versus ACE across subjects.

Methods: In a follow-up experiment we looked at the effect of stimulation rate on voice pitch perception. Since there are large inter-subject differences in overall temporal pitch acuity we hypothesised that some subjects' performance may be more greatly influenced by carrier rate than others, or that some subjects may find sound quality satisfactory with lower carrier rates than those in their clinical processors. We used a version of STEP with a very

short temporal envelope analysis window of 2 ms which allows a very low latency real-time processing implementation and large maximum modulation bandwidth. Subjects were tested using carrier rates of 1000, 500 and 250 pps/ch with modulation bandwidths controlled via low-pass filtering.

Results and Conclusions: Pilot data indicated that the new low-latency coder provides very good sound quality compared to ACE using 1000 pps/ch or 500 pps/ch. Also the modulation bandwidth could be tuned at different carrier rates to optimize voice pitch perception based on temporal cues. This opens the potential for lower stimulation rates to be used in CI coding while maintaining optimal temporal resolution.

Multipolar stimulation in a computational model of the implanted human cochlea

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Objective: A computational model of cochlear implant stimulation was used to examine several different types of multipolar electrical stimuli, in order to investigate to what degree multipolar stimulation can be used to manipulate neural excitation patterns induced by cochlear implants.

Materials and Methods: Electrical field patterns were simulated in a volume conduction model of the implanted human cochlea based on the Boundary Element Method. The volume conduction model employed five realistic three-dimensional cochlear geometries, each containing an electrode array inserted either along the later wall, in the middle of the scala tympani, or in a perimodiolar position. The simulated electrical field patterns were fed into an active electrical cable model of the auditory nerve fibre in order to simulate neural responses to arbitrary stimuli in 3200 auditory neurons defined in the cochlear geometries. The nerve fibre model used a double cable setup and was governed by a human-based Schwarz-Reid-Bostock neural kinetics scheme (Schwarz et al., 1995). Neurons were modelled both as healthy and partially degenerated nerve fibres. Neural responses to monopolar, (partial) tripolar, phased array and phantom electrode stimuli were simulated and analysed.

Results and Conclusions: Results showed that multipolar stimulation could be used to focus, broaden or shift neural excitation patterns in the cochlea. The degree to which this was possible depended heavily on the amount of electrical field interaction at the site of stimulation. However, using simultaneously stimulated opposite-polarity pulses invariably carried an additional cost in power consumption, and sometimes resulted in undesired secondary regions of excitation, raising the question of whether the potential benefits of multipolar stimulation are significant enough to justify the practical drawbacks.

FS 13: Empowering satisfaction with CI

Novel computer-based therapy enhances speech perception in Cochlear implant users

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Introduction:The limitations of auditory therapy in the UK are: 1) they require face-to-face interaction and 2) computer-based programmes utilise the same pitch and tone. Since we explored the possibility of providing personalized auditory therapy in patients' homes, we aimed to investigate if our new adaptive computer therapy, which varies tone and pitch based on patients' deficiencies, is more effective at improving speech perception

Methods: In this randomized control trial, candidates were split into two groups and underwent three rounds of testing. In the first round, all candidates identified words that they heard and the percentage of correctly identified words recorded. In the second round, they received training listening to sentences and identifying the words in the sentence. If they failed to identify a word correctly, the sentence was replayed identically for candidates in the first group. In the second group, specific emphasis was placed on the incorrect word by varying its tone and pitch. In round three, they underwent testing again and the percentage of words they were able to correctly identify before and after training was compared. A paired t-test was used to analyse the data and see if there was any significant difference in the levels of improvements between the two groups.

Results: There were 8 and 9 candidates in the first and second group respectively. The mean percentages for candidates in the first round of testing in the first and second groups were 50.63%(95%CI 37.3-65.2) and 53.5%(95%CI 38.1-69.3). The mean percentages for candidates in the second round of testing were 52.5%(95%CI 38.4-68.2) and 67.78%(95%CI 54.6-80.9). The mean improvement in scores was greater in those in the second group than first group(p=0.0432).

Conclusion: Our new computer program improves their speech perception to a greater extent with the same amount of training. Given the promising results, broadening the study to a larger patient population would be ideal.

Examination of psychophysical parameters at cochlear implanted patients

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Objectives: The cochlear implant is a hearing aid as hair cell prosthesis, that is connected to a programmable sound

processor. The fitting of audio processors is essential for hearing sounds, speech understanding or maybe listening music. To learn fitting cochlear implant devices, necessary to know the variables of sound processors programming and how the rehabilitation is going.

Materials and methods: In this research two groups of patient were collected to statistically analysing. The selection based on development of speech; in first group was adults as postlingual recipients, and the other prelingual group for children. The main psychophysical parameters were registered, and electrical evoked comfort level was analysed.

Results: Three sessions separation were discernible from cochlear implant fitting tests; in beginning session the comfort level increased to stabilize at the highest level, as adaptation phase. In next long stabilized period the comfort level was not changing or minimal. In last regeneration phase, the comfort values decreased and fixed. The changing of phases generally really similar in same groups, but between two groups were big differences of value levels.

Conclusion: The cochlear implant is the most effective treatment method among the deaf patients. The rehabilitation is very long time for all recipients and necessary to estimate the outcome of treatment. The comfort levels at Pre- and postlingual groups were comparable, so there was permitted to conclude the fitting of adult with estimation of children fitting. The average sessions of comfort level determination could be help for right using or developing of fitting software.

Electrophysiological detection of electrode tip-foldover in perimodiolar cochlear implant electrode arrays

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Introduction: The exact position of the CI electrode array within the scala tympani is essential for a satisfying audiological outcome. If the electrode array folds over the result will be a worse hearing outcome. The intracochlear position can be determined radiological either intra- or postoperative. The aim of our study was to detect intraoperative electrophysiologic characteristics to identify and characterize the electrode foldover.

Material and Methods: In a retospective setup patients which showed postoperative perimodiolar electrode- and tipfoldovers, at three tertiary referral centers, were included. The ponit of the foldover was detected, characterized and the intraoperative Auto-NRTs were evaluated in terms of abnormality.

Results: Electrophysiologic abnormalities were detected and showed specifics in terms of electrode dimensions and direction of the foldover. Voluminous electrodes showed greater electrophysiologic variability whereas slim electrodes are less conspicuous.

Discussion: The cochleaimplantation for hearing impaired patients with bilateral and unilateral deafness has become a major role in modern auditory rehabiliation. Perimodiolar electrode arrays may fold over during the insertion and hence have a negative influence on the audiological outcome as well as on vertigo and facial costimulation. Elekcrophysiologic voluminous and slim elelctrode arrays show certain specifics. Nevertheless dead regions of the spiral ganglion have to be kept in mind.

Evaluation of the Audio Processor Satisfaction Questionnaire (APSQ)

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Hearing implants such as cochlear implants, middle ear implants, and bone conduction devices amplify or restore hearing in individuals with hearing loss. In recent years patient-reported outcomes, especially subjective benefit on quality of life and quality of hearing, have gained increased attention in hearing research. While generic and hearing-specific questionnaires on quality of life have been widely used, a reliable and validated questionnaire on user satisfaction with their audio processors has been lacking for hearing implants.

To validly and reliably evaluate user satisfaction with everyday use of their external device, MED-EL developed the Audio Processor Satisfaction Questionnaire (APSQ). This questionnaire consists of 15 items answerable on a visual analog scale ranging from 0 (no satisfaction) to 10 (very high satisfaction). Principal component analysis had shown that these 15 items can be allocated to one of three subscales: Wearing Comfort, Usability, and Social Life. The aim of present study is to investigate the test-retest reliability and validity of the questionnaires in 40 hearing implant users. All subjects were asked to complete the APSQ twice with a time window of 2–4 weeks in between.

A preliminary analysis was performed on 36 subjects. Their median total score (8.8) showed a high level of satisfaction. The median scores for the three subscales also showed high levels of satisfaction: Wearing Comfort (8.3), Usability (9.0), and Social Life (8.4). The test-retest reliability will be calculated when the study is closed.

According to the preliminary results, subjects are highly satisfied with their audio processor. In general, the APSQ also allows user satisfaction to be compared across different processor types and/or generations.

Improving performance of unilateral CI users

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Cochlear implants (CIs) provide severe to profoundly deaf recipients with substantial speech intelligibility in quiet. In difficult listening situations such as background noise however, communication often remains challenging. For unilateral CI recipients with a bilateral hearing loss, speech intelligibility for speech sources on the non-implanted side is further impaired by the head-shadow effect. One possibility to overcome this impairment is the use of Contralateral Routing of Signal (CROS) systems, which capture sounds from the non-implanted side and wirelessly transmit them to the implant processor, therefore increasing audibility.

With the Phonak Naída Link CROS, a wireless CROS system is now available that is compatible with the latest generations of Advanced Bionics sound processors, Naída CI Q70 and Q90. Several studies have investigated the speech intelligibility benefit such a system is able to provide to unilateral CI users.

In addition to acute speech intelligibility tests, all studies also included chronic trial phases. The subjects' feedback was gathered regarding sound quality, subjective speech intelligibility benefit as well as the practical usability of the device in everyday life.

The Naída Link CROS enables consistent listening performance regardless of the target speaker location. For speakers located on the non-implanted side, benefits of up to 8 dB SRT and 30% speech intelligibility were shown, compared to listening with the CI alone. Subjects reported high satisfaction with the device itself as well as perceived speech intelligibility benefits.

The wireless CROS system provides a viable option to improve upon unilateral implantation for rehabilitating bilateral deafness. Such a system is most applicable in cases where medical or financial reasons only permit unilateral implantation.

Empowering and motivating cochlear implant recipients with access to self-directed rehabilitation through direct streaming

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Traditionally, Auditory Rehabilitation is carried out with support from a Speech and Language Therapist, usually in a clinical centre. Training may be required to acquire optimal performance from a Cochlear Implant, for example, speech recognition in challenging situations such as distance, background noise, different speakers, telephone use, etc. In addition, sequential cochlear implantation and new indications, such as SSD or asymmetrical hearing loss, require intense and specific auditory training.

Clinical studies of auditory plasticity following placement of Cochlear implants suggests that additional auditory training may be needed for reorganization of the brain to occur (1). Traditionally, this training has required an economic and time effort on the part of the patient, family or caregivers.

The literature also emphasizes many reasons that support the importance of daily practice taking advantage of routine activities and in natural contexts (2). There are software programs designed for this purpose, but there may be barriers to access such as cost and technical equipment requirements, etc.(3)

This paper will present one approach to empowering Cochlear Implant recipients to use the opportunities for listening practice and rehabilitation afforded by the Nucleus 7 sound processor and streaming with IOS devices. Options for using a range of different commercially available apps, many of them free, will be shared along with ideas for using data streaming, not always with a specific educational purpose, but through activities that can be more pleasant, engaging and entertaining for the patient such as listening to audiobooks, podcasts and other listening resources to build auditory experience and confidence. This paper will present options for using the N7 MFI processor for self-directed rehabilitation using streaming, to provide the patient with training possibilities tailored to his or her interests and needs, adapted to maximize and motivate their time availability; the incentive being the ability to select and design their own varied listening program.

The key elements of how to support and motivate recipients to design their own listening program plus the options and how this has been applied in clinical practice as well as clinical examples and outcomes will be addressed.

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2. Lone Percy-Smith, Tenna Lindbjerg Tønning, Jane Lignel Josvassen, Jeanette Hølledig Mikkelsen, Lena Nissen, Eveline Dieleman, Maria Hallstrøm & Per Cayé-Thomasen. Auditory verbal habilitation is associated with improved outcome for children with cochlear implant. Cochlear Implants International Vol. 19, Iss. 1, 2018

3. Olson AD. Options for Auditory Training for Adults with Hearing Loss. Seminars in Hearing. 2015;36(4):284-295. doi:10.1055/s-0035-1564461.

FS 14: Listening Effort and Performance in Pediatric CI

EEG variations as estimators of listening effort during recognition of words in noise in unilateral and bilateral sequential adult cochlear implant users

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The listening effort, defined as "the mental exertion required to attend to, and understand, an auditory message" [McGarrigle et al 2014] is a matter receiving wide interest in the scientific community. In particular the challenge is its evaluation beyond the self-report data obtained through questionnaires or individuals' verbal reports. Multiple evidences highlight a role for posterior Alpha and frontal Theta EEG rhythms variation for the estimation of the listening effort, implying an inhibitory activity toward irrelevant/distracting stimuli for Alpha, while working memory and lexico-semantic processing for Theta [Strauß et al 2014; Wisniewski et al 2015]. The evaluation of the listening effort appears extremely worthy in hearing impaired patients, since the presence of noise or distortions in a speech signal increases cognitive demand and listening effort [Stenfelt & Rönnberg 2009]. In addition, such evaluation it would be interesting to be investigated comparing the unilateral CI with the bilateral CI condition, since the availability of more auditory information in the second one.

The balance between Theta and Alpha EEG rhythms seems essential for the word recognition. Therefore aim of the present study was the assessment of the listening effort during a word in noise recognition task in CI adult users before and after the implantation of the second CI. Present results evidenced an increase in the frontal Theta and parietal Alpha for a quite difficult noise condition, and for Theta in correspondence of the stimulus. Moreover, frontal Theta activity increased along the task for the same difficult noise condition during and after the stimulus.

These considerations appears useful for the neurophysiological characterization of CI users in order of further applications toward the management of cognitive resources and tailor-made rehabilitations.

Listening effort during speech in noise recognition: a neurophysiologic evaluation of consecutive sound processors

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The technological development in the cochlear implants (CI) has been producing external processors designed to increase performances in patients facing word in noise recognition conditions.

In our study we investigated the neurophysiological responses underlying these abilities, firstly aiming at obtaining an electroencephalographic (EEG) measure of the listening effort experienced by patients. Secondly, we investigated whether the technological progress reduced such listening effort levels in these patients. In parallel to this neurophysiological assessment, also behavioral performances have been evaluated, in order to test the eventual influence of different processors on the outcome of the task execution, that is word in noise recognition task.

EEG Theta and Alpha rhythms activity has been estimated in Unilateral CI users undergoing word recognition test in the cocktail party background noise with a signal to noise ratio + 10, when employing four consecutive generations of CI sound processors, using or not the noise-reduction filter function.

Results showed that from an older processor to a more recent one, an increase in the speech discrimination has been observed, above all in the filtered condition.

Comparing the conditions with and without the noise-reduction filter, the latter one reported an increase in the EEG Alpha and Theta activity, especially for the two more recent processors. In the comparison between the different generations of sound processors the newer models reported the lowest levels of cognitive effort, as indicated by the lower values of Theta activity. These considerations support the usefulness of the employment of such EEG estimations for the assessment of clinical devices development. The present results also showed that technological evolution improved speech discrimination in noise, reducing the cognitive effort.

Listening effort in children with cochlear implants

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As the enrollment of hard-of-hearing students in mainstream schools steadily increases over the years in

developed regions such as Flanders (De Raeve & Lichtert 2012), the relationship between effortful learning and chronic fatigue in a noisy environment has become an emerging concern. To remedy the situation, a method must first be devised to effectively measure what has come to be known as "listening effort" – the extra load on finite cognitive resources when one attends to on-going auditory speech signals. We have, therefore, developed a novel behavioural listening effort assessment targeting especially the Dutch-speaking school-age population. The first part of the tool consists of a classic word recognition task performed in quiet and in noise. In addition, a child is asked to classify the target word into one of two categories based on its meaning. The response time (RT) recorded during the classification portion is considered a measure of listening effort, and different categorization tasks tap into different depths of cognitive processing to be performed on the words. After administering the assessment to more than 100 normal-hearing participants, it had been shown that RT tended to increase when auditory signals became more degraded or when processing moved into a deeper level. Moreover, listening effort (as measured by RT) decreased with age from early school-age years until around mid-teenage years. This age effect remained even after maturation in eye-to-hand coordination had been accounted for. Armed with the new tool and its associated normative data, we have set out to measure listening effort in children with cochlear implants (CI) and will present the findings from this new study during the CI conference.

Relationship between the hearing ability and the results of WISC-IV in children with cochlear implants

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Objectives: The present study was conducted to examine the relationship between hearing ability and the results of evaluation by WISC-IV in twelve children with cochlear implants.

Method: Assessments of the children's hearing ability was conducted by sound-field threshold measurements and the children's performance in speech recognition tests, speech discrimination tests and speech discrimination tests in noise.

Results: We found no correlation between the full-scale intelligent quotient (FSIQ) and the age at which the children received their cochlear implants. There were significant differences between the verbal comprehension index (VCI) and the perceptual reasoning index (PRI) in three children. Two of these 3 children had lower VCI scores as compared to the PRI scores; furthermore, their FSIQs were also low.

Conclusion: One children who got low scores on WISC-IV results had problems with her circumstance. Her sound processors and cables had not been well maintained because her parent did not care so much for equipment. Malfunction or breakage of sound processor equipment could cause poor hearing performance. Another children who got low scores on WISC-IV might have retro-cochlear hearing problem. Our results demonstrated that having well maintained sound processor is vital for children's best hearing performance, and hearing ability influence the language/learning ability in children with cochlear implants.

A shift of focus: using functional listening skills to guide paediatric cochlear implant candidacy and measure outcomes

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Introducation: Increasingly parents and professionals are looking for more than an audiogram and speech perception results to understand a child's real world listening skills to make decisions about implantation and intervention. The Functional Listening Index-Paediatric (FLI-P) was developed to provide a measure of listening development from birth through to 6 years. Items cover auditory skills in natural settings that underpin language, literacy, communication and social competence, listening from a distance, in noise, and the subtleties of language conveyed through audition.

Objectives: To determine the impact of using the FLI-P in evaluation on age of identification; levels outside traditional criteria; candidacy length, parent levels of engagement; and on measures post implantation.

Materials and Method: A retrospective analysis of the FLI-P use with over 500 children in a cochlear implant and early intervention program. Group analysis compared children with different levels and types of loss with different devices. Specific analysis examined age of implant (from 6mths), additional needs; family contexts; languages; ANSD; and SSD.

Results: Group data indicate strong levels of concurrent validity. Differences in individual trajectories provide evidence of a strong impact on age of evaluation and outcomes outside traditional candidacy levels. Outcomes post implantation were indicated sooner than in traditional measures. Listening scores at 3yrs were predictive of language scores at 5yrs.

Conclusion: Integrating functional listening as a critical component of evaluation and use as an outcome measure provides the opportunity to bring a child's real world listening skills into candidacy considerations and quantify cognitive components of auditory skill development. Use demonstrated sensitivity to discrete changes and acquisition of listening skills to support early choices and informed decisions throughout evaluation and post-operative progress.

FS 15: Role of Music in CI Habilitation

The role of music activities to the perception of speech and language development in children with cochlear implants

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Objectives. It is known that the greater the area of the brain that is activated, the more synaptic learning and plasticity changes occur in that specific area.

Research indicates that developing the musical brain is multiply represented across different parts of the brain, can support the underlying plasticity of the brain and can boost early development of communication skills.

Material and Method. Our results show that 11 children with CIs engaged on music have enhanced perception of words, sentences and auditory working memory compared to other children with CIs. The children with CIs who are engaged on music (particularly singing), have enhanced word finding (naming) and rhyming skills and enhanced speech perception in background noise.

Results and Conclusions. The music perception in quiet and noise was better in the group of bilateral CI users.

The more the parents and children sing predictable children's songs, the better these children sing the rhythms of songs, while attention-related brain responses for predictable changes in music (pitch, intensity, duration, timbre, pauses) are stronger and earlier. Music activities are also associated with better perception of speech in noise. These findings can be related to the effects of the rhythm of song on prediction and temporal attention, connectivity and oscillatory activity in the brain. (Ritva Torppa, 2017).

Children with CIs who participate in musical activities are better at the perception of pitch, intensity, sentence and word stress than other children with CIs. As 70 % of the variance in word finding (naming) skills and 45% of the variance in verbal IQ can be explained by the perception of prosodic stress, and the musical activities of the child and those of the parents.

The effects of musical activities such as singing on auditory attention and perception should be studied further. Singing is a promising tool for the rehabilitation of CI children.

The role of music in families with normally hearing children compared to children with cochlear implants and/or hearing aids

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Familial involvement has been shown to have a positive impact on children's speech/language development, as well as their social and educational progress. However, what about music? Children with normal hearing (NH) are often involved in informal music activities as part of their upbringing. Parents often incorporate music into everyday routine and in school, NH children are involved in music classes. Music participation for children with a hearing impairment (HI) does not always follow the same path as NH children as often more time is dedicated to speech/language development, and parental attitudes and perceptions may shift regarding their child's musical potential. Many parents have the perception that their child may be less able at music lessons due to their HI, and do not engage them in musical activities as they would if the child had NH. This study aims to look at the role of music in families of children with and without hearing loss, to provide information for professionals and parents around integrating music into a HI child's day-to-day life.

A study-specific questionnaire, the Role of Music in Families Questionnaire (RMFQ) was administered to parents/guardians of children with 56 NH children and 25 children with a HI (17 with hearing aids, 8 with cochlear implants). The RMFQ included seven subsections covering: General Information, Childhood Music Participation and Experiences, Attitudes and Reactions to Music, Music Resources, Importance of Music in the Family, Child's Music Listening Preferences and Future Perspectives. Children were aged 2-6 years, and yet to start primary school.

Results showed that, on average, music held a similar level of importance for NH and HI children's lives, and their family. The attitudes of both groups were overall very positive, with only a few significant differences such as more HI children learning percussive instruments compare to the NH children. There were differences in relation to the child's participation level and enjoyment, but the importance of music's role in the family is not dramatically differed by the presence of a hearing loss.

Helping little ones develop listening, language and literacy using music on the go!

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A growing body of evidence suggests that musical activities can enhance the listening brain and develop executive functions, including Literacy. Empowering families of newly diagnosed babies and infants with a hearing loss, through early intervention home based support is proven to be beneficial. Music can captivate babies and allows them to explore and demonstrate their awareness of sound in an easy, more developmentally appropriate way, through body movements, facial expressions, vocalizations and playing instruments. Babies listen for predictable melodies and harmonies as found in lullabies (Barker & Macklinlay, 2006). The BabyBeats™ early intervention resource is a musical habilitation resource which was designed to help improve early parent- child bonding, listening behaviour, communication skills, and social emotional development, pre- and post-implantation. To give parents the opportunity to engage with their child in their daily routines a mobile application was created.

The families visiting our centre used the app and audit data were collected based on a simple parental and professional questionnaire. The collected feedback was positive and ideas from the resource were carried over into the family's everyday routines. In the monitoring phase increased vocalization, attention, and anticipation of the activities were observed. Increased confidence in singing, moving, and playing with their baby was also reported by these families.

These outcomes are encouraging as they support the aims of the musical rehabilitation resource and help the natural development of attachment, supporting babies and toddlers to build early developmental skills essential for later language development as they are waiting for a cochlear implant.

Development of music skills after cochlear implantation – Case report

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Objectives: Main aim of the cochlear implantation in congenital or acquired total and partial deafness is provision of systematic development of hearing, speech and communicaton skills. Excellent results of rehabilitation in a large group of patients implanted at different ages made the development of artistic skills of patients a measure of progress in therapy.

This clearly indicates that music can be an excellent support for both auditory and artistic development as well as tinnitus therapy.

The purpose of this report was to present a unique case study, a teenage boy who was operated due to deep sensorineural hearing loss.

Material and methods: Case study of a patient with deep congenital sensorineural hearing loss, non-functional residual hearing and tinnitus preserved in the low frequency range. The patient was implanted with a Med-El cochlear implant with a flexible electrode according to Skarżyński's surgical procedure. One of the decisive aspects of the rehabilitation of hearing and speech was music.

Results: The effective process of development of auditory skills, speech and language was ahead of or parallel to the musical skills of the boy. In the first period of rehabilitation, it involved acquiring musical skills and reproducing well-known classical music pieces, in which the main emphasis was placed on low and medium frequencies. In the next stage of musical development the young man created his own music. This had a significant impact not only on his speech development, but also on the perception of tinnitus.

Wnioski: Treatment of various types of deafness or deep sensorineural hearing loss using cochlear implants means not only possibilities of auditory development, speech and language, reduction of tinnitus, but also creates opportunities for musical development of implanted patients.

Evaluation of the pitch perception abilities of adult cochlear implant recipients

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Objectives: There is a growing body of evidence related to the impaired music perception in cochlear implant (CI) recipients. Interest to this unique research area has been increased in the last 10 years and different spectral and temporal contributors to the music perception of CI users were revealed. Pitch perception is suggested as an important variable that have an effect on the music perception of CI users. Therefore, the aim of our study is to evaluate the relationship between pitch perception abilities and audiological profile of adult CI recipients.

Material and Method: 16 adult CI recipients with postlingual hearing loss was assessed with the pitch discrimination subtest of Clinical Assessment of Music Perception Test (CAMP). CAMP scores were calculated for three base frequencies and average of these three frequencies. CAMP was conducted in a soundproof room with the signal presented at 65 dB A and 0-degree azimuth.

Correlation coefficients analysis between pitch perception scores, duration of CI use, speech reception thresholds (SRT), word discrimination scores (WDS) and pure tone averages (PTA) for four frequencies (500, 1000, 2000, 4000 Hz) were performed after the descriptive statistics.

Results: Correlation coefficients between 262 Hz base frequency and WDS and duration of CI use; 330 Hz base frequency and duration of CI use; 391 Hz and SRT; pitch discrimination average and WDS, SRT and duration of CI use were statistically significant ($p<0.05$, $r>0.6$). There were also statistically significant correlations between duration of CI use and PTA, SRT and WDS ($p<0,05$) values.

Conclusion: Our study suggests that as the duration of CI use increase, both the pitch perception abilities and conventional audiological outcomes of CI recipients increase too. These finding supports the effectivity of CI on the plasticity of auditory cortex on many different levels.

FS 16: Changing CI criteria

Expanding cochlear implantation criteria for adults with bilateral acquired severe sensorineural hearing loss?

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Objectives: In the Netherlands, a relatively broad inclusion criterion for CI is applied. Patients are considered for CI if the phoneme score, obtained with a well-fitted conventional hearing aid, is <70%. Other countries hold on to a more a conservative approach (e.g <30% phoneme scores in Belgium or an unaided hearing loss >90 dBHL at frequencies of 2 and 4 kHz in England, see the BCIG website).

Material and Methods: In this study, speech perception and quality of life were studied in a Dutch cohort of 164 CI users, divided in two subgroups; those fulfilling the conservative criteria (PTA3 >85dBHL and a phoneme score <30%, group A, n=112) and those with a broader inclusion criterion (PTA3 <70dBHL and a phoneme score >30%; group B, n=52).

Results: The results showed a better phoneme score after one year CI use in the expanded criteria group B compared to the more conservative group A (84% versus 79% respectively; $p<0.05$). Concerning Quality of life (NCIQ), similar benefit was found regarding psychosocial wellbeing, irrespective of group.

Conclusion: We concluded that CI candidates satisfying the group B inclusion criteria might have better speech recognition and similar improvement in quality of life with a CI than group A CI users.

Changing adult cochlear implant criteria: moving away from NICE guidelines

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The National Cochlear Implant Programme (NCIP) in Dublin Ireland is a unique public service in that it has a ring fenced fund and decisions to implant are made by the multidisciplinary clinical team. The NCIP is guided by best practice and had followed NICE guidelines; however, found these guidelines too restrictive for an adult population in determining CI candidacy. Beginning in 2016 the adult CI criteria at the NCIP was changed to include severe SNHL as long as aided speech discrimination, using BKB sentences, was below 65% in one ear. Recipients implanted January 2016 to present were separated into three groups for analysis: 1) PTA & BKB within NICE criteria, 2) PTA above CI NICE criteria & BKB within criteria, 3) PTA meeting NICE criteria & BKB above criteria. For each group average pre op PTA as well as pre and post BKB scores were collected and analysed. Results show Group 1: Avg. PTA for implanted & non-implanted ear met NICE guidelines and BKB post op showed improvement over time but never exceeded 50%. Group 2: Avg. PTA for implanted ear met NICE guidelines & non-implanted ear was above. A 6 kHz notch was noted bilaterally in this group as well as the right ear being significantly poorer on average. Post op BKB showed a marked improvement by 3 months post op particularly in a bimodal condition. Group 3: Avg. PTA for implanted & non-implanted ear was similar to group 1 and BKB pre op showed the left ear to be the poorer ear. By 9 months post op BKB, CI only, were comparable to pre op binaural aided condition & SiN scores were the best for group 3.

The NCIP's decision to move away from NICE guidelines for CI criteria was made due to the clinical view that those needing a CI were being denied. The audiogram alone and/or BKB scores should not solely be considered for adult CI candidacy, rather the person' presentation as a whole needs to be considered. Expanding adult CI criteria to be more inclusive has greatly improved outcomes.

CI candidacy criteria amongst the HEARRING network of hearing implant centres

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On behalf of the HEARRING Network of Hearing Implant Centres

Objectives: Evolution in candidacy criteria for CI continues at a remarkable pace. It is inevitable that differences will exist in candidacy criteria between centres, countries and geographical regions, influenced by factors including surgical and audiological experience, healthcare systems and available individual and national funding. Information was sought by questionnaires from individual centres in the HEARRING network with the aim of characterising areas of greatest agreement and contrast between centres.

Paediatric Candidacy :Regarding minimum age for implantation 5/17 centres sampled stated that they did not have a minimum age for implantation, with the remaining 12 centres varying between minimum ages of 4-12 months of age.

All 17 centres indicated that children could receive bilateral CIs and would not consider physical disability or blindness as a barrier to implantation, but 6/17 centres would not implant a child with a severe cognitive impairment. A significant majority of centres would implant a child with ASD. 4/17 centres would not implant a child with severe tinnitus. 8/17 centres indicated that CIs are used for the treatment of SSD in children in their departments or countries. When asked whether they would consider implanting a child with a syndrome or condition associated with death in childhood, 15/15 centres would implant if the expected age at death was 6 years and above, with 9/13 centres willing to consider implanting a child expected to die by 5 years of age.

Conclusion: Organisations such as HEARRING have a responsibility to promote best practice and produce the high-quality research necessary to support evidenced based medicine, with the ultimate aim of ensuring that the maximum number of patients benefit from CI. This study demonstrates the willingness of centres to now consider candidacy for CI in situations that would previously have been considered relative or absolute contra-indications to CI. The onus is now on CI centres and organisations to produce the evidence of efficacy to support expansion in practice.

A systematic review to define the audiologic thresholds for pediatric cochlear implant candidacy

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Objective: To perform a systematic review to identify audiologic thresholds (dB) that could serve as an audiological candidacy criterion for pediatric cochlear implantation using 4 domains of speech and language development as independent outcome measures (speech production, speech perception, receptive language and auditory performance).

Methods: PubMed and EMBASE databases were searched up to June 28th 2017 to identify studies comparing speech and language development between profoundly deaf children using cochlear implants and children with severe hearing impairment (HI) using hearing aids, since no studies are available directly comparing children with severe HI in both groups. If cochlear implants users outperform those with hearing aids, then perhaps cochlear implant criteria are too stringent and this could support adjusting audiologic thresholds for pediatric cochlear implantation.

Results: Title and abstract screening of 2822 articles resulted in selection of 130 articles for full-text review. Twenty-one studies were selected for critical appraisal, resulting in selection of 10 articles for data extraction. Two studies formulated audiologic thresholds (in dB HL) at which children could qualify for cochlear implantation: 1) at 4-frequency pure-tone average (PTA) thresholds of ≥ 80 dB HL based on speech perception and auditory performance subtests and 2) at PTA thresholds of 88 and 96 dB HL based on a speech perception subtest. Children with profound HI using cochlear implants performed similar to children presenting with severe HI using hearing aids on only a minority of selected outcome measures.

Conclusion: Literature indicates lower audiologic thresholds (in dB HL) as audiological candidacy criteria for pediatric cochlear implantation [≥ 80 dB HL] than are advised in current manufacturer guidelines [> 90 dB HL]. Literature actually shows that children with severe hearing impairment could benefit from cochlear implantation.

FS 17 : CI and ABI in Menière and Laybyrinthitis

Longterm experiences with CI and labyrithectomy in single sided Meniere's disease and deafness

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Background: Surgical treatment of single sided Meniere´s disease and deafness by labyrinthectomy and cochlear implant (CI) has been shown to be audiologically and posturally successfull. Concerns persist in terms of the longterm contrateral occurrence of Menieres disease and vertigo control as well as for intracochlear structural changes. The objective was to investigate the longterm outcome of Meniere's disease patients treated with cochlear implantation and vestibular labyrinthectomy.

Methods: In this retrospective study eight patients with initially single-sided Meniere's disease treated 4-6 years ago with cochlear implantation and vestibular labyrinthectomy were evaluated in terms of audiological outcome, occurence of Menieres disease on the contralateral side, persisting vestibular dysfunction (Dizziness Handicap Inventory (DHI)) and complications.

Results: Audiological outcome showed speech understanding in the range of regular cochlear implant recipients for most of the patients. No patient developed Meniere diseases on the contralateral side. DHI values remained low indicating a high degree of vertigo control. Two patients developed a decompensating tinnitus. One patient developed an ongoing increasing shift of the stimulation threshold.

Conclusion: Longterm results with Cochlear implantation and vestibular labyrinthectomy underline the effectiveness in terms of audiological and vestibular rehabilitation. Complications like tinnitus generation and stimulation level shift might indicate intracochlear changes related to the labyrinthectomy.

Simultaneous cochlear implantation and labyrinthectomy for advanced Meniere's disease

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Objectives: Cochlear implantation (CI) has recently been utilised in patients with Ménière's disease (MD) with unaidable sensorineural hearing loss with favourable results. A more challenging group of MD patients are those with intractable vertigo. Surgical labyrinthectomy is one of the most effective methods of eliminating vertigo that is refractory to medical management and simple surgical strategies. The major disadvantage of labyrinthectomy in the past was loss of residual hearing, and as such this procedure has traditionally been reserved for patients with non-serviceable hearing. CI is now an option in these patients. Our objective was to assess cochlear implant outcomes in this group.

Method: Retrospective case note review was performed of seven patients with unaidable hearing and recurrent incapacitating attacks of vertigo despite conservative management who underwent simultaneous labyrinthectomy and CI.

Results: There was complete resolution of vertigo in all patients. Mean City University of New York (CUNY) sentences in quiet score improved from 8% preoperatively (n=7; range 0-22%) to 75% at 6 months (n=7; range 35–98%) and 70% at 12 months (n=5; range 40-92%).

Conclusions: CI was for many years considered to be contraindicated following labyrinthectomy due to damage to cochlear neural elements and fibrosis/ossification following surgical trauma. However there is good histological and electrophysiological evidence that the spiral ganglion cell population remains intact. The clinical results in this study demonstrate that speech understanding comparable to non-MD patients and to MD patients post CI only can be achieved in this group. Simultaneous CI and labyrinthectomy can be employed successfully to eliminate intractable vertigo and rehabilitate hearing in MD patients. Simultaneous procedures enable prevention of implantation of a fibrosed/ossified cochlea, a decrease in the duration of deafness and a single operative procedure.

Challenges and variability in outcomes for cochlear implant candidates deafened following pneumococcal meningitis

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The purpose of this retrospective study was to review the outcomes of cochlear implantation for adult patients implanted following deafness secondary to pneumococcal meningitis.

Between 2016 and early 2018 four adults underwent bilateral cochlear implantation having been diagnosed with profound sensorineural hearing loss after suffering from pneumococcal meningitis. Surgery took place as soon as they were considered medically fit to undergo the procedure. Varying degrees of cochlear ossification were found at the time of surgery. One patient required bilateral split array devices due to the extent of ossification; the other three patients received conventional arrays.

The rehabilitation of these patients has been of varying degrees of difficulty. Two patients in particular posed particular challenges in programming due to the requirements for high current levels and the occurrence of non-auditory stimulation. These two patients have obtained minimal benefit from their cochlear implants and have been offered alternative support including counselling and lip reading classes. Initial benefit for the other two cases has been more favourable.

The findings will be discussed and suggestions made regarding rehabilitation and support for this complex group of patients.

Hearing outcome of cochlear implantation for post-irradiated Nasopharyngeal Carcinoma (NPC) patients

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Background: Nasopharyngeal cancer (NPC) is highly prevalent in Hong Kong and the mainstay of treatment is radiotherapy. Sensorineural hearing loss is a common complication in post-irradiated NPC patients which may progress to profound deafness over years.

Method and Materials: A case comparative study was conducted to evaluate the efficacy of cochlear implantation (CI) as an option of hearing rehabilitation in deafened patients who had received radiotherapy for nasopharyngeal carcinoma. In this study, we retrospectively reviewed the adult patients who underwent CI in our center from 1995 to 2015 and compared the outcomes of NPC patients to non-NPC patients matched with age, sex and duration of deafness. Speech perception tests were used to assess the hearing performance of patients pre-operatively, and then at 6 months, 12 months and 24 months postoperatively using the Cantonese speech perception tests.

Results: The NPC group did significantly better at the 12 months and 24 months postoperatively in terms of sentence recognition. The two groups performed similarly in the other two outcome measures, namely word recognition and tone perception within the two-year period.

Discussion and Conclusion: The radiotherapy-induced damage to was the hair cells primarily while the cochlear nerve is resistant to radiation and its function was well preserved. This probably contributed the overall better performance in this group of patients. Therefore, cochlear implantation is recommended for the management of significant hearing impairment with NPC.

Cochlear implantation for treatment of deafness for patients suffering from eosinophilic otitis media

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Introduction: Eosinophilic otitis media (EOM) is an uncommon type of chronic suppurative otitis media characterized by recurrent or persistent thick glue like discharge, resistant to medical treatment or tympanoplasty and progressive gradual deterioration of hearing. EOM is a challenging clinical entity which imposes difficulty management problem to otologists.

Method: A case of a patient suffered bilateral discharging ear and bilateral profound hearing loss due to EOM underwent two sequential cochlear implantations were reported in this paper. And a literature review of cochlear implantation for patients suffering from hearing loss resulted from EOM is also presented.

Results and Conclusion: Typically, patients suffering from EOM have strong atopic history including asthma, nasal polyposis, allergic rhinitis and drug allergy. Tympanoplasty and mastoidectomy were ineffective treatments for the inflammatory disease process. Repeated topical steroid to the middle ear or systemic steroid therapy can alleviate the local inflammation and decrease the ear discharge. However, topical or systemic steroid therapy will not alter the natural course of illness with progressive gradual deterioration of hearing and some patients will eventually suffer from bilateral profound deafness. As reported in the literature, cochlear implantation is a feasible treatment of deafness in patients suffering from EOM. In our opinion, it is necessary to eradicate the mucosal disease in the middle ear and isolated the middle ear and the surgical implant to prevent secondary bacterial infection.

Audiometric performance and tinnitus suppression in an Auditory Brainstem Implant Patient with unilateral profound sensorineural hearing loss

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Background: Cochlear implantation (CI) has been found to be an effective technique for hearing restoration and tinnitus suppression in patients with severe to profound sensorineural hearing loss and ipsilateral incapacitating tinnitus. While the effects of CI on tinnitus is an aria of active investigation, the effect of electrical brainstem stimulation by use of an auditory brainstem implant (ABI) on tinnitus perception has scarcely been reported and mainly in NF2 patients.

Aim of the study: To investigate the effects of auditory brainstem implantation in a patient with unilateral profound sensorineural hearing loss and incapacitating tinnitus.

Methods: The present study reports on a case study of a 59 - year - old male patient with an asymmetrical sensorineural hearing loss with ipsilateral incapacitating tinnitus after labyrinthitis. First, the patient underwent cochlear implantation (MED-EL Pulsar100 FL) in the deaf ear. In the contralateral ear, he was wearing a hearing aid. Due to obliteration of the cochlea, the electrode array could only be partially (4 electrodes) inserted. Consequently, hearing

performance was unsatisfactory and tinnitus suppression decreased over time until there was only minimal tinnitus suppression. Therefore, the patient received an ABI (MED-EL Concerto) at the same ear 6 years post-cochlear implantation. He was evaluated pre- ABI implantation and up to 5 years after ABI implantation. Audiological test battery comprised free field pure-tone audiometry (PTA500, 1000 and 2000Hz), speech perception in quiet (phonetically balanced monosyllabic word lists) and in noise (LIST sentences). Tinnitus was assessed with the Visual Analogue Scale for loudness (VAS).

Results: Daily ABI use was reported by the patient. A PTA(500, 1000 and 2000Hz) of 45 dB HL with ABI was obtained. With activation of the ABI, the tinnitus decreased. Pre- implantation, the tinnitus loudness was rated 9.3/10 on the VAS and was reduced to 3/10 12 months after ABI implantation, 5/10 36 months post-ABI and 4.5/10 after 48 months. When the ABI was switched off, tinnitus immediately appeared with a loudness of 8-9/10 on the VAS. The patient obtained a 61% score on the Dutch opens set monosyllabic word list (NVA) at the 48 month interval with ABI alone, 45% with hearing aid only and a 94% score with the combination of the ABI and the contralateral hearing aid. 4 years after the ABI implantation, speech in noise scores showed a speech to noise ratio from +10 dB SNR with ABI only, +7 dB SNR with hearing aid alone and +4 dB SNR with the combination of the ABI and a contralateral hearing aid

Conclusion: This case study reports on a patient with unilateral profound sensorineural hearing loss and ipsilateral incapacitating tinnitus after labyrinthitis. The patient benefitted from tinnitus suppression and improved speech recognition in quiet and in noise through auditory brainstem implantation at the deaf side.

FS 18: Fitting and Algorythms in Adult CI Patients

Evaluation of a Strategy Based Fitting approach

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Background : A Cochlear Implant (CI) is individually adapted using the manufacturers fitting software, in order to provide benefit in sound and speech perception. This routinely performed periodic fitting is a time consuming process which may take up a significant proportion of the relevant staff's working time.

The major aim of CI centers worldwide is to achieve an optimal map efficiently with as few fitting sessions as possible.

This study aimed to address the question how performance with a flat strategy based fitting (FSBF) map compares to a traditional single channel fitted (SCF) map. In particular, the study explored the feasibility, performance and subjective preference of a flat strategy based fitting map (FSBF) compared to a traditional, time consuming, single channel fitted map (SCF).

Material and methods : A cohort of experienced post lingual Cochlear Implant users was included in this prospective, acute, randomized multi-center study. Subjects were unilaterally implanted with a MED-EL implant using the OPUS 2 or SONNET audio processor. Maps were programmed using three different approaches: 1. FTC (Fine-tuned clinical map): the map the user had in daily use; 2. SCF (Conventional map based on single-channel beeps): map created during the study according to the MED-EL fitting guideline; 3. FSBF (Strategy based fitting map): Map created by using a live audio signal (ISTS) at 65 dB SPL and fitting of all 12 channels simultaneously.

Objective tests assessed the speech perception using the Oldenburg Matrix Sentence Test (OLSA). The subjective benefit was evaluated using a study specific visual analogue scale (VAS) scale to rate frequency perception (bass and treble) and overall preference.

Results: Preliminary results that speech perception in noise with the FSBF map is comparable to understanding with the SCF map but worse to FTC map. Spectral balance with FSBF and SCF maps, as subjectively evaluated, appears to be better as with FTC maps for low and for high frequencies. The FSBF procedure can be performed in consistently less time and was subjectively judged better in sound quality than the SCF and FTC maps.

Conclusion: The FSBF approach is time efficient and leads to comparable results in speech perception. First results show no significant negative effects on sound quality when compared to the SCF and FTC maps.

Interleaved high-rate pulse trains improve speech perception in MED-El cochlear implant users

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Objectives: Abnormally high neural synchrony with electrical stimulation negatively impacts speech perception with cochlear implants (CIs). Constant-amplitude high-rate pulse trains (HRPs) can desynchronize responses and improve stimulus encoding at the level of the auditory nerve. The study objective was to investigate the effects of interleaved HRPs on speech perception in adult CI users.

Materials and Methods: Ten experienced adult MED-EL CI recipients participated in this acute experiment. Stimuli were created using RIB II software and hardware compatible with MED-EL devices. IEEE sentence stimuli were programmed by modifying a basic CIS strategy (1000 pulses per second; pps) with interleaved biphasic pulse trains

(3000 pps) on even electrodes. Sentences in quiet and in +10 SNR 4-talker noise were tested without HRPs, and with HRPs ranging from 100-400 current units. All stimulation conditions and sentence lists were randomized across trials. Sentence perception was scored in percent correct. Subjects also completed subjective assessments of sound quality.

Results and Conclusions: Interleaved HRP stimuli significantly improved sentence perception in background noise (p<.001). For the group, HRP stimuli did not show any significant effects on sentence perception in quiet; however, 7 of 10 subjects experienced some benefit from HRP stimuli in quiet. HRP benefit in quiet was significantly correlated with baseline IEEE performance (p=.026) and age at implantation (p=.043). Subjects rated sound quality the same with and without HRPs. These findings show that interleaved HRPs can improve patient performance and are promising for future use in clinical sound processing strategies.

A cross over trial comparing the fine structure sound coding strategy FS4 high rate to FSP in cochlear implants

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Introduction: New versions of coding strategies for cochlear implants have aimed at the transmission of temporal fine structure to the cochlear implant recipient. FS4 is the latest development transmitting fine structure on 4 apical electrodes.

In a previous study the addition of a high stimulation with FS4 has shown improved subjective sound quality and improved speech perception in an acute setting.

Objective: The aim of the present study is to compare FS4 using a high stimulation rate with the previously available fine structure strategy FSP in a clinical setting with 3 months adaptation time per strategy.

Methods: 34 adult Ci patients with a minimum of 1 year cochlear implant experience are included. Patients need to have a minimum of 10 active electrodes of a long (≥ 28mm) electrode array.

Each patient uses each coding strategy for 3 months in a randomized sequence. Outcome measures include a monosyllables test in quiet and the speech reception threshold of an adaptive sentence test in noise (Oldenburger Sentence test). Formant frequency discrimination thresholds (FFDT) are used to assess the ability to resolve timbre information.

In addition, the subjective sound quality using VAS scales as well as a quality of life questionnaire is evaluated after each 3 month period

Results: Speech perception in noise and quiet is similar with both coding strategies.

The extended fine structure range of FS4 yields a statistically significant improvement (p<0.03) in FFDT for sounds ocurring in this frequency range. Furthermore, there is a significant interaction (p=0.04) between the extend of fine structure coverage and FFDT performance.

Sound quality was rated very heterogeneously, showing that the availability of both strategies in CI fitting practice is important.

Conclusion: This study evaluates the potential benefit of a high stimulation rate with the FS4 fine structure coding strategy compared to FSP.

Do fitting parameters and ECAP thresholds predict speech recognition in quiet and in noise for adult cochlear implant users?

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Introduction: Speech recognition performance varies highly among cochlear implant (CI) users. Multiple studies have investigated possible predictors of this variation, however, the variance in speech recognition can still not be fully explained. The aim of this study is to investigate the relationship between CI related factors (e.g., T and C levels, dynamic range, automatically recorded ECAP thresholds), individual factors and speech recognition in quiet and in noise. Ultimately, we aim to find mapping rules to optimize speech recognition in quiet and in noise.

Methods: We retrospectively identified 427 CI users with CochlearTM implants who visited the VU University Medical Center for their annual appointment between January 2015 and December 2017. Several exclusion criteria (e.g., implantation before the age of 18 years, < 1 year CI experience, bilateral implantation) were applied to form a homogeneous study group of 160 CI users (mean age: 63 years; SD = 16 years). Speech recognition was assessed with monosyllable words in quiet (mean percentage of phonemes correct: 79%; SD = 15%) and digit-triplets in noise (mean SRT: 0.6 dB SNR; SD = 4.9 dB SNR). Additional data were collected, including demographic characteristics, MAP parameters, automatically recorded ECAP thresholds, impedances, T and C levels and aided soundfield thresholds. First, univariate analyses will be conducted to investigate the influence of these factors on speech recognition. Subsequently, multivariate linear regression analyses will be conducted to determine independent predictors of speech recognition in quiet and in noise.

Results & Conclusion: The analyses are currently being conducted. The results of the analyses will be presented at the conference.

ESRT as a predictor in fine structure audio coding strategy and variable pulse duration in CI fitting

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Objectives: The introduction of new charge-based coding strategies, i.e. fine structure processing (FSP), requires correlations for the change in charge in order to assess the clinical relevance of the eSR threshold measurements. FSP-type strategies make use of changes in pulse duration and amplitude. These changes are achieved automatically by means of the Maestro software, in order to prevent the saturation of current sources.

The aims of the study to compare the eSR thresholds recorded using charge units in experienced adults fitted with Med-El cochlear implants with the MCLs obtained for the apical, medial and basal electrodes.

Material and Method: 30 experienced patients participated in the preliminary part of the study. All of them used Med-El implants and Opus 2 or Sonnet speech processor. All of them were fitted using Maestro 7 or earlier.

All subjects followed the same sequence of measurements. Firstly, the MCLs were set on all active electrodes. Then eSR measurements were obtained on basal, medial and apical electrodes (electrodes 2, 6 and 11). After successfully finished preliminary stage, we enlarge study group to more than 500 CI users, fulfilled the same criteria.

Results: The eSR thresholds and MCLs were obtained successfully in every participant in preliminary group, and in majority of patients in enlarged group.

In the preliminary group the mean eSR threshold was 92.7% of the mean MCL for all electrodes combined. The mean eSR thresholds for the electrodes tested varied from 88.2% (electrode 6) to 95.1% (electrode 2) of the MCL. The correlations between the eSR threshold and MCL measured for each electrode varied from 0.8 to 0.83.

Further study in bigger group confirmed described values.

Conclusions: ESR thresholds, recorded in units of charge on experienced patients implanted with Med-El cochlear implants, have been correlated with MCL values obtained using apical, medial and basal electrodes.

Comparison between behavioral, Modified Brown ECAP, ESRT

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Different methods can be used for fitting adult CI patient These approaches vary between pure subjective to pure objective ones passing with new Sub-Objective approach which is the Modified Brown ECAP Approach (MB-ECAP).This objective of this study was to find out and compare 3 important approaches used in programming of adult cochlear implants patients, which are behavioral approach, modified brown Evoked Compound Action Potential (ECAP) approach and Electric Stapedius Reflex Threshold (ESRT) approach. Total 11 CI recipients (aged 17 to 68 years) were involved in this study. All were implanted with MEDEL SYNCHRONY implant and SONNET audio processor. Comparison was based on their audiological outcome, session's time and correlation between the three approaches parameters. The results of this study will help to know the best approach to be used with adult CI recipient also to validate the modified brown ECAP based approach and compare it with well-known approaches like behavioral and ESRT based approach. This study showed good correlations and outcomes when comparing the results of the modified brown ECAP based approach with the other approaches. It was recommended to be also used during children CI recipient fitting which consider more challenging than adult.

FS 19: Diagnosis of Neonatal Hearing loss and CI

Mutational analysis for GJB2, GJB6, GJB3, WFS1, and POU3F4 genes in populations with non-syndromic hearing loss

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Objectives: The objective of this study is to determine the mutation frequency in GJB2, GJB6, GJB3, WFS1, and POU3F4 genes in children with congenital non-syndromic hearing loss.

Methods: One hundred fifteen patients aged between 0 and 12 who were diagnosed with congenital hearing loss and a control group of 60 children from the same age group with normal hearing ability who were randomly selected were incorporated into this study. The analyses of GJB2, GJB6, GJB3, WFS1, and POU3F4 genes were performed through MLPA technique.

Results: The most commonly-seen mutation in this study was 35delG (13.1%) in GJB2 (connexin 26) gene. The GJB6 gene mutation, which was undetected in the studies conducted previously in our country, was determined as a homozygote mutation in 1 of our cases, a heterozygote mutation in 1 of our patients, and as heterozygote mutation in 3 individuals within the control group. Within the study group, POU3F4 was detected at the rate of 7%, whereas WFS1 was detected at the rate of 3.5%, GJB3 (connexin 31) was detected at the rate of 0.9%, IVS1+1G>A was detected at the rate of 2.6%, and 313del14 was detected to be 2.6%. There was a significant difference between the case and control groups in terms of homozygote mutations ($p<0.05$). Yet, there was no significant difference in terms of heterozygote mutations ($p>0.05$). It was determined that consanguineous marriage and the incidence of hearing loss in the family history significantly increased the risk of hearing loss ($p<0.05$). Consanguineous marriage did not significantly increase the frequency of the mutation incidence, whereas the presence of hearing loss within the family significantly increased the risk of the mutation incidence.

Conclusion: In our region, the most common mutation in patients with congenital non-syndromic hearing loss was determined as GJB2 gene and 35delG mutation. In the control group, however, this mutation rate was 3.4%. Additionally, cx 30, cx31, and POU3F4 mutations, which had been undetected before in our country, were observed.

Mutational and phenotypic spectrum of OTOF-related auditory neuropathy in Koreans

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Objectives: Auditory neuropathy spectrum disorder (ANSD) is a disorder, in which the transmission of sound signal from the inner ear to the auditory nerve/ brain cortex is impaired, while the outer hair cells function normally. Previously, our group reported that anatomically intact, prelingual-onset, ANSD in Koreans is mainly due to mutations in OTOF (DFNB9). Since our previous report, we further recruited anatomically intact, prelingual-onset ANSD subjects and we disclosed a mutational and phenotypic spectrum of OTOF-related ANSD in the Korean population.

Materials and Methods: Six patients with ANSD were recruited from two referral hospitals. Genetic diagnosis was made through the screening panel, targeted exome sequencing, or whole exome sequencing. Together with five previously documented DFNB9 patients, a total of 11 patients' genotypic and phenotypic analysis was made.

Results: Genetic diagnosis identified three novel variants of OTOF in our cohorts: a nonsense variant, p.Tyr1064Ter, a missense variant, p.Gly1845Glu, and a splice site variant, c.4227+5G>C. Regarding the contribution of each OTOF variants in Korean ANSD, p.Arg1939Gln was most commonly identified among the 22 alleles in 11 DFNB9 subjects, with its frequency in our cohort calculated to be 36.4%, followed by p.Glu841Lys (13.6%), p.Leu1011Pro (9.1%) and p.Arg1856Trp (9.1%). Although ABR results of our patients consistently did not show responses to sound, ASSR results demonstrated relatively diverse spectrum of hearing status including significant residual hearing and asymmetric hearing. Ten of 11 patients received cochlear implantation for auditory rehabilitation, showing favorable outcomes with more rapid improvement on early-CI group (age at CI ≤ 18 mo.) than late-CI group.

Conclusions: Here, we report three novel variants of OTOF, related with ANSD and confirmed the significant contribution of a recurring predominant variant (p.Arg1939Gln) of OTOF to Korean ANSD in our cohorts which is, to date, the largest OTOF-related ANSD cohort in Korea. Additionally, relatively diverse auditory spectrum of DFNB9 was observed in the ASSR results of our patients. Clinically, given the genotypic spectrum of our cohorts, we suggest the four major alleles of OTOF: p.Arg1939Gln, p.Glu841Lys, p.Leu1011Pro and p.Arg1856Trp as included in a screening panel to facilitate the molecular genetic diagnosis of Korean OTOF-related ANSD, further prompting the early CI for timely development of auditory perceptive ability.

Cochlear implant outcomes in large vestibular aqueduct syndrome: should we be implanting earlier?

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Objectives: Large vestibular aqueduct is a relatively common cause of hearing loss in cochlear implant recipients. The challenge for clinicians is to decide when is the ideal timing for cochlear implant surgery in this cohort as hearing progressively deteriorates and hearing aids become less useful. The aim of this study was to examine the post-operative speech perception outcomes in a large group of LVAS patients at a major cochlear implantation centre with at least 12 months cochlear implant experience to inform decision making regarding speech perception criteria for surgery.

Methods: Retrospective analysis of the Sydney Cochlear Implant Centre database from 1994 –2016 was performed. This identified patients with a diagnosis of LVAS who received treatment with a cochlear implant. Post-operative

speech perception evaluation was assessed at least one year following the surgery with the most recent assessment being used for analysis. Exclusion criteria included lack of follow up data or inability to measure necessary outcomes e.g. developmental delay.

Results: There were 176 adult and paediatric patients with a diagnosis of LVAS who had received a cochlear implant. Of these 162 were suitable for review.

The median age of the group at the time of first cochlear implantation was 6.0 years old with an inter-quartile range of 12 years.

The post-operative median BKB speech perception score was 93% with a first quartile score of 85% (n= 96). For CUNY sentences, the median score was 95%, with a first quartile score of 76% (n= 25). Crucially all patient demonstrated improvements in score from their pre-operative. The lower quartile results were with patients with poorer pre-operative results.

Conclusion: From these results we can counsel patients that three quarters of patients would be expected to score at least 85% for BKB sentences and 76% for CUNY sentences and all patients improve.

Timing of cochlear implantation for patient with large vestibular aqueduct syndrome

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Objectives: To analyze the influence factors of the outcomes of cochlear implantation with LVAS.Including the time of hearing loss,the age of CI,pre-operative hearing level,the using time of hearing-aid.To discuss the best time of cochlear implantation for LVAS.

Method: 35 patients (15men and 10 women)with LVAS participating in our research from 2013 through 2015.The mean age at implantation was 12 years(range=2~35yr),27 of them were postlingual deafness,the other 8 were prelingual deafness. The mean pre-operative hearing was 95.5dB HL(range=66~115dB HL).The mean time of hearing loss was 8 years(range=1~31yr). The mean time of using hearing aid was 8.8 years(range=0~31yr). The mean hearing threshold with cochlear was 32.2 dB HL(range=25~40dB HL).Using Mandarin speech perception test (MSP) to evaluate the outcomes of CI 2 years after the surgery. Application of the impact of logistics regression analysis of factors related to the outcomes of CI.

Results: The mean speech recognition rate of MSP was 72.5% (range=42%~96%).The logistics regression analysis showed that the age of CI,the time of hearing loss,the time of using HA were associated with the outcomes of CI in patient with LVAS.($P<0.05$)

Conclusion: The age of CI,the time of hearing loss and the time of using HA may influence the outcomes of CI in patient with LVAS.

Experience of Trans-tympanic Electrical evoked Auditory Brainstem Responses (TT-EABR) at the Royal National Throat Nose and Ear Hospital Auditory Implant Team

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Cochlear implantation has proved to be a suitable treatment option in some cases for patients with Auditory Neuropathy and Hypoplastic Auditory Nerves. However the prediction of outcomes is still a challenge for Clinicians in these very challenging cases. Trans-tympanic electrical auditory brainstem response (TT-EABR) is an established pre-operative investigation for cochlear implant recipients and provides valuable information in selection of the ear for surgery and also will provide useful information on responses of the auditory nerve to electrical stimulation.

A retrospective review was undertaken at the Royal National Throat Nose and Ear Hospital in London, United Kingdom, on all patients who underwent TT-EABR testing. These patients had various aetiological causes (Auditory Neuropathy, Hypoplastic Auditory Nerves, Neurological degenerative disease, Head injury and Superficial siderosis) for their hearing loss and in the majority of these cases the results provided valuable information for candidacy as well as post-operative counselling on the outcomes.

Results indicated that TT-EABR is crucial for the majority of these complicated cases and therefore is standard practice at this centre.

Oculo-auditory syndrome: ophtalmologic impairment screening in deaf children

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Introduction: The association of visual disturbances with deafness is frequent. These disorders range from a simple anomaly of refraction to blindness which may constitute a hard handicap.

The objective of our study is to show the importance of ophtamological disorders screening and multidisciplinary collaboration in deaf children.

Materiel and methods: Our study is prospective and mono-centric involving 640 children followed for congenital hearing loss from January 2011 to December 2016.

All children with congenital hearing loss have had a complete ophthalmologic examination to detect any visual impairment.

Results: Ophtalmologic impairment was observed in 22 childrens. the average age has been 7 years (1 month-15 years) with 13 boys and 18 girls. We have diagnosed an Usher Syndrome in 4 cases, Waardenburg Syndrome in 5 cases , Alport Syndrome in 1 case, Wolfram Syndrome in 2 cases, Goldenar syndrome in 3 cases, Cogan Syndrome in 1 case, Fracheschetti Syndrome in 1 case, Charge Syndrome in 1 case, Otomandibular Syndrome in 1 case, Stickler Syndrome 1 case, Alstrom Syndrome in 1 case, and KID Syndrome in 1 case. Management was multidisciplinary. the deafness was rehabilitated either by auditory prosthesis or by cochlear implantation depending on the degree of deafness. the visual disturbance was taken care by the ophthalmologist. A genetic survey was done.

Discussion and conclusion: Oculo-auditory Syndrome in a disabling situation and must to be screened because of the embryological and cellular similarity of these two organs, in particular the retina and the inner ear. The diagnosis of these disorders is facilitated by the existence of a facial dysmorphism, but it remains difficult when the visual and auditory impairments are isolated.

The earliest diagnosis of oculo-auditory disorders allows for better psychomotor development and optimal social integration. Therefore, early multidisciplinary care is necessary in order to allow the best psychomotor, speech and visual rehabilitation.

FS 20: Habilitation Outcomes after Pediatric CI

Auditory verbal habilitation is associated with improved outcome for children with cochlear implant

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Objectives: To study the impact of (re)habilitation strategy on speech-language outcomes for early, cochlear implanted children enrolled in different intervention programmes post implant.

Material and Methods: Data relate to a total of 130 children representing two pediatric cohorts consisting of 94 and 36 subjects respectively. The two cohorts had different speech and language intervention following cochlear implantation, i.e. standard habilitation vs. auditory verbal (AV) intervention. Three tests of speech and language were applied covering language areas of receptive and productive vocabulary and language understanding.

Results: Children in AV intervention outperformed children in standard habilitation on all three tests of speech and language. When effect of intervention was adjusted with other covariates children in AV intervention still had higher odds at performing at age equivalent speech and language levels

Conclusion: Compared to standard intervention, AV intervention is associated with improved outcome for children with CI. Based on this finding, we recommend that all children with HI should be offered this intervention and it is, therefore, highly relevant when National boards of Health and Social Affairs recommend basing the habilitation on principles from AV practice. It should be noted, that a minority of children use spoken language with sign support. For this group it is, however, still important that educational services provide auditory skills training.

Mandarin tone recognition in noise by prelingually deafened children with cochlear implants

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Objectives. Mandarin tone is characterized by its pitch contours or fundamental frequencies. Contemporary cochlear implant (CI) does not deliver sufficient pitch information through its electrical stimulations to the users. Many studies have examined lexical tone recognition in CI users in quiet testing conditions. Results showed variable performance with an average tone recognition of 70 to 80% correct. The purpose of the present study was to investigate Mandarin tone recognition in background noise in prelingually deafened children with CIs.

Materials and Methods. A total of 90 prelingually deafened children with CIs and 54 normal-hearing (NH) children as controls were recruited to participate in the study. Mandarin tone recognition was tested using a two-alternative forced-choice paradigm in various signal-to-noise ratio (SNR) conditions (i.e., -6, 0, +6, +12 dB and quiet). Two types of masking noise were used (i.e., speech-spectrum shaped noise and two-talker babbles). Linear correlation analysis was performed to examine possible relationships between the tone-recognition performance of the CI children and the demographic factors.

Results and Conclusions. Children with CIs showed overall poorer tone-recognition performance that were particularly susceptible to noise as compared to their NH peers. Most CI children could not be tested at -6-dB SNR. Interestingly enough, the two types of noise produced similar tone-recognition performance in CI users thus showed little masking release with two-talker babbles. Tone confusions between Mandarin tone 2 and tone 3 were most prominent in both CI and NH children. Age at implantation was significantly correlated with tone-recognition

performance of the CI children in noise. Therefore, there is a marked deficit in tone recognition in prelingually deafened children with CIs, especially in noise listening conditions that were typical of their everyday life conditions. Early implantation could be beneficial to tone development in pediatric CI users.

Auditory verbal intervention for the infants with hearing problems

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There has not been much evidence about rehabilitation results for the infants with hearing problems under age 1 even though the 1-3-6 principle of early diagnosis and intervention was accepted worldwide. In this study, we tried to reveal auditory verbal intervention effects for the infants with hearing problems followed by the principle. A total of 50 babies and their caregivers participated. The average hearing thresholds of the babies were worse than 80 dB HL(B) and they were fitted HAs or CIs except 5 babies with no hearing prosthesis. The average age of the participants at the initial assessment was 7.3 months and the average age at the final assessment was 12.6 months. After the initial assessment, their development was closely followed in the 8 developmental areas of sound responses, listening skills, receptive & expressive language, speech development, oral functions, social interactions, and cognitive communication with auditory verbal approach. Their initial developmental rate was 0.55 and the rate had been accelerated up to 1.8, however, after 6 month-intervention, final development rate was 0.76 which had not reached to the normal rate of 1. There were large individual differences as expected, in average, the area of cognitive communication was the most developed area while the area of speech was the least developed area at the end of the intervention. Auditory verbal approach was suitable for the babies as well as their caregivers and could provide valid and timely information about the effects of prostheses they were wearing and the timing of changing devices for the babies. It would be more informative with longer period of the intervention.

Paediatric cochlear implantation outcomes in children under 12 months of age

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Objectives: To assess the outcomes of early paediatric cochlear implantation (CI) in children under 12 months of age

Material and Methods: All patients who underwent bilateral simultaneous CI under 12 months of age at a tertiary paediatric centre were reviewed. Preoperative diagnostic testing results were examined including newborn hearing screening testing, auditory brainstem responses, otoacoustic emissions and cortical auditory evoked potentials. Postoperative outcome measures included the Little Ears questionnaire, aided CI thresholds, aided cortical auditory response testing, detection of Ling sounds at 35dBA, and simple left and right localisation with visual response audiometry.

Results: In total there were 23 patients who received a CI under 12 months of age, representing the fastest growing age group in our implant program. Of these, 6 patients were implanted under 7 months of age, 9 patients between 7 to 9 months, and 8 patients between 9 and 12 months of age. All patients had aided CI thresholds between 15-25dB from 250 to 8000Hz indicating good access to speech sounds. Where aided cortical testing could be performed, the P1 waveforms were detected at 55dB SPL. The electrical dynamic range trended towards larger values for younger infants than our older cohort of recipients. Simple left and right localisation testing with visual response audiometry were obtained in the majority of patients who also demonstrated significant improvement on the Little Ears questionnaire. There were no major surgical complications noted.

Conclusions: Early paediatric cochlear implantation under 12months of age is possible and has in our experience been associated with significant hearing benefits for the patient with relatively safe surgical outcomes. Longer term follow up is required to determine if there is a significant difference compared to those patients implant over 12 months of age.

Early auditory development of cochlear implanted children with partial deafness

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Objectives: As candidacy criteria for cochlear implantation (CI) have been progressively relaxed to include very young children and those with residual hearing, there is the special interest in evaluation of early auditory development in these groups of children. The research question is whether there are differences in early auditory development between children with and without residual hearing.

Material and Method: 63 with residual hearing and 59 with profound deafness were tested with the LittlEARS questionnaire. The test was performed at CI activation assessing pre implant auditory development and up to 12 months of CI use. The LittlEARS normative values were used to calculate the delay in auditory development of children from both groups. The delay in auditory development was analyzed separately for children implanted before the age of 12 months and for children implanted at the age of 12 to 24 months.

Results: In children implanted before 12 months of age the delay in auditory development decreased over 12 months

of CI use from 8 months to 1 month in the group with profound deafness and form 7 months to 1 month in children with residual hearing. In children implanted at the age of 12 to 24 months the delay in auditory development decreased over 12 months of CI use in both groups. However in children with profound deafness this delay after 12 months of CI experience was significantly higher comparing to the delay in auditory development in children with residual hearing.

Conclusion: Children with profound deafness should be implanted before their first birthday to promote faster auditory development.

Systematic review of auditory training in pediatric cochlear implant recipients

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Background: Auditory training (AT) is a sound-based intervention aimed at improving individuals' speech and hearing skills through varied listening exercises. It has been used with individuals using hearing aids and/or cochlear implants (CIs) to maximize benefit of hearing devices.

Objective: The purpose of this systematic review PROSPERO (2017:CRD42017057346) is to evaluate the published research in AT for pediatric CI recipients. This review investigates whether AT in children with CIs leads to improvements in speech and language, cognition, and/or quality of life; and whether improvements, if any, remain over time post AT intervention. Outcomes of this review may help clinicians to make informed decisions about the usefulness and type of AT for pediatric CI users.

Method: A systematic search of seven databases identified 96 papers published up until January 2017, 9 of which met the set criteria. Data were extracted and independently assessed for risk of bias and quality of study against a PICO framework.

Results: All studies reported improvements in the trained AT tasks including speech discrimination/identification and working memory tasks. Retention of improvements overtime was found whenever it was assessed. Transfer of learning was measured in four out of six studies, which assessed generalization. Quality of life was not assessed in any of the reviewed studies. Level of evidence for the included studies was determined to be low.

Conclusion: Benefits of AT were clearly illustrated through the improvement of all trained tasks across all studies regardless of the duration or type of training. Transfer of improvement to other domains and retention of benefits post AT were evident when assessed. However, higher quality evidence to further examine outcomes of AT in pediatric CI recipients is needed.

FS 21: Towards a Comprehensive Profiling in Bilateral Vestibulopathy Patients

Vestibular perception in patients with bilateral vestibulopathy

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Purpose: At this moment clinical vestibular testing mainly focuses on testing reflexes such as the vestibulo-ocular reflex and the vestibulo-collic reflex. The objective of this study was to evaluate the perceptual thresholds in patients with bilateral vestibular loss using a recently proposed clinically useful test for vestibular perception.

Methods: Fifty patients with bilateral vestibular loss and a control group of 55 healthy volunteers were tested on a MOTEK perception platform in dark. All BV patients had a reduced caloric response of summated slow phase mean peak velocity of less than 20°/s and a reduced VOR gain on the rotatory chair (0.1Hz). The platform delivered 12 different movements: 6 translations (forward, backward, right, left, up and down) and 6 rotations/tilt (yaw left, yaw right, pitch forward, pitch backward, roll left and roll right). Thresholds were determined by a staircase paradigm.

Results: Perceptual thresholds of translation showed a wide distribution in both groups. Thresholds above 0,4 m/s2 were more prominent among BV patients. Perceptual thresholds for rotation/tilt movements in BV patients were significantly higher compared to those in the control group.

Conclusion: BV patients show generally higher perceptual thresholds than healthy volunteers. The spread of perceptual thresholds in BV patients is probably due to the use of other pathways than the regularly evaluated reflexes. Therefore, perception could be used as an additional treatment outcome measurement in the future.

vHIT VOR-gain is not yet a reliable measure for bilateral vestibulopathy

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Objective: To evaluate the vestibulo-ocular reflex (VOR) gain of three different video head impulse test systems (vHIT).

Methods: vHITs were performed in 50 patients with bilateral vestibulopathy (BV) and a control group of 37 healthy volunteers. All BV patients had a reduced caloric response of summated slow phase mean peak velocity of less than 20°/s. In the BV patients, a lateral vHIT was performed with the EyeSeeCam, Otometrics and Synapsys systems and the vertical vHIT was performed with the Eyeseecam and Otometrics systems. These results were compared with the group of healthy volunteers. VOR-gains obtained by the different systems were compared. The order of the tests was randomized. All tests were performed under standardized circumstances.

Results: As expected, VOR-gain of the lateral vHIT was mainly reduced in BV patients. Most importantly, VOR-gains between systems differed significantly for BV patients as well as for healthy volunteers. When only relying on vHIT-results, some BV-patients did match the criteria for BV with one system, but not with the other.

Conclusion: VOR-gains remarkably differed between systems within the same subjects. This could lead to misdiagnoses regarding vestibular function. The differences could most likely be attributed to different types of gain calculation. It is therefore of utmost importance to have a uniform way of gain calculation for all VHIT-systems.

The Video Head Impulse Test (vHIT) and the influence of daily use of spectacles to correct a refractive error

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Objective: To determine the influence of daily use of spectacles to correct a refractive error, on the VOR gain measured with the video head impulse test (vHIT).

Material and Methods: This prospective study enrolled subjects between 18 and 80 years old with and without a refractive error. Subjects were classified into three groups: (1) contact lenses, (2) spectacles and (3) control group without visual impairment. Exclusion criteria comprised ophthalmic pathology, history of vestibular disorders and alternated use of spectacles and contact lenses in daily life. Corrective spectacles were removed seconds before testing. One examiner performed all vHIT's under standardized circumstances using the EyeSeeCam system. This system calculated the horizontal VOR-gain for rightward and leftward head rotations separately.

Results: No statistically significant difference was found in VOR gain between the control group (n=16), spectacles group (n=48) and contact lenses group (n=15) ($p = 0.111$). Both the spectacles group and contact lenses group showed no statistically significant correlation between VOR gain and different refractive error, for rightwards ($p= 0.071$) and leftwards ($p= 0.716$) head rotations. There was no statistical significant difference in VOR gain between testing monocularly or binocularly ($p = 0.132$) and between testing with or without wearing contact lenses ($p = 0.800$).

Conclusion: In this study VOR gain was not influenced by wearing corrective spectacles or contact lenses on a daily basis. Based on this study, no corrective measures are necessary when performing the vHIT on subjects with a refractive error, regardless of the way of correction.

Predictive value of caloric and video head-impulse testing of the semicircular canals

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Objective: predictive value of semicircular canal assessment

Study Design: Retrospective cohort study

Patients: 192 adult patients received pre- and postoperatively vestibular testing. Patients with preoperative areflexia and patients <7 years of age were excluded.

Main Outcome Measures: Subjects underwent pre-post caloric irrigational testing, video Head Impulse Test (vHIT) and completed the Dizziness Handicap Inventory (DHI).. Results were compared and categorical analysis were applied. In contrast to most studies, non-implanted side was also taken into account and 4 categories were defined to assess possible deterioration.

Results: Caloric tests show a significant but minimal reduction: 3.1 °/s and 4.7 °/s for warm and cold irrigation, respectively, but 37.4% of patients dropped one or more categories. VHIT analysis showed a small, but significant decrease in gain of -0.057, -0.040 and -0.045 for the anterior, lateral and posterior canal, respectively. 7.7% show a change to abnormal (impaired) gains for the anterior semicircular canal. Subjective symptoms (DHI) did not show postop changes for composite total score, as well for scores on functional and emotional subdomains. The physical subdomain score however, showed a small but significant increase. 9.0% show a deterioration of 1 or 2 categories.

Conclusion: Although a significant postoperative vestibular deterioration (calorical, vHIT and DHI physical subdomain) was found, its clinical impact and predictive value seem to be limited and show to have less impact when analyzed on group level, compared to other previous studies. Nevertheless, on the individual level, vestibular deterioration after CI can still lead to serious postoperative deterioration and subjective complaints in a small group of patients, compelling clinicians to assess vestibular function pre- and postoperatively.

VEMP results of unilateral cochlear implant user with inner ear malformation: Preliminary results

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Objective: To evaluate vestibular evoked myogenic potentials (VEMP) results of unilateral cochlear implant users with inner ear malformations.

Method: VEMP is a short latency myogenic response recorded with surface electrodes placed over muscles. VEMP response could be recorded even in subjects with severe to profound hearing loss and this reveals intact vestibular organs. However, it is complicated that what happens in case of inner ear malformations. In the current study, 10 unilateral cochlear implant users with inner ear malformations were included. These subjects were selected randomly from institutional ear malformations database. Both cervical VEMP (cVEMP) and ocular VEMP (oVEMP) was applied for all subjects.

Results: Age range was in between 7 years and 6 months and 40 years with 20,7 mean. All subjects had different cochleaovestibular malformations and in same subject both ear also had different malformations. 9 subjects had right CI and 1 subject left CI. All subjects had bilateral normal middle ear function. They were tested with cVEMP and oVEMP in a random order. In implanted ear, cVEMP response got in 4 subject, but oVEMP response got in 2 subjects. However in non-implanted ear, cVEMP and oVEMP responses got in 5 subjects. VEMP wave forms revealed some difference in both latency and amplitude form CI user with normal inner ear structure and normal subject's reports from literature.

Conclusion: Cochlear implant could change vestibular functions and this could be evaluated with VEMP especially to see saccul and utricul functions. It was known that dizziness and balance problems commonly accompany with inner ear malformations also after CI their complaint may increase. Different cochleovestibular malformations result in different VEMP recordings. But it is not clear that absence of VEMP result from cochleaovestibular malformation or from CI. Therefore, further studies need.

The impact of bilateral vestibulopathy on spatial and non-spatial cognition in humans

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Introduction : Hearing loss have recently been recognized as an independent risk factor of dementia. Likewise, growing evidence suggest a link between the vestibular system and cognition.

Objectives: To evaluate

(1) if patients with bilateral vestibulopathy (BV) suffer from spatial and non-spatial cognitive deficits and

(2) to assess if these deficits are caused by their vestibular and/or hearing loss.

Methods: 40 patients (59y±14) with an established diagnosis of BV according to the Barany criteria, were included. All patients received audiometric and vestibular testing. Cognition was assessed by the means of the Repeatable Battery for the Assessment of Neuropsychological Status, for hearing impaired persons (RBANS-H). The RBANS measures 5 domains of cognition: immediate memory, delayed memory, visuospatial abilities, attention and language. 82 healthy, normal hearing, controls (63y±11) without vestibular complaints completed the RBANS-H. Spatial cognition was assessed by the Virtual Morris Water Maze (VMWT) in the 40 BV patients and in 20 healthy normal hearing controls (48y±12) without vestibular complaints.

Results: RBANS-H. Overall, patients with BV and hearing loss had a worse total score then patients with BV without hearing loss and healthy controls (95±17, vs respectively 101±13 and 100±13, p>0.05). Mainly, immediate memory

(p=0.04) and attention (p=0.03) seem to be affected in BV patients with hearing loss compared with healthy controls. No statistically significant differences were observed between BV patients with normal hearing and healthy controls. VMWT. Regardless of their hearing status, BV patients seem to take longer paths and more time to find a hidden platform than healthy controls (p>0.05).

Conclusion: Our results confirm the previous findings of impaired cognition in BV patients, although the deficits in non-spatial cognition seem to be rather caused by the associated hearing loss in BV patients than their vestibular loss.

FS 22: Organization and Efficiency of Implant Centres

Analysis and categorization of problems in the mapping of CI referral cases

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Objectives: The aim of this study is the analysis and categorization of common problems in the CI mapping, and to further consideration of mapping solutions from our past experience.

Material and Methods: This study included 31 patients who had undergone CI and were referred for CI mapping to our hospital from another medical centers. All patients were pre-lingual hearing impaired CI users who were implanted with a Cochlear Nucleus. The physical examination and radiologic study were taken by an experienced otologist. Speech perception test and standardized articulation test named U-TAP (Urimal Test of Articulation and Phonation) were evaluated by a speech therapist before and after the mapping. Mapping was controlled and adjusted by a CI mapping specialist.

Result: Articulation problem was most common (87.1%) subjective problem in CI patients of this study, and second problem was speech perception (38.7%). In addition, patients complained of uncomfortable sound level, abnormal voide tone and eye twitching. In the mapping status of our evaluation, inappropriate setting of the threshold (T) and comfortable (C) level was most common (96.8%) problem, and narrow dynamic range was second (61.3%). In addition, "out-of-compliance" and electrode problems can be categorization of the mapping problems. After the evaluation, the fine adjustment of the mapping was done through the close collaboration of otologist, speech therapist, and the audiologist. Compared with initial evaluation, significant gain of speech perception test and U-TAP score were observed.

Conclusion: Speech production and perception problem was the common complaints of CI patients. Inappropriate setting of T and C level was most common problems of CI mapping. Close collaboration between the otologist, speech therapist and audiologist enable appropriate audiological development of CI patients and it seems the most important process in CI mapping.

Pathways of management for clients with SSD

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Background: An increased number of children and adults with SSD receiving cochlear implants over the past 10 years has guided clinical protocols for evaluation and ongoing management. The benefits of CI are clear for hearing in background noise, localising sound, and decreased overall listening effort. This paper will provide an outline of SCIC's protocols including pre-operative support and counselling, guidelines for device programming, & rehabilitation. Outcomes and rate of progress will also be discussed.

Methods: A total of 65 people with SSD were included in this retrospective review of management pathways. This included 5 groups of children that received specialist advice, assessment and management by a multidisciplinary team. These groups included those with absent auditory nerves, benefit from conventional devices, no devices who received ongoing monitoring, children who received a CI, and those suitable for CI, but did not proceed to surgery.

Results: In adults, approximately 30% of those assessed chose to use a conventional device or have no intervention. Children who received CI's for SSD comprised only 29% of the children in the entire sample of those assessed. Auditory nerve was absent in 43% of the children. Recipients showed functional benefit on one or more of the subtests of the Speech Spatial Qualities questionnaire. Methodologies for device programming and rehabilitation varied across the cohort. A review of these processes was required for ensuring protocols were addressing client need.

Conclusions: Evaluation and intervention protocols for SSD must take into account the onset and duration of the hearing loss; integrity of the cochlear nerve on the affected side; benefit received from other hearing devices; current functional hearing performance, and the investment in time and resources that will be required to facilitate the integration of the acoustic hearing from the better ear and electrical hearing.

Evaluation of barriers and drivers to an efficient cochlear implant service delivery to adults; uptake, utilisation, and maintaining a cochlear implant

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Objectives: To systematically analyse the journey of adult cochlear implant (CI) recipients to determine the barriers and drivers to obtain, efficiently utilise and maintain a CI.

Method: A semi-structured qualitative study design using Concept Mapping was used in which participants brainstormed three questions related to uptake, utilisation and maintenance of a CI, and then sorted and rated the generated statements based on their experience.

Participants were recruited from large implant clinics in Australia, comprising: CI-recipients (N=81), CI-candidates (proceed/not) (N=6), Family members (N= 27), Implant audiologists (N=28), CI surgeons (N=6), clinic administration staff (N=5), clinic managers (N= 7), manufacturer representatives (N=6).

Results: Brainstormed statements of all participants were combined and edited for redundancies to form 110, 86 and 76 unique statements for first, second and third questions, respectively. These statements were sorted by participants to form the main themes of barriers and drivers. Initial analysis of sorting showed themes like quality of pre-operative information provided to patients and influence of other CI recipients and professionals as some of the main themes to uptake a cochlear implant, surgical complications and rapport with and confidence in implant audiologists or therapist as main themes for using and efficiently maintaining and cost and gained benefit as main themes for the last question. All statements were rated based on the importance and the impact on the patient's journey. Complete results will be reported following current data analysis.

Conclusion: The study has identified key themes that drive or are barriers to implantation, as well as areas in which the different groups of participants agreed.

Evidence-based schedule for the frequency of programming cochlear implants over time for adult implant users

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The number of cochlear implant users is predicted to increase over time. A cochlear implant is generally programmed throughout the user's lifetime. When setting the frequency of programming sessions over time, there is currently very little consideration and understanding of the changes in programming levels over time. The primary aim was to provide an evidence-based schedule for programming.

Methods: The schedule was developed using evidence of change in programming levels for a large cohort of 680 adult implant users. For each participant, changes in levels were investigated as a function of dynamic range over 2 years post implantation. In addition, for 128 implant users, patterns of change in levels were investigated over 10 years post implantation. Associations of change with demographic characteristics were also investigated.

Results: Findings showed little change from 3 to 6 months out to 10 years post implantation for more than 75% of the participants. For all participants, regardless of demographic characteristics, the mean amount of change over 10 years post implantation was less than 11 current levels.

Conclusion: Interestingly, findings from this study showed that levels vary in the first few months post implantation, but once levels stabilize, little change in levels is expected over the first decade of implant use. The integration of these findings provided sufficient evidence to develop one of the first evidence-based schedules for programming. The proposed schedule recommends 5 sessions over the first 6 months post implantation, and to program on patient and clinician request thereafter. The schedule recommends a 5-year check-up programming session, and for subsequent sessions to be based on the outcome of the 5-year session. Clinical application of the proposed evidence-based approaches will enable more efficient programming services for current and future implant users over time, without compromising patient care.

The feasibility of day case cochlear implant surgery

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Aim: Day case surgery was originally described as far back as 1909. Even then, the now accepted advantages were recognized, including reduced hospital infection rates,

financial benefits and reduced pressure on hospital beds. Cochlear implant (CI) surgery has traditionally required inpatient stay in hospital.

The aim of this study is to determine the viability of day case cochlear implant surgery in our unit and to develop strategies to increase the rates of same day discharge if possible.

Methods: A retrospective review was carried out of all adult and paediatric patients who underwent cochlear implantation in a single centre (Guy's and St Thomas' Hospital) between January 2014-October 2017. Patients were obtained from a prospectively created departmental database and data captured from the medical notes.

Every patient had a post-operative follow-up between 7-10 days after surgery and clinical progress was formally recorded subsequently.

Results : During the study period 511 CI were performed. This included 334 paediatric CI (193 patients) and 177 adult CI (41 patients).

The total number of complications was 14 (3.7%), including local wound infections (9 patients), wound dehiscence (2 patients) and vertigo/dizziness/nausea requiring an extended stay (3 patients). 11 (5.7%) paediatric and 15 (8.4%) adult patients were discharged on the same day of surgery (7% of total). Only one patient (3.8%) experienced a complication (a minor wound infection).

Conclusion: Day case CI surgery appears to be safe practice. We did not encounter any complications within the first 72 hours in those patients discharged on the same day of surgery.

We aim to increase our day case CI surgery rates, whilst acknowledging that it may not possible in all cases.

We have implemented changes in the department to increase the number of day case patients who are suitable for CI surgery. We are also prospectively collecting patient satisfaction questionnaires.

FS 23: Hearing Management in Skull Base Lesions

The occurrence of primary brain tumors in cochlear implant patients in Sweden between 1989-2014

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The sound processor antenna of a cochlear implant creates a radiofrequency electromagnetic field (RF-EMF) transmitting the sound signal to the implant, similar to that in a mobile phone. A recent case-report suggested a relationship between cochlear implants and malignant glioma, and some epidemiological studies have suggested an increased glioma and acoustic neuroma risk associated with long hours of mobile phone use. To examine if this chronic RF-EMF signaling was associated with an increased brain tumor risk, a population based cohort study was performed examining all 2,748 patients receiving a cochlear implant in Sweden during the years 1989-2014. In all, 3,169 surgeries were performed in the total cohort. The expected occurrence of glioma, meningioma, and acoustic neuroma in the patient cohort was calculated using specific national incidence rates in the Swedish population. Four patients were diagnosed with a brain tumor during follow-up, three of these were meningioma compared to 0.95 expected (SIR=3.16, 95% CI 0.65 - 9.24), and one was a glioma compared to 1.34 expected (SIR=0.75, 95% CI 0.02 - 4.15). No case of acoustic neuroma was observed compared to 0.09 expected. In this study, we did not find support for concerns raised in a previous case report regarding a potentially higher risk of glioma. The number of brain tumors observed was well within the numbers expected from national incidence figures.

MRI follow up after intralabyrinthine schwannoma resection and cochlear implantation

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Objective: MRI observation is part of the regular tumor follow up after the resection of vestibular or intralabyrinthine schwannoma. Since cochlear implantation after intralabyrinthine tumor resection is a central part of the audiological rehabilitation MRI behavior of CI systems needs to be considered. With recent developments in MRI artifact

position and pain prevention it was the aim of the present study to evaluate MRI observations after tumor resection and CI surgery.

Methods: We evaluated 5 patients with a T1 KM sequence MRI observation after intralabyrinthine tumor resection and cochlear implantation. Timespan between tumor resection/ cochlear implantation and MRI scan was between 1 day and 8 years.

Results: In all cases the MRI- observation allowed a visual assessment of the intralabyrinthine tumor region.

Conclusion: MRI follow up after intralabyrinthine schwannoma resection and cochlear implantation needs to be considered before cochlear implantation to allow a visual assessment afterwards.

Intralabyrinthine schwannoma – concept of surgical management and hearing rehabilitation

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Introduction: Evidence of a intralabyrinthine schwannoma can seldom be found in the diagnostic pattern investigating a single side severe to profound sensorineural hearing loss. Depending on the grade of the hearing loss of the patient different treatment strategies exist ranging from "wait and scan", irradiation to recommending an operative procedure. However, postoperative hearing rehabilitation with a cochlea implant (CI) should be included in the counselling of the patient.

Methods: Based on a retrospective chart analysis (n=5 / tertiary referral centre) we like to point out possible options for an individual intervention pathway in cases of presence of intralabyrinthine schwannoma detected by MRI imaging and severe to profound sensorineural hearing loss.

Results: Focusing on the exact localization of the schwannoma in the labyrinth cochlear implantation was planned on the patients` requests. In all presented cases a histologic analysis of the resected tissue was undertaken to secure the diagnosis. Intracochlea schwannoma only located in the lateral basal turn of the cochlea or in the vestibule close to the round window can be treated by tumorresection and simultaneous CI. As radical complete resection of an intracochlea schwannoma located anterior medial to the basal turn of the cochlea or far apical may lead to a potential irrecoverable damage of neural structures a careful opening of the second turn of the cochlea might be an option as well as an incomplete tumorresection. In this case a temporarily insertion of a placeholder might be a possibility with a postoperative irradiation and a consecutive CI. From 5 cases 2 patients achieved an open speechunderstanding (monosyllable words at 65db over 60% only with the CI), one patient reached a limit of 30% monosyllables on the implanted ear after irradiation therapy and 2 patients are currently in an early fitting period.

Conclusion: In presence of intralabyrinthine schwannoma and severe to profound hearing loss we recommend to counsel the patient about hearing rehabilitation by cochlea implantation referring to the described treatment options. The aim is to preserve anatomic integrity of the cochlea and neural structures as much as possible. Therefore, incomplete tumorresection must be individually discussed.

Cochlear implantation after synchronous removal of an intrcochlear acoustic neuroma in a case of NF2. Progress report with longterm follow-up

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Objectives: Intracochlear schwannoma is a rare entity. Tumours arise either primarily in the labyrinth or invade from the internal auditory canal. Our case follows a patient with Neurofibromatosis Type 2 and bilateral severe to profound hearing loss. She received a unilateral cochlear implant on the side where here tumour had been stable previously untouched by surgery but where there was MRI suspicion of intracochlear extension from the internal auditory canal. There is very little in the literature regarding hearing rehabilitation in these patients with cochlear implantation.

Method: This is a case presentation with an indepth review of her clinical pathway, the decisional conflicts encountered, her radiological and audiological assessments with long term follow-up over 7 years.

Results: Preoperative suspicion of cochlear invasion was confirmed at surgery. Schwannoma was confirmed histologically after piecemeal removal at cochleostomy and successful electrode insertion was achieved. Factors influencing the device chosen and modifications made to the surgical technique are outlined.

Conclusions: The case highlights that cochlear implantation can achieve success with careful removalof an intracochlear schwannoma in a patient with NF2.

Our patient went on to full-time implant use with enhanced communication abilities. Challenges arising from her NF2 are ongoing.

Lateral petrosectomy in cochlear implant surgery

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Introduction: Lateral petrosectomy (LP) is a surgical procedure performed usually in chronic otitis media surgery and middle ear tumours but also in cochlear implant surgery. The topic remain controversial as cochlear implantation should be performed as one or two stage procedure.

Aim of the study: The aim of this study is presentation of two cases of cochlear implantation with LP. Two cases were man and woman aged 72 and 63 alternatively. Both patients underwent canal wall down ear surgery because of cholesteatoma, more than 20 years ago. The history of ear leakage was negative and patients were free from cholesteatoma formation for many years. They suffered from deep sensorineural hearing loss and had no benefit from hearing aids. The speech discrimination score was lower than 50% for 60dB. They both underwent lateral petrosectomy with cochlear implantation. In perioperative period there was slight facial nerve paralysis in a woman (House Brackmann score 3) which revealed after conservative treatment and remains within normal limits. The time from CI is now 2 years. Both patients are good CI users with benefit according to hearing level (average 30dB) and speech discrimination.

Conclusion: CI procedure performed with LP is safe and effective method of surgery for patients with radical cavity after previous ear surgery

Practical experience with MRI scanning of cochlear implants users

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IntroductionOver more than three decades MRI has steadily gained importance, and it is the diagnostic imaging method of choice in many cases. Nowadays, practically everyone will need an MRI at least once in lifetime, and this is also true for CI users.

There is a growing number of publications about MRI scanning of hearing implant users, including a few reports about problems during MRI. Radiographers are in the difficult situation to find out about the safe conditions for MRI scanning with implants and to assess whether an MRI can be safely performed with a specific implant model.

Objective A data review about MRI scanning of patients with cochlear implants is presented. This includes a literature review, a review of MRIs within hearing centers and data from a magnet removal questionnaire. Out of this, scanning conditions are extracted which allowed for safe MRI scanning.

The presentation also addresses where the MRI safety information for implants can be found and what considerations are essential when planning and performing an MRI in a safe way.

Also trends in MRI technology will be covered, with a focus on implant safety and imaging artifacts.

Results and ConclusionMRI scanning can be performed in a safe way when keeping to the safety guidelines for the implant.

Recent innovations in CI design enable safe MRI scanning at reduced effort.

Intracochlear schwannoma resection and simultaneous cochlear implantation leads to improved speech perception in noise, sound localization, sound quality and significantly decreases tinnitus loudness and intrusion.

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We present the case of a 38-year-old lady with a left-sided intracochlear schwannoma of the basal turn. She noticed pulsatile tinnitus and progressive hearing loss for over 7 years. She was referred to our department for evaluation and treatment because of a sudden deafness followed by incapacitating tinnitus.

We opted for simultaneous resection of the intracochlear schwannoma and cochlear implantation. Via a C-shaped retroauricular incision, a mastoidectomy and facial recess approach was performed. The external auditory canal was temporarily removed by means of an oscillating Feldmann saw to get an optimal view on the promontory. The bony overhang of the round window was removed as well as part of the lateral wall of the basal turn to identify the intracochlear schwannoma and enable its complete resection. Subsequently a Medel Synchrony PIN Flex24 was used for cochlear implantation and umbilical fat was used to obliterate the lateral wall of the promontory and middle ear. The external auditory canal was repositioned and fixated using hydroxyapatite bone cement. The postoperative follow-up was similar to routine cochlear implantation.

The unified testing framework for single-sided deafness studies was used to report data up to 12 months after surgery. Speech perception in noise results were -0,67 dB SNR S0N0 summation effect, -3 dB SNR S0NSSD squelch effect, and -2,66 dB SNR head shadow effect. Sound localization improved progressively from 83 RMS error and 65,6 absolute value preoperatively to 37,32 RMS error and 27,86 absolute value, while the HISQUI score improved from 66 to 54 at 6 months after surgery. The tinnitus loudness visual analogue scale was 9/10 in the unaided situation versus 4/10 in the aided situation, while the total tinnitus questionnaire progressively improved from 40/100 to 16/100.

In conclusion, resection of the intracochlear schwannoma and simultaneous cochlear implantation with the Medel

Flex24 resulted in improved speech perception in noise, sound localization and sound quality, while tinnitus loudness and intrusion decreased significantly.

FS 24: Hearing Outcomes in Adult CI Recipients

Cochlear implantation between expectation and outcome in a background of serum stress hormones

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Background: Elevation in many plasma stress-related hormones occurs in different stressful conditions. Cochlear implant (CI) patients are exposed to the surgical stress and different emotional reactions during the first fitting session (1stFS) when the expectations are met with the outcome. Information about hormonal changes may help us to modify our preoperative and pre-fitting counselling that may ameliorate patients' stress. Many surgical procedures are accompanied by elevation of cortisol and catecholamines. Meanwhile, we do not have information about serum changes of those hormones during the process or procedures accompanying CI.

Objectives: This controlled study was performed to measure the changes in serum levels of Epinephrine, Norepinephrine and Cortisol in cochlear implant patients in two different stressful conditions, the surgery and (1stFS). The serum levels were correlated to the overall expectations and/or outcome.

Patients and Methods: Three serum samples were tested for 21 post lingual cochlear implant patients. Two samples acted as study samples testing the Adrenalin, Noradrenalin and Cortisol hormones in the two conditions and compared with the patient's own control sample. Patients put their expectations on a visual scale graduated from 0% to 100%. . 3 months Post-op., they put their opinion regarding the outcome on a similar scale

Results: showed a highly statistically significant (HSS) increase in serum level of the three studied hormones in the pre-operative sample (Pre-opS). Moreover, the serum cortisol level showed a correlation with expectations in (Pre-opS). Norepinephrine showed a positive correlation between (1stFS) with the outcome. While, Epinephrine showed in-significant correlations.

Conclusion: The (1stFS) is a non-stressful occasion for post lingual CI patients compared to the CI operation which is surrounded by an increase in Serum level of the 3 stress hormones.

Key wards: Cochlear implantation- expectations – outcome- stress- Epinephrine- Norepinephrine- Cortisol

Benefit from upgrade to the CP900 sound processor in cochlear implant users for more than 20 years

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Objective: To demonstrate the audiological and subjective benefits by upgrading patients implanted for more than 20 years, to a new generation of sound processor.

Design: Thirty-three adults cochlear implant users for 21 years [19-26] were prospectively included (cochlear implantation (CI) between 1989 and 1997 with a CochlearTM Nucleus® 22 device). Sixteen subjects with a pre-lingual hearing loss were aged between 3 and 16 years at time of implantation (mean: 5.2 years). The mean age of the 17 post-lingualy deaf subjects was 36 years [16-60] at time of implantation. Subjects were tested in quiet at 60 dB SPL with monosyllabic words (Lafon words), and in quiet and noise with the adaptive French Matrix test in the best-aided conditions. During the upgrade visit, subjects were tested with the previous speech processor (ESPrit 3GTM, n=2 and FreedomTM, n=31). After a take-home phase of two months, tests were repeated with the new processor CP900. Subjective assessment of the sound quality in daily environments was recorded using the Abbreviated Profile of Hearing Aid Benefit (APHAB) questionnaire.

Results: No difference in performance was observed in quiet for monosyllabic words between the two processors. The Matrix test in quiet was possible in 18 subjects with a median benefit of the SRT (speech level necessary to obtain 50% intelligibility) of -6 dB ($p<0.05$, Wilcoxon paired test). In noise, the Matrix test was possible before and at the follow-up session in 13 patients, with a median benefit of the SRT (speech-to-noise ratio necessary to obtain 50% speech intelligibility) with the new processor of -5.3 dB ($p<0.0005$, Wilcoxon paired test). In 6 Patients, the Matrix test in noise was only possible with the new speech processor (previous processor, SRT>18 dB; new processor, median SRT of 12.4 dB [7.4-15.1]. No difference was observed between patients with a pre-lingual and a post-lingual hearing loss. Scores of the APHAB were similar with the previous and the new speech processor.

Conclusion: Patients implanted for more than 20 years with the first generation of cochlear implant can continue to improve their speech performance in quiet and noise with the new generation of speech processor, without to be reimplanted. This study highlighted the reliability of cochlear implant devices, the importance of upgrading cochlear implant recipients to new technology and to include accurate assessment of hearing outcomes as part of the evaluation process after speech processor upgrade.

Factors affecting speech recognition performance in quiet and in noise in adults with cochlear implants

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In the past decade, numerous papers have published on variability in speech recognition in adults with a cochlear implant (CI). Many variables thought to influence the outcome of cochlear implantation have been investigated both in retrospective and prospective studies. In this study, we investigated different biographic, audiologic and electrode position related variables for their relation with speech recognition performance in both quiet and in noise.

Participants were 134 adults with post-lingual onset of deafness, with Cochlear CI systems (either with a Contour Advanced or with a Slim Straight electrode) implanted at one single CI center. Biographic factors were: age, level of education and psychological screening questionnaires. Audiologic factors were: duration of hearing loss, and pre-implantation speech recognition scores. The electrode position was determined on a high-resolution CT-scan post-implantation, using "Matlab" software. Electrode position variables were: electrode scalar position, electrode insertion angle and wrapping factor (electrode proximity to the modiolus). NVA-wordlists, (55 dB and 70 dB) were used to measure speech recognition scores in quiet at three time-points post-implantation: three months, 12 months and at the time of post-implantation CT-scan. Speech recognition scores in noise were assessed using the digits-in-noise (DIN) test at 12 or more months post-implantation.

To investigate the influence of biographic, audiologic and electrode position related variables of adult CI patients on speech perception performance in quiet and in noise, we used multivariate linear regression analysis.

Retrospective hearing performance outcome in a larger cohort of CI532 recipients

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Objectives: The aim of this study was to retrospectively assess hearing performance and electrophysiological characteristics based on routine audiological measures for the Nucleus® CI532 cochlear implant with Slim Modiolar electrode. Changes from pre- to post-CI treatment for a planned number of 150 patients with a CI532 in a German speaking cohort will be demonstrated. Finally benchmark data shall be established.

Materials and Methods: This retrospective multi-centric study has been established to systematically assess speech understanding in quiet and in noise, unaided and aided thresholds. In addition medical history and recipient's electrode-specific objective and subjective measures (impedances, T-NRT, T- & C-Levels) and data logging will be evaluated. Data will be acquired pre-operatively as well as 3 and 6 months post-operatively in adult CI532 recipients.

Results: CI aided speech understanding in quiet and in noise at 6 months post activation improved over pre-operative baseline data. The proportion of the recipient's cohort examined showing post-operative improvement for test and listening condition is ≥ 80% for the 6 months post-operative visit. The mean T-NRT profile shows increased threshold levels towards the basal part of the cochlea.

Conclusion: The outcome presents sufficient evidence to show the effectiveness of the CI532.

Effect of cochlear implantation on nasalance of speech in post-lingually hearing-impaired adults

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Objectives/Hypothesis: Hypernasality is considered a prevalent speech abnormality that could significantly contribute to the unintelligibility of the hearing-impaired speakers. The aim of this study was to evaluate the effect of

cochlear implantation and the duration of hearing loss on nasalance of speech of a post-lingually impaired group of Saudi adult patients.

Material and Methods: This study included 25 post-lingually hearing-impaired patients who underwent cochlear implantation and 25 age-matched control subjects. Patients were divided into three groups according to the duration of hearing loss. The nasometric data of the hearing-impaired group were compared with the control group. Also, the preoperative values were compared with the postoperative values 6, 12, and 24 months after surgery.

Results: Significant differences were demonstrated between the pre-implantation nasalance scores of the three sub- groups and between the patients and control groups. There were statistically significant differences demonstrated between the pre- and the post-implantation nasalance values for the three groups of patients.

Conclusion: Cochlear implantation appears to have significant effects on improving the nasalance of the speech of post-lingually hearing-impaired adult patients. However, the degree of improvement might vary according to the duration of hearing loss the patients had pre-implantation.

Clinical outcomes with a slim modiolar electrode

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Objectives: The properties of the electrode array of a cochlear implant may affect ease of insertion, scala tympani placement and residual hearing preservation, all of major importance for hearing outcome. Evaluating a new electrode array design is therefore essential. The perimodiolar CI532 electrode has been used at Karolinska University Hospital since November 2015. The aim of this study of CI532 cases was to evaluate one year postoperative clinical outcomes.

Methods: A retrospective chart review was performed. A total of 25 adult patients and 32 children, each subjected to a primary implantation with CI532, had undergone a one-year follow up. Adults were tested on speech discrimination score and data analysis of low frequency pure tone hearing thresholds in 14 of these patients was performed. The children were evaluated on aided (CI) pure tone thresholds and early speech outcomes. Impedances, auto NRT and eABR (children) was compared between the CI532 cohort and recent CI512 and CI522 cohorts. The findings were also correlated to postoperative x-ray.

Results: One year after surgery the mean speech discrimination score in adults was 46% (sd: 6%). No correlation was found between pre- and postoperative scores or between postoperative score and deaf length. Low frequency pure tone hearing thresholds demonstrate a wide range of hearing preservation (poor to good) without correlation to preoperative demographics. In children early results indicate good speech development on Reynell. Early results from a CI532 hearing preservation protocol cases indicate good residual hearing preservation.

Conclusions: Auditory outcome, evaluated by speech recognition in adults and early spoken language in children is comparable to previous perimodiolar electrodes. Short term residual hearing preservation is possible with the CI532.

FS 25 : Perimodiolar Electrode Insertion Aspects

Optimal retention force of audio processor magnets

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Objectives:,Recent implantable hearing implant systems consist of an external audio processor connected to the implant by means of magnets. The actual retention force can be modified and influences the comfort of the user. Small forces will loosen the connection. Large forces induce pressure to the skin and the risk of skin irritation and pain. So far, there are no guidelines specifying the optimal retention force.

Material and Methods: In an experimental setup the retention forces of all available magnet combinations of Advanced Bionic, Cochlear, and Med-El cochlear implant and implantable hearing system magnets were measured as function of the distance between the magnet pairs by a force meter and the labview software after changing the distance between the magnet pairs by an increment motor. In a clinical trial with 100 users of cochlear implant, Soundbridge or Bonebridge audio processors the actual retention forces were measured by a thin force sensor foil. Paint, comfort and discomfort as well as duration of usage were measured by a questionnaire.

Results and Conclusions: We report the distributions of skin status as function of the actual retention force applied to the patients' skin. We give an advice for the optimal retention force. Optimal retention force is a compromise between the risks of skin irritation and audio processor loss. By means of the fitting function the optimal magnet type can easily be calculated for every patient after measuring the actual retention force.

Comparing the effectiveness of different surgeons during insertion in hearing preservation cochlear implantation

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Aim: To quantitatively compare the insertion forces of various cochlear implants surgeons from around the world experienced in hearing preservation cochlear implantation.

Methodology: Attendees at two separate conferences were invited to participate in quantitative analysis of their surgical technique. Participants were evaluated for insertional time, sum intra-cochlear pressure rise and intra-cochlear pressure variation in an In Vitro model of a cochlea with an inbuilt pressure sensor system. The model was a 3D-printed cochlea-model with a mechano-optical fibre-optic pressure sensor installed at the apex of the Cochlea that measured pressure changes along the fluid column.

Results: Analysis consisted of 48 insertions by 36 different participants, including 9 Professors of Surgery, 6 audiologists and 21 surgeons from around the world.

Experience and training was positively correlated with minimal pressure variation. Surgeons (particularly professors) with an established technique for hearing preservation implantation demonstrated a reduction in overall pressure rise when compared with surgeons without an established or experimentally supported technique. Qualified surgeons demonstrated a significant reduction in both pressure variation and sum pressure rise when compared to audiologists.

Established factors of hearing preservation were supported. Fast insertions when compared to slow insertions by the same surgeon led to a significant increase in intra-cochlear pressure rise. Dry electrode insertions when compared with wet electrode insertions produced a marginal yet significant increase in intra-cochlear pressure rise.

Conclusion: A comparison of In-Vitro atraumatic insertion techniques amongst a varied group of participants demonstrated that the skill of the surgeon, the speed of implant insertion and moisturisation of the electrode were significant factors that affected intra-cochlear pressure variation

The “pull- back technique” for the 532 electrode

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Objective: Perimodiolar position of CI electrodes is known for less electrophysiological channel interaction. Although designed for a perimodiolar position homogenous wrapping is not reached in all cases of 532 insertions. Electrode pull back is a surgical option to further decrease modiolar distance of the electrode.

It was the aim of the present study to observe the pull back behavior of the 532 electrode.

Method: In a temporal bone study with 5 decapped temporal bones of different sizes a video tracking observation of the behavior of the 532 electrode was performed.

Results: We observed a relation between temporal bone size, initial insertion depth and pull back effect.

Conclusion: Defined electrode pull back allows a homogenous wrapping of the 532 electrode to the modiolous.

Intracochlear pressure changes during insertion of the slim modiolar electrode array with the ‚pulback’ technique

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Introduction: Different factors influence the functional atraumatic insertion of the cochlear implant electrode array. The intracochlear pressure changes during the insertion have a certain impact on preservation of residual hearing. Aim of our study was to investigated each substep of the implantation of the new slim modiolar electrode array in terms of intracochlear pressure changes.

Material and Methods: All implantations were conducted in an artificial cochlear model. Intracochlear pressure changes were recorded with a micro-optical sensor in the apical part of the cochlea. All insertions were performed with the same insertion speed. After complete insertion a ‚pullback’ was performed.

Results: Significant differences were found between each substep of the cochlear implantation. Insertion of the sheet leads to great intracochlear pressure changes. The insertion of the electrode shows moderate pressure changes. After complete insertion, the ‚pullback’ shows non significant pressure changes.

Dicussion: The elelctrode design has a significant influence on intracochlear pressure changes. Insertion of the sheet leads to great pressure changes, whereas the ‚pullback’ shows non significant pressure changes.

Electro array stabilization project

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Objectives: Describe a surgical technique aimed to stabilize the electrode array of a cochlear implant (CI) without using autologous tissues or artificial materials.

Materials and Methods: The surgical technique described consist in creating three stabilizing elements for the electrode array, the first one in the sinodural angle, the second one in a partially preserved Koerner´s septum and the

third one in a partial opened aditus. The posterior tympanotomy does not show differences in its execution. After the procedure a temporal bone radiography was performed to confirmed the right placement of the electrode array. All temporal bones were then agitated using a Titramax 1000 platform. The correct placement of the array post agitation was then confirmed using the microscope a through another temporal bone radiography.

Results: The surgical technique was successfully performed in five human temporal bones by two surgeons, the electrode array inserted was a N522. No migration of the electrodes outside the cochlea was observed in any temporal bone. In all the temporal bones the electrode guide remained in the same position at two of the stabilization points: the aditus and Körner septum. In three cases (60%) the electrode array moved from the canal carved in the sinodural angle

Conclusions: The new surgical technique described stabilize the electrode array using the temporal bone´s normal anatomy. It preserves free the spaces of the middle ear, without its obliteration with muscle, fascia, bone, fat or artificial materials and does not obliterate the round window niche. These advantages facilitate explantation and reimplantation if necessary, might reduce cost and also surgery time.

Delayed diagnosis of misplacement of cochlear implants into the vestibule - A novel technique to reinsert the existing pre-curved electrode (CI-512 Contour Advance)

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Objectives: Uncommonly, the diagnosis of misplacement of the pre-curved electrode of a cochlear implant may be missed, either at the time of surgery or after, and a delayed diagnosis made when the patient is underperforming audiologically in the early rehabilitation phase, or later. If the displacement is into the vestibule, this may be accompanied by severe vertigo or imbalance.

We review several cases of delayed diagnosis of cochlear implant misplacement into the vestibule, and a novel technique used to replace the existing CI-512 Contour Advance electrode correctly into the cochlea at revision surgery, negating the need to use a new implant.

Material and Methods: Three cases of delayed diagnosis of cochlea implant misplacement into the vestibule were analysed, and the individual management described. In two cases the cochlear implant was replaced with a new unit. However in one case (in 2014), a pre-curved Cochlear CI-512 Contour Advance electrode was able to be carefully replaced into the basal turn correctly at revision surgery without having to discard and replace the implant.

We describe this technique in detail, and it is easily achieved with readily available instruments and disposables in any hospital.

Results and Conclusions: It is unfortunate that cochlear implants may be incorrectly inserted into the vestibule, but this novel technique described to re-insert the existing CI-512 pre-curved electrode is simple, using readily available instruments and disposables, and saves the cost of replacing the implant unit, which is an expensive cost saved. This is a useful technique to keep in mind for these cases.

Delayed electrode dislocation is prevented by the „bone groove" technique

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Electrode dislocation is a complication in cochlear implant surgery that presumably was overcome. In the past primarily straight electrode arrays were used. Since the introduction of preformed electrode dislocation has become a rare event. However, hearing preservation often facilitates the use of straight lateral CI carriers, potentially leading to a higher frequency of electrode dislocations.

We have determined the number of dislocation events over a period of 10 years (2006-2016) in our patient population. In addition we determined the time between surgery and dislocation. Furthermore we propose a surgical technique to fixate the electrode carrier we have introduced to our clinic in 2010. For this, a "bone groove" is drilled into the facial recess to take up the electrode in order to fixate the array permanently.

Results showed 1.627 CI in the time between 2006 and 2016. Of these 54% were straight 46% were preformed electrodes by various manufacturers. Within this time period 17 cases (2%) of electrode dislocation migration was detected. In all 17 (100%) cases migration occurred in patients that received a straight electrode array, while no migration was detected in patients with preformed electrodes. This difference was statistically significant ($p < 0.001$). Since we have deployed the "bone groove" technique the number of dislocations in straight electrodes was decreased from 3.4% significantly to 0.5% ($p<0.01$)

In conclusion the described bone groove technique is an effective procedure to reduce the rate of electrode dislocation in CI patients.

Transanal cochlear implant surgery

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Objectives: To prospectively study a transcanal microscopic/ endosocpic access for cochlear implant surgery

Methods: We describe 5 patients operated from February 2016 to January 2017 with techniques of exposure of the inner ear and placement of the receiver-stimulator through the transcanal access without an endaural or postauricular incision except in the first patient. The indications were cochlear otosclerosis, vestibular schwanomma, osteoradionecrosis of the temporal bone and chronic otitis media. The last 3 patients had a blind sac closure instead of a tympanic membrane preservation.

Results and Conclusions: This transcanal access may be performed with the microscope or the endoscope, and the latter may allow additional visualization to inner ear anatomy as illustrated by a case of vestibular schwanomma removal and simultaneous cochlear implant surgery and two patients who required endoscopic drill-out of severely ossified cochleas. An additional advantage of speedy recovery all patients was observed without any complication observed. Operative videos with discussion of variations of the technique and its potential applications in patients who might otherwise need a subtotal petrosectomy, 2-stage surgery, or combined approach are illustrated. Comparisons to previously described non-mastoidectomy microscopic techniques including suprameatal and transcanal access are made with reference to current development in endoscopic ear surgery.

FS 26 : Late Age at Implantation

Speech production in prelingually deaf adults before and after cochlear implantation

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Since cochlear implantation (CI) has become a standard procedure, speech perception and production skills have been improved a lot for deaf children and adults. Results for speech perception and production after CI are inversely related to the duration of deafness. Nonetheless, more and more prelingually deaf adults take the step toward cochlear implantation. The speech perception levels for those CI-users are significantly below the levels published for postlingually deaf CI-users, mainly because of cross modal reorganization and pathological degenerative changes of the auditory nerve. Deaf speech is characterized by several abnormalities on articulation, phonation, resonance and intelligibility. The aim of this study is to compare several aspects of speech production in 9 prelingually deaf adults before and after cochlear implantation. For the articulation, spoken words are elicited using a picture naming test and the error types are analysed making a distinction between distortions, substitutions, omissions and additions of consonants. The objective vocal quality is measured by means of the Dysphonia Severity Index (Wuyts et al., 2000). The Nasometer (Kay Elemetrics) is used for registration of the nasalance values of the three sustained vowels (/a/, /i/, /u/), and one consonant (/m/) and "oronasal", "oral" and "nasal" Dutch reading texts. To judge the intelligibility, the percentages of correctly understood Dutch consonants in the initial and final position and the vowels and diphtongs in the middle position in the word is calculated, using the Dutch Intelligibility Assessment test (Middag et al., 2009). The pre-CI and post-CI results for these different speech production aspects are compared using a Wilcoxon test. After implantation, significantly less articulation errors were observed, and a positive evolution was seen for the speech intelligibility scores.

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2. Middag, C., Martens, J.-P., Van Nuffelen, G., & De Bodt, M. (2009). DIA: a tool for objective intelligibility assessment of pathological speech. Models and Analysis of Vocal Emissions for Biomedical Applications, 6th International workshop, Proceedings. pp. 165–167.

The influence of sound deprivation on audiologic outcomes and tinnitus after cochlear implantation

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Objectives: To study the relationship among duration of sound deprivation and audiometric gain (by means of speech perception test) and tinnitus after cochlear implantation.

Material and Methods: We evaluated surgical and audiologic results among post-lingual deafened adults, in different times of sound deprivation, and correlated with social isolation, presence of vertigo or tinnitus, and the speech therapy yield, between pre- and post-operative stages.

A longitudinal retrospective observational study, based on the analysis of medical records of patients with post-lingual hearing loss, aged over 18 years-old, that underwent to a cochlear implant surgery in a public hospital from 2004 to 2014. Audiological, socio-demographic questionnaire, and manifestations of vertigo and tinnitus, during pre- and post-operative stages, we compared correlating to the different periods of sound deprivation.

Results and Conclusion:We divided the participants into 2 groups: group A was composed of 38 participants (14 male and 24 female) with sound deprivation of less than 10 years; and group B that was composed of 17 participants (8 male and 9 female) with sound deprivation longer than 10 years. We found no differences regarding age, sex, duration of sound deprivation, mean pure-tone audiometric results

(pre- and post-surgery), and speech perception tests (preoperatively). After one year of the surgery, we observed a significant difference between both groups, with a better performance of group A.

The results of speech perception test, after cochlear implantation in group B, were worse than the results obtained in group A, although these correlations are not determinant whether to perform cochlear implant surgery or not.

Cochlear implantation in postlingual deaf adults is time-sensitive towards positive outcome: clinical utility of advanced machine learning techniques

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Objectives: We investigated the effects of preoperative factors on outcomes of CIs in postlingually deaf adults using a general linear model (GLM) and a nonlinear Regression Forest Regression (RFR) model.

Study Design: Postoperative monosyllabic word recognition scores (WRS) served as the dependent variable to predict. Predictors included duration of deafness, duration of auditory deprivation (duration of deafness without hearing aid use), age at implantation, preoperative hearing threshold and monosyllabic WRS in quiet.

Patients: Postlingually deaf adults (n = 120) who received CI, which was fully inserted, without any inner ear abnormalities or combined disabilities and with follow-up of more than 2 years.

Methods: The prediction accuracy was evaluated with the mean absolute error (MAE) as well as the Pearson's correlation coefficient between the true WRS and predicted WRS. To determine the importance of predictors, we measured increase in the MAE when a given variable was omitted in the regression model relative to when it was included. We used a leave-one-out cross-validation to avoid bias related to inclusion of the test data into the training procedure.

Results: The fitting of GLMs resulted in prediction performance with correlation coefficient r=0.7 and MAE of 15.6+/-9.5). On the other hand, the RFR machine learning yielded superior prediction performance to the GLM with r=0.96 and MAE of 6.1+/-4.7 (t=9.8; p<0.00001). Computation of the importance showed that the contribution of DAD to the prediction was the highest (MAE increase when omitted: 12.1), followed by duration of deafness (8.6) and AgeCI (8.3). In a subsequent analysis, a subgroup of patients with DAD ≤ 10 years showed higher postCI WRS and smaller variation than those with DAD > 10 years.

Conclusion: The current study on clinical utility of machine learning on auditory outcomes of CIs in postlingually deaf adults demonstrated that an advanced nonlinear classifier yields a highly accurate prediction ability with an error of +/-6 in WRS. Our finding also suggests that CI should be implemented no later than a sensitive period (10 years) after deafness to lead to successful outcome. Finally, our machine learning technique has the potential for patient counseling and predicting benefit from CI to patients.

Quality of life in cases of longterm deafness

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Introduction: Treating patients who have been deaf for more than a decade uni- or bilaterally can be a challenge in many ways, not the least of which is convincing health insurance companies that the treatment is feasible and the expected outcome worth the effort. We therefore report data of all patients with an onset of deafness more than 10 years prior to implantation who have received a CI at our centre from 2014 onwards.

Methods: Of 35 patients (20 female, 15 male, mean age 54 years) with onset of deafness >10 years prior to implantation, quality of life assessment using the Nijmegen questionnaire as well as postoperative speech perception thresholds and results of "Freiburger Einsilbertest" 3, 6 and 9 months postoperatively have been compared.

Results: 24 patients reached speech perception levels of less than 65 dB 6 months after the implantation, another 4 levels of up to 85 dB. 14 patients reached > 40 % monosyllable recognition in "Freiburger Einsilbertest" after 6 months, another 6 > 30 %. Scores for Social Interaction and General Activity were considerably higher – in some cases quite unrelated to the acquired speech perception.

Conclusions: With Cochlear Implantation even after more than a decade of deafness uni- or bilaterally it is possible to reach satisfactory results regarding speech perception and quality of life. Nonetheless, careful patient selection and even more importantly, thorough information of the patients with regards to the duration of the rehabilitation process to be expected prior to the treatment is important to avoid disappointment and failure of the treatment.

Hearing outcomes of cochlear implant recipients with preoperatively identified cochlear dead regions

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Background: Cochlear dead regions (DRs) occur where there is absence of function of inner hair cells or adjacent auditory neurons at the characteristic frequency. DRs contribute to poor auditory perception, and are associated with worse outcomes in patients with conventional hearing aids compared to those without DRs.

Currently in the UK, the audiological and functional inclusion criteria for cochlear implantation (CI) are greater than 90 dB hearing loss at 2 and 4 kHz, and a score of less than 50% on BKB sentence testing. The presence of cochlear DRs may allow patients who do not fulfil traditional audiological criteria, to meet extended criteria for CI. The effect of DRs on their postoperative outcomes is unknown.

Objectives: To test the hypothesis that CI recipients who met extended CI criteria due to preoperatively identified cochlear DRs have worse outcomes compared to CI recipients who fulfilled traditional audiological and functional criteria.

Materials and Methods: Retrospective analysis of outcomes of CI recipients who had the presence of DRs identified by threshold equalizing noise (TEN) test. Outcomes are compared to CI recipients who fulfilled conventional CI criteria.

Results: On preliminary analysis, 47 patients had identified cochlear DRs prior to CI. Mean pre- and post-operative BKB scores for the DR group were 22% and 77% respectively. A control group of 150 patients underwent CI based on traditional criteria. Mean pre- and post-operative BKB scores for the control group were 16% and 69% respectively.

Conclusions: Our study suggests that patients who become candidates for CI due to preoperatively identified cochlear DRs have comparable functional outcomes to patients who have CI after fulfilling conventional audiological and functional criteria. This supports DR testing in the work-up of patients for CI if they fail to meet traditional audiological criteria, but do not receive adequate benefit from acoustic hearing aids.

Quality of life assesment on late implanted pre-lingual deafened adolescent patients using Cochlear™ Implanted Recipient Observational Study (Cochlear IROS)

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With the growing public awareness of the benefits of cochlear implantation, there has also been an increase in the number of prelingual implant users who want to operate.

The Cochlear™ Implanted Recipient Observational Study (Cochlear IROS) is a prospective international patient-outcomes registry who are implanted in routine clinical practice with one or more hearing devices.

Objective: The aim of the clinical study was to evaluate changes in quality of life, Qol, and hearing function for subjects and their families, following late cochlear implantation in adolescents implanted at Academic Hospital, Istanbul, Turkey.

Material-Methods: Qol was reported via proxy representing the parental perspective using the Children Using Hearing Implants Quality Of Life questionnaire, (CuHI Qol) was used.

Daily hearing was reported by subjective assessment using the Speech Spatial Qualities scale (SSQ-P 49) completed by the implantee (note suitable for > 8 years)

Results: Quality of life expectation increased judged via proxy using the CuHI-QoL at 3-12 -18 months compared to preimplant. A trend of increasing quality of life of the child, post-implantation is also reported.

Reports of additional impact on family life post implant may be in part related to increasing financial and emotional burden associated with CI intervention including tangible and intangible costs.

Hearing function assessed via the SSQ P 49 – showed improved mean performance in speech, spatial, and qualities sub-cateogries for the group. A high degree of variation in performance is noted (large standard deviations).

Greatest improvement was observed for ‚Spatial' hearing, followed by ‚Qualities of Hearing' and ‚Speech sub-scales.

Further longitudinal data is needed from a larger cohort of late implanted adolescents to validate these preliminary findings and to determine statistical significance of changes over time.

All treatments were privately paid, including CI device and hospital costs.

Improvements observed for the families expectations and the quality of life.

Counselling, both pretreatment and postimplant, is key to ensure the patient and family commence with appropriate expectations and continue high levels of motivation.

FS 27 : Organising CI Flow

Is the adult cochlear implant penetration rate affected by the referral pathway from a hearing aid clinic to a cochlear implant candidacy assessment?

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Introduction: It is well accepted that the penetration rate of cochlear implants (CI) in postlingually deafened adults is low. For example, in Australia, less than 1 in 10 adults who could benefit from a CI actually get one. Whilst there are many contributory factors, the referral pathway from a hearing aid (HA) clinic to a CI clinic is one that has not been adequately explored in the literature. Hence the aim of this study was to investigate the referral rates of postlingually deafened adult CI candidates from a HA clinic for a CI candidacy assessment in Australia, and the factors that may impact on this.

Methods: There were two parts to this study. Firstly, the database of a HA clinic was reviewed for adults clients who had been assessed at the clinic in the preceding 16 months, and with a PTA >/= 65 dB HL as well as unaided phoneme recognition scores of ≤50% correct in the better hearing ear. Files meeting these criteria were individually reviewed to determine whether a CI had been discussed with the client, and the outcomes of this discussion. Secondly, clinicians at that clinic completed an online questionnaire covering topics such as their knowledge of the CI candidacy criteria, typical CI outcomes, factors affecting their decision to refer clients, and their general feedback on making CI referrals.

Results: 1249 files were reviewed, of which 18 adults met the pre-determined CI referral criteria. From these 18 adults, 16 (89%) had record of a CI discussion in their file, with 11 of these being formally referred for a CI evaluation. Of these 11, four proceeded to implantation, suggesting a penetration rate of 22% for this study. Questionnaire responses revealed the need for HA audiologists to have access to more-frequently updated information on CI candidacy and outcomes, as well as better bi-directional communication between the clinics.

Conclusions: Results indicate that the referral pathway from a HA clinic to CI clinic is a barrier to the adult implantation rate, and that HA audiologists not working with CI patients find it challenging to keep abreast of the changes in the CI field.

Cochlear implantation as a the standard of care - Beyond the status quo

Kaplan B.

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Cochlear Implants have been commercially available for over 30yrs and are widely acknowledged as effective in restoring the sense of hearing and improving the quality of life in both adults and children with bilateral severe to profound hearing loss. The recent World Health Organisation (WHO) resolution re-confirmed the impact of untreated hearing loss on "communication, education, livelihood, social well-being and economic independence of individuals as well as on communities and countries" and the importance of treating hearing loss. Even with extensive literature demonstrating the benefits of cochlear implants however it is still considered an underutilised therapy with limited adoption within existing indications and reimbursement structures. This talk will outline the current challenges, with reference to parallels from other disease areas, and propose solutions to ensure people with hearing loss have access to the appropriate treatment depending on their disease state. Four areas of focus will be addressed being 1) Defining hearing loss as a disease and linking to other health consequences to define value of treatment, 2) Creation of consensus statements, leading into practice guidelines, 3) Big data do allow predictive outcomes modelling and prove benefit of the intervention, both hearing and QoL to better guide referrers, payers, and regulators, 4) Redesign of the delivery model, enabling more patients to be treated in an economically sustainable environment. Successfully addressing these four items will allow a significant increase in market penetration and treatment availability.

Incorporating patient choice and participation in the decision-making process of selecting a cochlear implant model

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Background: There are multiple companies that manufacture cochlear implants available for patient use. Currently, the Cochlear Implant Clinic at St. Paul's Hospital uses primarily one manufacturer, and patients do not have the opportunity to choose a particular manufacturer during the decision process. Using the latest models there is no evidence to show that there is superiority with any one particular manufacturer when comparing hearing results post-implantation. Adding choice could potentiate patient anxiety, however, there are other centres that do offer choices to patients with evidence to show that there is high patient satisfaction with this model as well.

Objectives:
- To determine if patients at our centre wish to have a choice and participate in the selection of their cochlear implant manufacturer

- To gather and evaluate patient experiences with the current pre-operative cochlear implant decision process at our centre

Methods: Thirty semi-structured qualitative one-on-one interviews will be conducted to evaluate patient choice and preferences when it comes to deciding on a particular cochlear implant manufacturer. Both pre-operative CI candidates and post-operative patients are allowed to participate. Transcripts of the interviews will undergo qualitative analysis tools, including coding and thematic analysis.

Results: Qualitative analysis of the data currently suggests that many patients do not place large emphasis on the manufacturer or brand of cochlear implant, as long as the decision is supported by the cochlear implant team.

Conclusions: At this time, there may not necessarily be significant advances in patient satisfaction by allowing patients to select the manufacturer of their cochlear implant. When it came to the decision process, patients felt more empowered selecting a device that matched their personal preferences and lifestyle, which correlates more to the specific model of the implant, as opposed to the particular brand or manufacturer.

Improving the value stream of cochlear implant service models

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Background: Increases in the demand and range of cochlear implant services due to expanded criteria over the past 30 years have not correlated with increases in funding. Quality standards for CI service delivery must be maintained. This paper outlines the mapping of value stream of the CI model of service and the financial implications for ensuring standard of care is maintained whilst maximising economic efficiencies.

Method: A total of 56 intervals of service delivery over a 10 year period was mapped across the journey of adult CI recipients. A review of the profit and loss of service delivery over this 10 year period based on a range of parameters cost of service, recipient and clinician numbers and appointment types.

Results: Results indicated that cochlear implant services were not profitable until 5 years post cochlear implantation. All service delivery prior to that point was running at a significant loss. Costs did not even out until approximately 9 years following cochlear implantation. Five areas emerged that showed cost inefficiencies.

Conclusion: Cost inefficiencies of a cochlear implant service delivery model were identified using the value stream mapping approach. This enabled steps to be taken toward implementing a more sustainable model of CI service delivery whilst maintaining good quality of care.

Generally analysing of the cochlear implants on 3717 Chinese patients

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Objective: To analyse the experience in Chinese auditory rehabilitation and CI programs.

Method: Hearing loss (HL) is a common sensory impairment in humans, with significant economic and social impacts. With nearly 20% of the world's population, China has focused on economic development and health awareness to improve the care for its hearing-impaired population. Recently, the Chinese government has initiated national programs such as the China Disabled Persons Federation to fund prevention, treatment, and rehabilitation of hearing impairment. Newborn hearing screening and auditory rehabilitation programs in China have expanded exponentially with government support. While facing many challenges and overcoming obstacles, cochlear implantation (CI) programs in China have also experienced considerable growth. We discuss the implementation of CI programs for HL in China and presents current HL data including epidemiology, newborn hearing screening, and determination of genetic etiologies. Generally, we analyze the total information in a Cochlear Implantation Center, one of the biggest one in China, from Chinese PLA General Hospital, and the primarily outcome of postoperative speech rehabilitation of cochlear implantation in Chinese patients.

Results and conclusion: During 1996-2017, totally 3717 cases were performed in our centre. Among the CI patients, the age ranged from 3 months to 89years, and there were about 80%with prelingual deafness in children and only about 20% post-lingual deafness. Cochlear implantation was safe and stable in our CI centre, and outcomes of postoperative speech rehabilitation were satisfactory in Chinese patients, as well as the long-term outcomes of required further study in Mandarin patient.

Sharing the experience in Chinese auditory rehabilitation and CI programs will shine a light on the developmental pathway of healthcare infrastructure to meet emerging needs of the hearing-impaired population in other developing countries.

FS 28: Management, Remote fitting and awareness of Auditory Implants

CI children with severe complex needs - Quality of life QLICI assessment tool and QLICI study results

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CI children with severe complex needs - quality of life QLICI assessment tool and QLICI study results

Many studies confirm that during the last two decades the population of children with complex needs has grown. In particular, a greatly increased number of very premature babies are now surviving through advanced medical care

where this is available. However, up to 40% of very early born babies have significant and permanent disabilities. These frequently include difficulties in the areas of hearing, vision, kidney function and respiration. Society can now offer much to premature babies.

Multiple disabilities can cause fatigue and frustration in dealing with everyday situations, especially: communication, learning, orientation and mobility, social relationships (isolation, lack of confidence and self-esteem), independence in daily living skills, access to information, access to education, access to employment, access to aids and equipment (because of cost), access to interpreters. Significant changes have taken place, and continue to take place, in the tools and technology to support them.

One example is the Cochlear Implant (CI): this can benefit children who are profoundly deaf, including those with complex additional needs.

Cochlear implants can bring benefits across a range of areas, including listening, the development of communication, psychosocial skills, and pre-academic and academic function. However, there are differences in the type of benefits cochlear implantation will bring to children who are deaf with complex additional needs and to those whose primary need is caused by deafness alone.

By using standard tests, it is sometimes difficult to measure different benefits from CI for complex needs children. Also the rehabilitation strategies to develop different listening skills, communication and social skills are different than strategies usually used with hearing impaired children without additional disabilities.

MED-EL has useful materials supporting children with severe complex needs. One of such materials is the assessment tool Quality of Life Improvement of Hearing Impaired Children with Complex Needs and Their Families Related to Cochlear Implant Use 'QLICI . « QLICI' is to highlight different but significant benefits for children with severe complex needs which they can get from CI and impact of this device for quality of life for this population of children and their families

This material will be introduced during the lecture as well as QLICI international multicente study results.

Remote support for first- and follow-up-fittings of MED-EL cochlear implants

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Cochlear implant audiology is fairly specialized, and is therefore often only available in larger cities or via

'outreach' services, which involve a specialist audiologist travelling to different sites. This can place a real burden on subjects who live in remote or rural locations, and their families. Remote programming is currently approved for any type of fitting session (first-fitting and follow-up fitting) in all subjects receiving a MED-EL cochlear implant regardless of their age.

This study aimed to compare the outcomes of electrophysiological testing, fitting parameters, pure tone audiometry and speech intelligibility measures. The subjects were fit via 2 procedures (remote and face-to-face) and electrophysiological parameters, pure tone audiometry and speech intelligibility

outcomes were assessed acutely after each session in a standard audiological test setup at the study centers. In addition each fitting session was appraised by the remote expert, local host, and the subject via an ad hoc designed questionnaire.

In this study we involved 25 children with their parents and 20 adults. Data gathered on subjects receiving a follow-up fitting, show a general good acceptance and a positive appraisal of the remote setting by the subjects themselves and the professionals involved. Likewise, fitting maps generated with either setting did not differ significantly and initial data on the outcomes of the two set-ups on speech intelligibility show similar performances for what concern subjects receiving follow-up fittings. In addition both, the remote and the local fitting, could be performed in a similar amount of time without experiencing major delays or interruptions. Remote fittings in persons with a MED-EL CI, in the setting made in this study, are as good as normal fittings.

Effect of communication prowess and temperament on loneliness in pediatric cochlear implant users

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Objective:. Pediatric cochlear implant (CI) users report more peer problems, fewer friends, and higher levels of loneliness compared to hearing peers. These peer issues may reflect communication difficulties (speech production or perception) or temperament/behavior factors (depressive mood). This study explores effects of communication prowess and temperament on self-reported loneliness in pediatric CI users.

Method: Participants include 60 pediatric CI users (M=11.9 years, 57% female). Mean age at first CI was 2.7 years. All CI users communicated orally. Participants independently completed an online questionnaire including (a) communication competence, a self-reported rating of speech perception and production on a 10-point Likert scale; (b) loneliness, assessed via the Loneliness and Social Dissatisfaction Questionnaire; and (c) temperament/behavior, measured via the Early Adolescent Temperament Questionnaire (affiliation, or the desire for closeness with others, and depressive mood domains).

Results: A 3-way analysis of variance revealed significant main effects of communication competence ($p<.001$), affiliation ($p<.01$), and depressive mood ($p<.05$) on self-reported loneliness and social dissatisfaction. Pediatric CI users with better speech perception in noise reported lower levels of loneliness than those with poorer perception in noise, regardless of speech intelligibility rating. Higher ratings of affiliation and lower levels of depressive mood corresponded with lower ratings of loneliness.

Conclusions: Pediatric CI users – particularly those with difficulties listening in noise, low affiliation, and/or high depressive mood - may have increased risk of loneliness and social isolation than hearing peers. A better understanding of the relationship between communication and social competence will help identify CI users at risk for social isolation, thereby generating referrals to mental health professionals to enhance quality of life beyond communication skills.

The awareness level on cochlear implants in a multi-country setting amongst otorhinolaryngologists in a secondary setting and amongst adults

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Objective: The main goal of this study was to determine the knowledge and beliefs of otorhinolaryngologists (ORLs) in a secondary setting and amongst adults in selected economically advanced European countries concerning severe hearing loss, hearing aids, and cochlear implants. Secondary goals of the study looked into the information sources of the otorhinolaryngologists and the adult population. In Europe, many adults who could benefit from a cochlear implant do not have one despite their availability via national health care systems. This lack of coverage might be due, in part, to the knowledge and beliefs of otorhinolaryngologists and the lack of awareness amongst adult candidates.

Methods: ORLs in a secondary setting in Germany, England, France, Austria, and Sweden were emailed a custom-made questionnaire on their knowledge and beliefs regarding hearing loss and its treatments. In addition, an online questionnaire was used to assess adults current health motivation to seek treatment for their hearing loss in the same set of countries and to assess their information sources.

Results: 240 ORLs responded (50 from each nation except Sweden). National and international conferences and conversations with colleagues were much more popular methods of keeping abreast of medical issues than other information sources such as online media or company information. In the adult population (n=500), we observed that medical issues were mostly researched through a doctor and then via the internet, including those relating to hearing.

Conclusion: The ORLs of each nation are knowledgeable but could still benefit from an increased knowledge and awareness of hearing loss treatment modalities whereas the adult population consulted the following key professionals about hearing problems: the General Practitioner and Ear Nose and Throat specialists. Medical issues, including those relating to hearing, were mostly researched through a doctor and then via the internet.

Preliminary results: clinical evaluation of a new care delivery model and fitting techniques with newly implanted recipients

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Introduction: Results of a multicenter study evaluating a new clinical decision assisted software that utilizes Artificial Intelligence (AI) and evaluation measures through a direct connect testing system and alternative post-operative programming schedule in the US will be presented. The evaluation measures are captured by a software package, Audiqueen, which introduces a psychoacoustic test battery to evaluate cochlear implant recipients. It is used in tandem with the Fitting Outcomes Expert (FOX) software that utilizes artificial intelligence to provide programming parameter recommendations to the audiologist during the appointment. The software was developed by Otoconsult (Antwerp, Belgium). Since this is a data driven approach to programming, it can be used with both experienced and newly implanted recipients and does not require as many appointments post-operatively to achieve comparable performance.

Objective: The objective of this study is to evaluate a novel care delivery model using both standard of care and direct connect psychoacoustic test metrics in newly implanted cochlear implant recipients.

Methods: 55 newly implanted cochlear subjects are included in the study across 8 cochlear implant centers in the United States. These newly implanted recipients are one arm of a larger study. Preliminary data will be presented. Test metrics for this within subject, repeated measures design included: CNC Words, AzBio Sentences in noise (+10dBSNR), and a psychoacoustic battery (including audiometry, loudness scaling, phoneme discrimination, and speech audiometry).

Conclusion: Utilization of a direct connect testing system and clinical decision assistant software that utilizes (AI) provides a unique post-operative programming opportunity and delivery model in newly implanted recipients. Results indicate this approach to programming is viable for newly implanted cochlear implant recipients.

Remote cochlear implant fitting and self-testing

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Objectives: We've conducted a proof of concept trial to replace the second CI fitting session with a remote session. Following our standard procedures, this second session encompasses audiological tests and computer-assisted MAP optimization. This was done remotely thanks to the use of (1) FOX, the fitting assistant using artificial intelligence; (2) audiological self-tests available in Audiqueen; and (3) Coala link, a calibrated direct connection between the laptop and the CI processor.

Materials and Methods: Six newly implanted adult Nucleus CI recipients agreed to participate in this study. Their CP1000 processor was switched on during the first CI session at the Eargroup. The second fitting session was organized in a remote hospital (Jessa, Hasselt, Belgium). The processors were connected to the laptop by the local audiologist. The subjects then performed audiometry and A§E spectral discrimination as self-tests. Results were uploaded to the FOX server in the cloud. If MAP-modifications were suggested, the expert audiologist at the Eargroup would validate them and write them to the subject's processor.

In this first phase the feasibility, efficacy, risks, and benefits of remote programming are assessed by means of questionnaires as well as audiological outcome. Results are compared with standard face-to-face programming.

Results: This presentation will report on the technical setup and the problems encountered. The audiological outcome and the questionnaire analysis will be presented. Results will be discussed in terms of feasibility and quality of care.

Conclusion: This is a next step in a transition from manual in-clinic CI fitting by expert audiologists towards home based self-testing and (semi-)automated fitting. A number of technical issues still remains to be addressed and more validation is required. It is anticipated that a number of CI recipients will be capable of performing self-testing and self-fitting in the near future.

FS 29 : Diagnostics, Hearing Loss and CI

Prevalence of dead regions of the cochlea in hearing impaired patients

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Dead regions are regions in the cochlea where there are no functioning inner hair cells and/or neurons. A dead region is described in terms of the range of characteristic frequencies in the cochlea that would normally be associated with that region. The presence or absence of dead regions can have important implications for the fitting of hearing aids or cochlear implants.

Objective: to study the prevalence of dead regions in the cochlea in hearing impaired patients with different audiometric configurations and to correlate the dead region with speech discrimination scores. Design: 80 subjects, with age ranging from 18-50 years, were divided into control group (30 normal hearing participant) and study group (50 patients suffering from SNHL). All had TEN test done for them. Results: 39 patients in the study group gave negative

results of TEN test, 11patients gave positive results of TEN test. Conclusion: Prevalence of dead regions of the cochlea in this study was 22%. Dead regions in the cochlea were more common in patients with sloping, long standing hearing loss and in high frequencies.

A successful case of hearing reabilitation with CI in a Mitochondrial Neurogastrointestinal Encephalomyopathy (MNGIE syndrome)

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Objectives: To report a case of successful hearing rehabilitation with cochlear implant in a patient with Mitochondrial Neurogastrointestinal Encephalomyopathy (MNGIE syndrome) since there are few reports of cochlear implant in patients with this syndrome.

Methods: R.C.C., 23 years old, female, was member of a consanguineous family of 4 Children. Patient developed rapidly progressive bilateral sensorineural hearing loss associated with gastrointestinal dysmotility, diabetes, neurological deficits and hypogonadotrophic hypogonadism. After the diagnosis of MNGIE syndrome was established, she was submitted to a cochlear implant for auditory rehabilitation. The processor Opus II of Medel was used.

Results: The patient had her hearing successful rehabilitated with cochlear implant.

A few months after the surgery, the patient presented recognition of practically all sounds in the speech perception test for profound deaf adults and featured 100% recognition of Ling's sounds, 96% recognition of open set sentences.

Conclusion: It is suggested that cochlear implantation may be a successful therapy for auditory rehabilitation in patients with MNGIE syndrome that developed severe to profound hearing loss.

Cochlear implantation in Mucopolysaccharidosis type VI – what makes this case special?

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Objectives: Mucopolysaccharidosis type VI (or Maroteaux-Lamy syndrome) is a rare genetic disorder characterized by lack of activity of the enzyme arylsulfatase B with subsequent accumulation of glycosaminoglycans in the body. Mixed hearing loss is a common symptom.

Material and Methods: We present a case of a child who initially passed the newborn hearing-screening test at birth. The child was re-evaluated at 18 months because the parents complained of inconsistent responses to sounds despite recent myringotomy and grommet insertion.

Results: Audiological evaluation with auditory brainstem evoked response testing revealed auditory neuropathy bilaterally and hearing aids were fitted. Meanwhile the diagnosis of Mucopolysaccharidosis type VI was confirmed. Permanent chronic otitis media with effusion was treated with new placement of grommets, hearing aid gain was increased but there was insufficient speech and language development. At 2 years and 5 months, cochlear implantation was performed on the left side and the right side was implanted five months later. After bilateral CI, the child presented with excellent freefield responses and good speech and language development. At five years, cholesteatoma was clinically diagnosed after recurrent ottorhoea on the right side. Surgery was then performed vıa an endaural approach. The pars tensa cholesteatoma expanded in the epitympanic area, supratubal recess and antrum entrance. Although cholesteatoma matrix was in a close relationship to the electrode array at the area of the cochleostomy, a complete removal of cholesteatoma was achieved. Tympanic membrane reconstruction was performed using conchal cartilage. Now, one year after the cholesteatoma surgery, the patient presents with a dry ear and good CI performance and speech development.

Conclusions: This case with Maroteaux - Lamy syndrome demonstrates special audiologic and surgical issues and difficulties that may arise in patients with mucopolysaccharidosis.

Evaluation of ototoxicity in children with head and neck cancer who received cisplatin and/or carboplatin therapy

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Objective: To evaluate cisplatin, carboplatin induced ototoxicity in children with head and neck cancer.

Material and Methods: Charts of 1095 patients with childhood cancer treated between 1988-2017 were retrospectively evaluated. Patients who received platinum-based chemotheraphy for head and neck cancers were determined. Patients were divided into 3 groups. Group 1 was consisted of patients who received only cisplatin therapy, Group 2 patients received cisplatin+carboplatin therapy

and group 3 patients was composed of patients who received only carboplatin therapy. Possible risk factors for the occurence of ototoxicity such as age,gender, various dose of platinum- based therapies, concomitant radiotherapy were evaluated.The audiological tests battery consisted of pure tone audiometry, transient oto-acoustic emissions, auditory brainstem response. Ototoxicity was evaluated according to Brock's criteria.

Results: There were 47 patients with head/neck cancer who received platinum. The median-age was 8 years (3mos-16.8 yrs), Male/Female ratio was 1.14. There were 18 patients in group 1 (cisplatin-only), 7 patients in group 2 (cisplatin+carboplatin),22 patients in group3 (carboplatin-only). Ototoxicity was seen in 15 (32%) patients. 5 patients (33%) had grade(1), 4 patients (27%) had grade(2), 4 patients (27%) had grade(3), two patients (13%) had grade(4) ototoxicity. Ototoxicity incidence was 44% (n:8) in group 1, 71% (n:5) in group 2, and %9 (n:2) in group 3. Ototoxicity incidence was significantly higher in patients who received higher cumulative dose of cisplatin (≥400mg/m2) (p:0.040) and in patients who were co-treated with head/neck radiotherapy (p:0.041). Other evaluated risk factors were not associated with the occurence of ototoxicity.

Conclusion: Higher cumulative doses of cisplatin and concomittant head/neck radiotherapy increase the risk of ototoxicity. Audiologic follow-up is necessary for early detection of ototoxicity.

New technique for audiometry in real environments simulation (NT-ARES)

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Objective: The aim of this study is to validate NT-ARES, a new booth for hearing analysis simulating listening conditions of real life.

Methods: It has been designed and performed a new booth with an audiological software using auditory-visual scenarios where the sounds sources are eight speakers in 360º around the subject and while the patient's audition is being studied 3D images alluding to what hears are shown to give a sense of realism. First step for a prospective validation study was carried out with 45 normal hearing patients (17 [38%] males and 28 [62%] females; mean age was 34.6 [SD: 10.7-] years). Audiological studies: Tonal and vocal audiometry (with and without noise) and uncomfortable auditory threshold were done in the Conventional booth and in NT-ARES. Statistical analysis was performed to study concordance between both exploration conditions.

Results: Statistical significance concordance (p>0.05 for the differences) was found between Conventional booth and NT-ARES results in Tonal and Vocal audiometry.

Conclusion: NT-ARES represents a complement to the conventional audiometric tests and it might complete audiological diagnostic. NT-ARES constitutes a methodology that can be applied to optimize the calibration of hearing aids and auditory implantable devices.

Etiology of hearing loss in children in southern Brazil

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Etiological diagnosis of infant hearing loss (HL) is important for the prevention, effective management and the prognosis of this impairment.

Objective: The aim of this study is to determine the etiology of hearing loss detected in children from southern Brazil.

Methods: A prospective cross-sectional study of 166 children from 0 to 12 years old, with mild to profound HL. Detailed family and medical history were obtained; diagnostics tests were carried out; mutations frequently associated with HL were analyzed: the mutation c.35delG in GJB2 and deletions del(GJB6-D13S1830) and del(GJB6-D13S1854) in GJB6.

Results: The HL is caused by perinatal events in 28,9% cases, congenital infections in 3,6% cases, genetic syndromes in 10,8% cases, genetics non-syndromic mutations in 9,0% cases (5,23% 35delG/GJB2 homozygous, 3,03% 35delG/GJB2 heterozygous and 0,71% del(GJB6-D13S1830), auditory neuropathy in 3,0% cases, unknown in 38% of the cases and more than one factor were observed in 6,0% cases.

Conclusion: Through the implementation of genetic tests for the most common mutations, it is possible to decrease the percentage of patients with no definite cause for hearing loss. Our results are similar to those observed in other publications.

Poster Sessions

Poster Session 1

Comparative effective of dexamethasone on intracohlear inflammation and residual hearing after cochleostomy : an aminal model

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Preservation of residual hearing after cochlear implant is an important issue with regards to hearing performance. Various methods of steroid administration have been widely used in clinical practice to reduce inflammation and preserve residual hearing. Here we compare the effect of different routes of dexamethasone administration on intracochlear inflammation and residual hearing in guinea pig ears. Dexamethasone was delivered into the guinea pigs either through intracochlear, intratympanic or systemic route. The intracochlear concentration of dexamethasone, residual hearing, inflammatory cytokines and histopathologic changes were evaluated over time. A higher intracochlear dexamethasone concentration was observed after intracochlear administration than through the other routes. Residual hearing was better preserved with local dexamethasone administration as was supported by the reduced inflammatory cytokines, more hair cell survival and less severe intracochlear fibrosis and ossification concurrently seen in the local delivery group than in the systemic group. The results demonstrate that local dexamethasone delivery can reduce intracochlear inflammation and preserve residual hearing better than in systemically administered dexamethasone.

Changes of cochlear glucocorticoid receptor and serum corticosterone in noiseinduced hearing loss animal model: A comparison of administration time of dexamethasone

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Objectives: The purpose of this study was to investigate the changes in cochlear glucocorticoid receptor (GR) and serum corticosterone levels following noise exposure. In addition, we aimed to investigate the effects of dexamethasone (DEX) when administered at different time points.

Materlals and Methods: Animals were divided into two groups according to the noise exposure level (transient threshold shift group [TTS] and permanent threshold shift group [PTS]). Each group was further divided into four subgroups according to the time of DEX administration (noise exposure only , pre-noise, post-noise, and pre- & post-noise exposure). Changes of hearing thresholds, GR and serum corticosterone levels were evaluated via various electrophysiologic and molecular biologic studies.

Results: The expression of GR was changed with noise exposure and with the administration of DEX and serum corticosterone level were changed with noise exposure and were affected by DEX administration. Exposure to noise induced an inflammatory response in the cochlea, which can be resolved with the administration of DEX.

Conclusion: This study demonstrated that cochlear GR expression and serum corticosterone levels were impacted by noise exposure, however, both were affected differently according to the time of DEX administration, which was more effective in decreasing intracochlear inflammation when administered pre-noise and pre & post-noise exposure. Therefore, we believe that serum corticosterone level and GR expression are important for maintaining cochlear homeostasis.

Clinically applicable neurotrophic treatment of the auditory nerve in deafened guinea pigs

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Presumably, in cochlear implant (CI) recipients the auditory nerve progressively degenerates, which may negatively affect their hearing. Spiral ganglion cells (SGCs) degenerate following severe loss of cochlear hair cells - likely because neurotrophic support from the organ of Corti is lost. Numerous studies have shown that neurotrophic treatment enhances SGC survival. Here we examine neurotrophic treatment strategies in guinea pigs aimed towards clinical application in CI users. We compare the effects of several neurotrophic compounds on the condition of the auditory nerve in ototoxically deafened guinea pigs. These compounds include brain-derived neurotrophic factor (BDNF), neurotrophin-3 (NT-3) and 7,8,3'-trihydroxyflavone (THF), a small-molecule BDNF mimetic. Gelfoam containing these compounds was placed on the perforated round window membrane, which is a clinically feasible delivery method (Havenith et al., 2015, Otol Neurotol 36:705-713). We applied histological analyses of the SGCs as well as recordings of electrically evoked compound action potentials (eCAPs) using advanced stimulation paradigms shown to be indicative of neural health (Ramekers et al., 2015, J Neurosci 35:12331-12345). Consistent with previous findings, BDNF treatment yielded SGC preservation in the basal turn of the cochlea. Treatment with NT-3 or with THF showed less SGC survival than BDNF. The functional eCAP measures were consistent with these histological findings. The effect of THF was expected to be higher based on reported superior pharmacokinetics. The lack of effect in apical regions following NT-3 treatment

defeated positive expectations based on generally high expression levels of NT-3 in the apex. Although prevention of SGC loss was limited to the base with this clinically applicable delivery method, auditory nerve responsiveness was improved. This suggests that clinical application, with BDNF as best candidate, is worth considering.

In vitro and in vivo models to test the effects of electrical stimulation on the inner ear

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Objectives: While there is a trend to implant patients with residual hearing, we know that cochlear implantation may cause some loss of this residual hearing. The direct effect of implantation of the electrode in macroscopic structures of the inner ear is well described, however, the effect of the electrical field generated by the implant has not been investigated to date. Some recent data suggests that the electrical stimulation can have a negative effect on hair cells. The objective of this study was to determine the effect of electrical stimulation on hair cells employing in vitro and in vivo models of cochlear implantation.

Materials and Methods: A custom stimulator circuit that allows to study several parameters, including stimulation amplitude, pulse width, and total stimulation duration was designed. For the in vitro work, organs of Corti explant cultures from P3 rats were used. For in vivo work, the adult guinea pigs were implanted with a cochlear implant and subjected to a number of periods of electrical stimulation via constant activation of the implant. Stimulation was applied with varying parameters to determine the effects of the stimulation on the survival of hair cells. Survival was quantified by counting hair cells in organ of Corti explants using confocal microscopy. Auditory Brainstem Recordings (ABR) were performed to determine hearing thresholds in the guinea pig model.

Results: In the present study, a compact and easily-adjustable stimulator circuit was developed. It has sufficient flexibility to imitate a wide range of cochlear implant settings. By varying the amplitude, pulse width, and time parameters, we are able to achieve the simulation required for the electrical effects similar to a cochlear implant. There was a decrease in hair cell count in the explants exposed to higher duration of stimulation. In vivo testing revealed the possibility of testing the effects of changing various stimulation parameters on hair cell survival. We also observed that electrical stimulation induces greater oxidative stress in the cochlea of animals subjected to stimulation compared to implanted unstimulated animals. Experiments are in progress where we are determining the effects of drugs to prevent the auditory damage as well as the generation of oxidative stress in response to electrical stimulation.

Conclusions: In summary, the electrical stimulator developed in this study can be used to understand the effect of electrical field on inner ear sensory cells. The models developed in this study using electrical stimulation can be used as a powerful tool to screen future otoprotective drugs for the preservation of residual hearing post-cochlear implantation.

The change of P1 amplitude in streptozotocin-induced diabetes rat model after noise expose

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Background;There are many studies that have reported the relation with diabetes and hearing loss. But, we still have a little knowledge about the pathophysiology of hearing aggravation in diabetes condition.

Therefore, we investigated the impact of streptozotocin-induced type 1 diabetes on the recovery from noise-induced hearing loss and synaptopathy in rat model after transient threshold shift noise expose.

Marterial and Methods; 14 Sprague-Dawley rats (SD) rats treated with streptozotocin were used and then measured blood glucose and body weight every week. We confirm streptozotocin-induced type 1 diabetes rat model.

We designed two conditions; acute (diabetes for 4 weeks), chronic (diabetes for 12 weeks) model. Click and tone hearing thresholds using TDT-ABR at frequencies of 4, 8, 12, 16, 32 kHz were measured before and 1, 3, 7, 14 days after transient threshold shift (16 kHz narrow band noise, 105 dB, for 2h) noise exposure.

The P1 amplitude of ABR were measured at frequencies of 4, 8, 12, 16, 32 kHz at 1, 3, 7 and 14 days after TTS-noise exposure. Immunohistochemistry of CtBP2 and and phalloidin were done.

Results; Hearing threshold in the control group was complete recovery but 16 kHz in acute diabetics model and 16 and 32 kHz in chronic diabetics model did not show the hearing recovery. P1 amplitude of ABR after noise exposure decreased in both group and the recovery of amplitude was definite and fast in control group but not in both DM groups.

The P1 amplitude of ABR were significantly higher in DM group than control group at 4, 8 kHz.

Conclusion; The P1 amplitude decreased after TTS noise exposure and then slowly recovered until 2 weeks. The recovery rate of P1 amplitude was faster in control group than DM group. We guess that synapthopaty maybe has important role in this results.

Cholesteatoma , a rare complication of the cochlear implantation : about an observation and review of the literature

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Objectives: Our aim is to present a rare complication of cochlear implantation.

Material and methods: This is a 12-year-old implanted at the age of 06 years successfully. After 2 years of implantation, the results were satisfactory, and during a check we found a purulent otorrhea on the side of the implanted ear, which we treated medically many times and surgically without success. Finally an explantation was decided

Results and conclusion: An otological examination under a microscope after aspiration found flakes of cholesteatoma and a postero-superior perforation revealing the electrode holder, a surgical revision was decided after a good medical treatment and local care; thus the patient benefited from tympanoplasty with enhanced perforation with cartilage.

The child was lost view, he returned 1 year later for a new episode of otorrhea and hearing loss. Expertise confirmed the integrity of the implant. The child was hospitalized again for medical treatment and surveillance but the lack of improvement led our team to a surgical revision for explantation, which found a cholesteatoma that enveloped the electrode.

Cholesteatoma is a rare and serious complication of cochlear implantation that must be suspected in the presence of persistent otorrhoea, hence the necessity for regular, long-term otoscopic examination of implanted patients.

Post meningitis hearing threshold improvement and cochlear implantation: a case report

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A 4 years old boy developed a progressive hearing loss (HL) starting 3 weeks after Neisseria Meningitidis type B meningitis leading to a severe and profound degree on both ears. For the prospective risk of cochlear ossification, bilateral cochlear implantation (CI) was performed with optimal auditory-speech perception outcome achievement.

Unaided hearing threshold began to show fluctuations and improvement up to a moderate HL on the left ear, starting 4 months after meningitis and continuing for years post CI surgery.

In order to explore the residual cochlear function, an exclusively acoustic amplification was fitted on the improved left side 5 years post implantation. Audiological testing showed very satisfactory discrimination outcomes with acoustic amplification demonstrate that a good cochlear function has been preserved in this case.

A certain degree of hearing recovery may be expected after meningitis related deafness. Moreover, this case example encourages surgeons and CI technology researchers to intensely explore techniques, therapies and technological solutions that can facilitate the preservation of inner ear structure and the still existing cochlear function during and after CI surgery in order to leave open the opportunities of new strategies adoption.

Cochlear implant in Patau syndrome: a rare case report

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Patau syndrome is a rare congenital disorder which was reported by Patau in 1960. The syndrome is caused by presence of an extra copy of chromosome 13. Trisomy 13 occurs with a frequency of about 1 in 10,000 livebirth. Associated symptoms and findings may vary in range and severity from case to case. However, many affected newborns have abnormalities of skull and facial region; cardiac, renal malformations; and/or other physical abnormalities.

The lifespan of babies affected by the severe malformations are shortened. Trisomy 13 causes congenital sensorineural hearing loss. Three years old male patient with trisomy 13 who applied to our clinic have cleft palate-lip anomalies, gastrointestinal system anomalies, urogenital system anomalies and hearing loss at the advanced right ear in the left ear.

In our clinic, cochlear implant surgery has been successfully performed in the right ear.

The value of preoperative high-resolution computed tomography in predictinground window niche visibility in cochlear implant surgery in children under 12 months old

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Objective: To predict round window niche (RWN) visibility using high-resolution computed tomography (HRCT) in children under 12 months old.

Methods: RWN visibility was determined by a senior surgeon with surgical videos. We use St Thomas's classification for the visibility of RW during CI as follows: Type I RWM is entirely exposed. Type II RW is partial exposure and is subdivided into type IIa, more than 50% but less than 100% of the RWM is exposed and type IIb, the exposure is less than 50% but more than 0%. Type III, the RWM cannot be identified Next, we measured the following four radiologic parameters: 1) the angle of the line of posterior membrane of RWN to facial nerve outer margin relative to the cochlear basal turn(angle A), 2) the angle of the external auditory canal (EAC) relative to the cochlear basal turn(angle B), 3) the width of the facial recess, 4) the relative location of the facial nerve (FN) to the cochlear basal turn. These were compared with the RWN visibility. Subsequently, we draw a line parallel to the EAC line and along the anterior lateral FN.

Results: 80 ears of 40 children were included in the study. Angle A and angle B had a significant correlation with the RWN visibility. The location of the prediction line to the round window membrane highly predicted the RWN view during the surgery.

Conclusion: Preoperative temporal HRCT can predict RWN visibility in cochlear implant surgery. Drawing the prediction line is a simple and useful way for preoperatively predicting the RWN visibility.

Polish universal neonatal hearing screening program and its influence on early cochlear implantation in Poznań, Poland

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The aim of the study was to present how the Universal Neonatal Hearing Screening Program in Poland works and its influence on number of implanted small children in Poznań.

The Universal Neonatal Hearing Screening Program in Poland began in the end of 2002. The main structure of the program consists of three levels. Neonate Departments are responsible for EOAE tests in all newborns in their first 2-3 days of life. On the second level at the age of 3 months children undergo OAE and ABR test. The third level is responsible for treatment of hearing-impaired children. The first hearing screened children were implanted with cochlear implants in our centre in 2005.

The cochlear implant programme in Poznan started in 1994. Till now we have performed 1418 cochlear implantations. This group consists of 799 children and 619 adults.

Until now 378 cochlear implants in children under 3 years of age were implanted. Between 2000-2004 only 1-9 children per year below 3 years of age were operated on. From 2005-2017 a number of children implanted below 3 increased till 16-30 per year. Poznan Cochlear implanted program was sequentially adapted to work with small children after implantation.

The program enabled early audiological intervention, including early cochlear implantation and influenced educational skills.

Speech discrimination and aided threshold outcomes for Carina patients, ollowing re-programming with the new Carina fitting software 4.0.1.

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The Cochlear Carina device is the only fully implantable middle ear device currently available. It is suitable for adults with severe mixed or sensorineural hearing loss who can't wear standard hearing aids or benefit from a BAHA.

In Oxford we have implanted 6 adults (7 ears) with Cochlear Carina Implants. We have presented our outcome data previously. This poster will compare outcomes for 5 of these patients following re-programming with the new Carina fitting software 4.0.1, which has an adaptive feedback canceller (AFC).

Initial results indicate improved speech discrimination scores and aided thresholds. The programming appointment time is significantly reduced due to the automatic adaptive feedback canceller, which does not require time consuming feedback measurements in different head positions.

Carina®: the before and after of a fully implantable hearing device

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Fully implantable active middle ear implants (AMEI) are recent technologic developments and represent useful alternatives in rehabilitating patients with moderate to severe hearing loss. One of these AMEI is the Cochlear Carina® device. There has been a great increase in the interest for AMEI in the last years in view of the excellent results obtained in heterogeneous hearing loss groups, such as pure sensorineural loss, external auditory canal atresia, sequels of otitis externa and media, otosclerosis, among others. Based on the benefits Carina® provides the patient and the clinical impact previously reported in literature, this study aimed at investigating the impact on quality of life and the decrease in hearing loss disability of patients who received Cochlear Carina® implant in Colombia. The patients that participated in this study presented conductive, mixed or sensorineural hearing loss and received Carina® implants. The clinical characteristics of the participating population were: pre and postoperative

audiometric thresholds, functional gain and measurements of quality of life and auditory disability pre and postoperatively using the GBI (Glasgow Benefit Inventory) and the APHAB (Abbreviated Profile of Hearing Aid Benefit) questionnaire, respectively. Measurements were made in 23 Carina®-implanted patients 6 months after activation of the device. No significant differences were observed between the pre and postoperative thresholds. According to the GBI, all participants reported that Carina® positively impacted their quality of life. The APHAB questionnaire showed significant differences among the results obtained with and without the device; however, performance was better with the device. Carina® demonstrated its positive impact on auditory disabilities and on the quality of life of patients that cannot or do not want to use conventional hearing aid devices.

Outcome of Vibrant Soundbridge implantation in young adults with sensorineural hearing loss: a case series

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Objectives: The aim of this study was to assess the surgical and audiological outcome of the middle ear implant Vibrant Soundbridge (VSB) in the patients younger than 40 years old with moderate sensorineural hearing.

Method: A retrospective, case-series study (n=3) was performed. The mean age at implantation was 32 years (min. = 19, max. = 39). Audiological outcome and speech intelligibility were assessed before and after the Incus short process vibroplasty.

Results: Bone conduction (BC) thresholds were preserved after the implantation and a functional gain of 20-30 dB was achieved in all frequencies including 250 and 500 Hz. All patients reported better sound quality and more natural voice perception.

Conclusion: The authors report that the residual hearing of the young patients with sensorineural hearing loss can be preserved with incus short process vibroplasty with remarkable functional gain.

Audiological benefit and subjective satisfaction with ADHEAR hearing system in adults with conductive hearing loss

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Objective: The aim of this study was to evaluate the audiological benefit and improvement in quality of life in patients with conductive hearing loss wearing ADHEAR non-implantable conductive hearing system.

Materials and methods: During the 6 months period, all patient diagnosed with conductive hearing loss in Audiologic Department in our Clinic were screened for potential enrollment in this study. Inclusion criteria were: unilateral or bilateral hearing loss (with bone conduction thresholds equal or better than 25 dB HL), subjects older than 18 years who were capable of answering the questionnaires and were willing to participate in all tests required for the study. Exclusion criteria were: mixed hearing loss (bone conduction thresholds higher than 25 dB HL), patient intolerance or incapability of wearing the device, presence of retrocochlear or central auditory disorder or any other physical or psychological disorder that would interfere with the ability to perform tests. All patient underwent tonal behavioral audiometry (with determination of air and bone conduction thresholds), free field with wobble tones and speech audiometry unaided and aided, and also filled Speech, Spatial, and Qualities of Hearing Scale, Assessment of Quality of Life-6dimensions and ADHEAR questionnaire at first visit, and two weeks after. They all also filled the device specific diary.

Results: The ADHEAR hearing system lead to the improvement of aided pure tone thresholds (at 0,5, 1, 2, and 3 kHz) compared to unaided condition. All patient showed improvement in their quality of life after two weeks of wearing the device, based on filled questionnaires.

Conclusions: The ADHEAR hearing system is valuable, safe and beneficial conductive hearing system and it can be used in patients with conductive hearing loss with different etiologies. It is easy to wear due to it adhesive adapter, and more importantly, patients are spared of any surgery.

Simulated conductive hearing loss for testing a new bone conduction hearing aid

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Introduction: The ADHEAR is a new bone conduction hearing aid, for use with an adhesive placement behind the ear. Mild to moderate conductive hearing impairment can be rehabilitated, especially when a defined time period is to be bypassed, as in small children until they reach the proper age for reconstructive surgery and hearing rehabilitation or after auditory meatus or middle ear surgery postoperatively until wound healing.

Material and methods: Ten normal hearing subjects were tested with simulated conductive hearing loss, either by placing a foam earplug or by inserting a bandage into the ear canal, as in a postoperative situation after ear surgery. The effective conductive hearing loss was measured with standard audiometry. The effect of the ADHEAR was assessed with free field audiometric testing using warble tone, Freiburger numbers and monosyllables and sound orientation in the horizontal plane with both ears.

Results: The improvement by the ADHEAR was 12dB at 500 Hz; 17dB at 1 kHz; 16dB at 2 kHz and 13dB at 4kHz. The improvement of PTA4 was from 38dB to 23dB. The recognition of the Freiburger numbers with ADHEAR at

35dB, 50dB, 65dB, 80dB was 25%, 83%, 100% and 100% respectively. The recognition of Freiburger monosyllables at 35, 50, 65, 80dB was 6%, 44%, 83% and 98% respectively (mean values). In the horizontal plane all subjects lateralised to the better hearing ear, only one subject with the bandage in the ear canal recognised the middle plane correctly at any sound level.

Conclusion: In every situation ADHEAR could improve the sound perception but it never reached the performance of a normal hearing ear. After short time of wearing the device, we could not detect sound localisation in the horizontal plane but in one case.

Treatment of malformations of the external and middle ear in children

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Objective: To describe clinical and audiological characteristics on patients with external and middle ear malformations and the intervention with bone conduction processors and different implants in children with moderate conductive or mixed hearing loss.

Material and Methods: Study retrospective and observational of 223 patients with bilateral or unilateral auricular malformation, period of time since October 2013 to November 2014. The patients were evaluated through a protocol standardized by the group.The different treatments performed bone conduction processors with softband or implant are described.

Results: During the study period, 223 children with congenital aural and ear abnormalities were included. 33 %(73/223) presented bilateral Ear Malformation, with a median age of two years (range 1-4 years). 77% (150/223) presented Unilateral Ear Malformation, with a median age of 7 years (range 1-16 years). 31 % (23/73) of children with bilateral malformation had genetic syndromes.

Conclusion: Audiological findings: 98, 6 % present Moderate Conductive o Mixed hearing Loss. 1,4 % present sensorineural deafness. Eighteen children with bilateral malformation under 18 months of age were equipped with bone conduction device with softband. In children over five years, implant surgery was indicating in 14 cases. In unilateral cases, a sound processor with softband was indicted in six children less than 18 months of age. In children older than five years, surgery with osseointegrated implants was indicated in 6 cases.

Surgical factors affecting NRT threshold of slim straight electrodes

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Objective: The duration of deafness and the ECAP threshold are known factors correlating with the audiological outcome of cochlear implantees. Different factors are known to affect the NRT threshold like surgical factors, electrode design and the insertional depth. The nucleus slim straight electrode gives the surgeon an insertional orientation with a contralateral to the electrode contact direction attached wing.

The aim of this study was to observe the correlation between NRT threshold and the contact orientation for slim straight electrode arrays.

Materials and Methods: In a retrospective controlled study in a tertiary referral center the electrophysiological data sets of 35 patients with measured intraoperative AutoNRTs and postoperative MSCT were evaluated. Additonally insertions in temporal bones were performed to further evaluate the insertional behavior of Nucleus slim straight electrodes. In a prospective part of the study different wing orientations during insertion were performed and NRT thresholds were measured.

Results: By the electrophysiological evaluation of 35 patients discorrelations between the NRT threshold between left and right side insertions were observed. Temporal bone observations showed a non torsional behavior of the slim straight electrode related to a wing related malinsertion. Electrode positions with different contact orientations have no impact on the NRT threshold.

Conclusion: Electrode wing orientation during insertion has no impact on the NRT threshold of Nucleus slim straight electrodes.

Correlation between ART and AUTOART thresholds at the intraoperative moment

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Objective: To analyze the correlation between the neural telemetry response thresholds obtained by the conventional method (ART) and the new method offered by the software Maestro 7.0 (AutoART).

Method: Auditory response telemetry (ART) measurements were performed intraoperatively by ART and AutoART. Data regarding the presence of electrical compound action potential (eCAP) in both methods and the correlation between the threshold values were analyzed. Both methods use the same pulse duration,but the stimulation rate and number of iterations differ. Average thresholds were calculated for the apical (electrodes 1 to 4), medial

(5 to 8) and basal region (9 to 12). Auto ART was always the first method of recording eCAP. ART thresholds were converted and comparison with t test was analyzed in the same unit (qu).

Results: Measures were recorded in nine surgeries, six with the Flex28 device, two with the FlexSoft and one the Flex19. All surgeries resulted in complete insertion and normal of impedances of all electrodes. In seven surgeries, the number of electrodes that presented presence of neural responses with conventional ART was equal to the number of present responses obtained with AutoART. In one surgery, we observed presence of neural responses in 75% of the electrodes with AutoART, and absent response with conventional ART. In another surgery, responses were found in 80% of the electrodes tested in AutoART and 100% in ART. We found statistical differences between AutoART and ART mean thresholds in all measures.

Conclusions: AutoART is an effective and faster way of measuring neural responses. However, the thresholds obtained through AutoNRT were significantly higher than the thresholds obtained by ART. We believe that the difference in thresholds may be due to the diferences in the number of iterations, the stimulation rate or because autoART was always the first of the measurements. We will continue to collect data randomizing the order of the evaluations.

ECAP measurements in the new MAESTRO 7.0: comparison between AutoART and ART standard

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Fitting cochlear implant consists in estimate current values within a dynamic área and objective measurements can be a very useful tool. Can quickly confirm implant function. They can also provide valuable insight into the physiological health of the auditory system. AutoART is a new software tool from MED-EL used to record electrically evoked compound action potentials of the auditory nerve, typically called ECAPs.

Objective: The objective of the study is to compare the results of ECAP obtained through the new AutoART in MAESTRO 7.0 with the ART standard in adult patients.

Method: 20 adult patients, post lingual using MEDEL device for 1 year or more were selected. Patients with partial insertion of the electrodes and/or with some electrode deactivated were excluded. We perform the AutoART and then the ART standard on all electrodes.

Results: 240 ECAP measurements were performed with each of the methods and 204 responses were obtained with AutoART (85%) and 115 responses (48%) with ART standard. Differences were also observed between the values obtained with AutoART and ART standard. The duration of the AutoART measurements was approximately 3 min. In all cases, the stimulation was comfortable for the subjects. If the Auto ART values are compared with the previously estimated values for the maximum comfortable level (MCL), we observe that the AutoART values are lower than the MCL values

Conclusion: AutoART in MAESTRO 7 provides a safe, easy to apply, reliable and very fast way to record ECAP thresholds and slopes, and the information obtained through the AutoART measurement is not reduced to ECAPs threshold determination alone. From the slope of the growth function very useful information for longitudinal monitoring is available, it has promising potential to inform on the neural health of the auditory nerve, and should be used in the clinical routine.

Relationship among neural response imaging threshold and behavioral comfort levels

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Programming Cochlear Implants (CI) takes a long time, more when behavioral responses are null or not reliable. Thus, different authors have developed studies of the NRI utility to find an effective MAP for auditory habilitation. Some authors have proposed that sequential behavioral programming in conjunction with electrophysiologcal test provide the best outcomes (Raghunandhan et al 2013). Others have written that Neural Response Imaging Thresholds (tNRI) can be clinically useful for programming CI (Caner et al 2007; Akin et al 2008; Van Den Abbeele et al 2012; Akin et al 2012).

Objectives: The goals of this study are: 1) to describe tNRI changes from intraoperative to 6 months of use. 2) to evaluate the relationship among tNRI and behavioral comfort levels up to 6 months of CI use and 3) to analyzed NRI according to the site along the cochlea.

Materials and methods:For this study we included 17 patients from Centro de Implantes cocleares Profesor Diamante (9 adults and 8 children). All with HR90K Advantage HiFocus MS cochlear implant.

The single NRI measurement was done in odd electrodes intraoperatively, at the first month and between 3 and 6 months of CI use. Behavioral comfort levels were collected at the tune up, after 3 and 6 months of use.

Subjects were evaluated using the Soundwave 3.0 programming software.

All data collected were analyzed with Graph Pad Prism 6.

Conclusion : For the first fitting intraoperative tNRI is useful to follow the pattern of neural response. tNRI intraoperative and M levels have statistically significant differences.

To find an optimal MAP we must combine objective measures with behavioral responses. The single tNRI is useful as a guideline to predict M level when behavioral responses are null or not reliable. But as exist differences between patients behavioral responses are mandatory.

Measurements up to 6 months postsurgery in electrode impedances and most confortable levels in pediatric patients

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Objevtive: To investigate variations in electrode impedances and Most Comfortable levels over time, since intraoperatively up to 6 months post-surgery, in children using the HiRes90K® device with HIFocus MidScala electrode

Methods: This study included pediatric patients implanted at the "CIC Prof. Diamante". Nine subjects (4 bilateral implants) participated in the study contributing a total of 13 measurement ears. The impedances were monitored through the CI fitting software at regular intervals from surgery to 1, 2, 3 and 6 months post-surgery. The electrical Most Comfort Levels (MCLs) was also monitored.

Results: The general trend of impedances observed were around 3 (±1.2) kOhm at intra-op and increased to 7.9 (±1) kOhm by 1 month (tune-up) and decreased to 6.5 (±1.3) kOhm by 2,and 3 months but slightly increased to 6.75 (±1.3) kOhm 6 months post- surgery. There was a significant difference between intra-op and all other measurements. Impedances increased from intraoperatively to tune up, with a tendency to decrease at subsequent periods of time without reaching the intraoperative measurements.

A gradual increase in MCLs was observed after post-op measurements The MCLs were 108(±29) CU at 2 months, 146(±40) CU at 3 months and 152 (±1) CU at 6 months after surgery. A significant difference observed between 2 and 6 months.

Conclusion: The impedance variances in current pediatric group are similar to other published studies. The future data collection involves keep measuring the data up to 2 years. Also involves monitoring impedances to understand reasons for changes in impedances across the electrode array. CI electrode impedances change following the implantation and through onset of electrical stimulation and later during CI usage.

In-line synchrotron-radiation phase-contrast imaging of the implanted cochlea

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Background: Visualization of a cochlear implant (CI) electrode relative to the basilar membrane (BM) is important for post-operative programming. Image processing techniques have been proposed to infer electrode and BM position using clinical computed tomography. To evaluate these algorithms, images are required that simultaneously show both the electrode and BM. We optimized in-line synchrotron-radiation phase-contrast imaging (SR-PCI) to permit this. In SR-PCI, imaging parameters such as object-to-detector distance (ODD) and beam energy (E) affect image quality.

Objective: To find optimum imaging parameters for in-line SR-PCI of the implanted cochlea.

Methods: Cadaveric temporal bones were used. A CI electrode (model Flex28, Med-El GmbH, Innsbruck, Austria) was inserted into the cochlea through the round window. The specimen was imaged using in-line SR-PCI at the Canadian Light Source. Five different combinations of (ODD, E) pairs were evaluated. At the ODD of 2 m, three scans with E values of 47 keV, 60 keV and 72 keV were acquired. The remaining two scans were obtained with constant E value of 72 keV at ODD values of 1 m and 3 m. The detector used has isotropic pixel sizes of 8.5 μm, 8.6 μm and 8.9 μm for ODD of 3 m, 2 m and 1 m, respectively. The acquired 3D image volumes were compared using contrast-to-noise ratios (CNRs) of the BM and of the electrode. The extent of streaks caused by electrode was quantified for each combination by computing standard deviations of voxels adjacent to it.

Results: Both intracochlear soft tissues and electrode were visible and discernable in all 5 imaging scenarios. However, artifacts were noticeably reduced in images with an E value of 72 keV. The maximum CNR and appropriate phase contrast were obtained with (ODD, E) = (1 m, 72 keV).

Conclusions: In-line SR-PCI is most effective in visualizing both the electrode and soft tissues with maximum CNR and minimum metal artifacts with (ODD, E) = (1 m, 72 keV).

Poster Session 2

The clinical significance of 3D-FLAIR MR images obtained 4 hours after Gadolinium injection in the sudden sensorineural hearing loss

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Objective: The aim of this study was to investigate the clinical significance of 4-hour delayed-enhanced 3.0 Tesla (3T) 3D-fluid attenuated inversion recovery (FLAIR) MR imaging in sudden sensorineural hearing loss

Method: From January 2015 to December 2016, eighty eight idiopathic sudden sensorineural hearing loss patients who completed the pre-contrast, 10-minute and 4-hour delayed-enhanced 3D-FLAIR MR images using double-dose IV gadolinium were analyzed. All patients received the high dose steroid therapy and Intratympanic steroid injections as a salvage treatment. Treatment results were evaluated 3month after the start of treatment, according to Siegel's criteria. After the lesion side laterality of inner ear enhancement was defined, the association between MR enhancement and other clinical parameters of ISSN-HL were analyzed. And the relationships between hearing recovery and MR image finding were also assessed.

Results : Fifty seven (57/88, 64.8%) patients showed obviously asymmetric enhancement of affected inner ear structures on 4-hour delayed images. The recovery rate (complete + partial recovery in Siegel's criteria) was significantly lower in the patients with lesion side laterality on 4 hour delay image (p=.028). In addition, the initial hearing level was significantly worse in asymmetric enhanced patients (p=. 004). In addition, lesion side laterality on 4 hour delay image was only associated with poor prognosis (OR=2.796) according to the multivariable analysis with other prognostic factors, including, age, onset of treatment, initial hearing level and presence of vertigo.

Conclusions: The contrast enhancement of inner ear structures could be identified on 4-hour delayed-enhanced 3T 3D-FLAIR MR images in idiopathic sudden sensorineural hearing loss. The asymmetric lesion side enhancement of inner ear was might be associated with the prognosis.

Speech-auditory brainstem responses in cochlear implant recipients: neural response or artefact?

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Objectives: Objective outcome measures that can be applied in clinical audiology for cochlear implant recipients are lacking. Currently, the objective assessment of cochlear implant outcome in infants or older children and adults with disabilities in the clinical setting is not possible, as these cases are unable to perform behavioural tests such as repeat words or sentences. A possible outcome measure is the Auditory Brainstem Response to short consonant vowel speech stimuli (Speech-ABR). Speech-ABRs have the potential for clinical application as an objective outcome measure of detection of speech and of hearing speech-in-noise.

The aims of this study were to assess the feasibility of recording speech-ABRs in cochlear implant recipients and to investigate a technique to remove any electrical artefact produced by the CI that may interfere with the identification of speech-ABRs.

Methods: Speech-ABRs were recorded to the 40ms [da] speech token via loudspeaker presentation from 12 adult cochlear implant (CI) recipients using a two-channel electrode montage. A CI electrical artefact removal technique that has been previously reported by Laughlin et al. (2013) was applied to all recordings.

Results: In ten participants, no clear speech-ABRs could be extracted from the CI electrical artefact. In two subjects, a possible speech-ABR was extracted after applying the CI electrical artefact removal.

Conclusions: This presentation will discuss the challenges to remove artefact from speech-ABRs recorded from CI users. More research is needed before speech-ABRs can be reliably recorded from patients with CIs

Laughlin, M.M., Valdes, A.L., Reilly, R.B., et al. (2013). Cochlear implant artifact attenuation in late auditory evoked potentials: A single channel approach. Hearing Research, 302, 84–95.

Use of Auditory Steady-State Response in infants less than 6 months in diagnosis confirmation of deafness after neonatal screening

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Objectives: Stady the correlation between Auditory Steady-State Response (ASSR) and Auditory Brainstem Responses (ABR) and results in infants less than 6 months of age.

Material and Methods: We compared the auditory thresholds of ABR that represent the Gold Standard for objective auditory threshold assessment fof child, with the average of the thresholds obtained on the frequency 2000 and 4000 HZ with the ASSR of 48 ears (24 newborns with positive screening by Automated Otoacoustic Emission). The infents have undergone the two tests at the same time or in a period of a month.

Results and conclusions: The average age of realization of ASSR was 3 months.

The Pearson correlation index was 0.98 (p <10-3).

The mean auditory threshold for PEA-TC was 62.08 ± 29.13 dBHL.

The average auditory threshold at the ASSRs was 65.15 ± 31.63 dBHL.

The results of the PEA-TC and ASSR were very concordant. The ASSR provided an objective audiometric curve in verry youngs infants for better therapeutic indications.

Dependence of cochlear implants settings on the components of the evoked compound action potentials

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Objectives. It has been suggested that the density of spiral ganglion neurons will affect on speech intelligibility. The results of previous studies shows that the supra-threshold characteristics of the Evoked Compound Action Potentials (ECAP) characterize the condition of spiral ganglion neurons.

Aim of this paper is to evaluate the dependence of maximum comfort levels on ECAP parameters (threshold and amplitude).

Materials and methods. The study included fitting data of 20 patients with sensorineural hearing loss with unilateral cochlear implantation. All patients were implanted with the Med-El (Sonata or Concerto) CI system with a standard electrode array. The results of electrodes impedance did not exceed 10 kΩ. Auditory development was assessed depending on the age of the patient and the condition of the hearing skills. Recognition results exceeded 90%.

Results. A correlation between comfort levels and ECAP thresholds was found. The values of the comfort levels were reduced when ECAP amplitude was increased.

Conclusions. ECAP thresholds can not be considered as an absolute reference point for determining the CI comfort levels. The amplitude of the ECAP response is one of the indicators of the preservation of the neurons of the auditory nerve. The correlation of the ECAP thresholds and comfort levels higher when ECAP amplitude values increase.

Objective assessment of the floating mass transducer coupling quality via ASSR

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Rationale and Objectives: A good coupling quality of the Vibrant Soundbridge's (VSB) Floating Mass Transducer (FMT) (MED-EL, Austria) is essential to obtain postoperative VSB-aided threshold and SRT improvements. An intraoperative assessment of the coupling quality would allow for correction of the FMT positioning and thus revision surgery could be avoided. Therefore, hearing thresholds must be measured objectively and frequency specifically while the patient is being stimulated via the implant. This was done in the first part of a prospective study including patients who were already implanted with a VSB in order to collect normative data and calibrate the set-up.

Methods: The hearing thresholds during stimulation via the implant's FMT were measured using ASSR (FMT-ASSR thresholds). The ASSR module of the Eclipse system (Interacoustics, A/S,Denmark) was used and narrowband CE-Chirps at 500, 1000, 2000, and 4000 Hz were presented simultaneously. The stimuli were transmitted to the implant using a Samba audio processor (MED-EL, Austria) and a miniTek (Siemens, Germany) connected to the Ecplise. Additionally, the subjective hearing thresholds for this set-up, i.e., for the Chirp-stimuli presented via the miniTek, were recorded. Bone conduction hearing thresholds were also measured before psychoacoustically (BC thresholds) and objectively via ASSR (BC-ASSR thresholds). The patients' Vibrogram thresholds were recorded using the Connexx software (Siemens, Germany). The thresholds were statistically analyzed by dependent t-tests.

Results: The preliminary results show that the FMT-ASSR thresholds are consistent with the subjective thresholds in this set-up. The relation between the FMT-ASSR thresholds and the Vibrogram thresholds shows an offset of approximately 30 dB over all frequencies. However, significant differences were observed between BC and BC-ASSR thresholds.

Conclusion: By the relation between the Vibrogram and FMT-ASSR thresholds the results provide the calibration factors for future measurements. For further evaluation intraoperative measurements are planned.

Function of amplitude growth of electrically evoked compound action potential in patients with cochlear implants

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Objective: To determine whether the correlation between ART and the MCL level depends on the inclination angle of the growth functions of the ECAP amplitude.

Materials and methods: 67 patients (N = 67) with a Concerto cochlear implant (Med-El).. All patients underwent ART registration as a function of the amplitude growth of the electrically induced auditory nerve action potential and the values of the ART level for each individual electrode were obtained. The value of the inclination angle of the growth function of the amplitude of the action potential of the auditory nerve was obtained with help of the tangent of inclination angle. The MCL data were obtained with a volume categorization scale.

Results: The following data were obtained: the minimum inclination of the growth function of the amplitude of the action potential of the auditory nerve was 18 degrees (Tn = 0.31). The maximum inclination angle was 70 degrees (Tn = 2.89). In calculating the correlation dependence between the telemetry of the auditory nerve response and the maximum comfortable loudness, we divided the patients into two groups: the first where the inclination angle of the growth function of the amplitude of the action potential of the auditory nerve was less than 45 ° and the second group where the inclination angle was greater than or equal to 45°.

Conclusion: An analysis of the data obtained showed that a higher correlation between telemetry of the auditory nerve response and a level of the maximum comfortable loudness occurs if the inclination angle of the growth function of the amplitude of the auditory nerve action potential is greater than or equal to 45 °, the correction factor should be added provided that the inclination angle is less than 45 °. These data can be used to improve the accuracy of the maximum comfortable volume level determination

Feasibility of promontory stimulation eABR recording in cochlear implant candidates with MED-EL clinical system: an update

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Introduction: Promontory Stimulation is a well-established tool to stimulate preoperatively the cochlea by a temporary transtympanic needle placed on the middle ear. It was shown that eABR (Electrical Auditory

Brainstem Response) recorded with Promontory Stimulation is an useful objective measure in CI candidates in testing and evaluating the presence and excitability of the auditory nerve and auditory pathway before cochlea implantation. This test is especially critical for a group of patient where it is hardly difficult or not even possible to judge the CI candidacy based on other pre-operative audiological tests. It was also demonstrated that a correct placement of the electrode tip on the RW niche, instead of the promontory, plays an important role on the efficacy of the electrical stimulation delivery. In this study we are going to show the feasibility of this measurement using the MED-EL clinical system.

Results: These updated data show the validity of PromStim test in ten patients. Comparing the wave forms of the different measurements / patients confirms the reliability of this PromStim eABR procedure for testing the hearing nerve before cochlea implantation. An analysis of the grand average of all waveforms shows a similar form like a eABR with stimulation by CI.

Conclusion: PromStim eABR with MED-EL clinical system results easy to be used and feasible on CI candidates especially in whom the presence and excitability of the auditory nerve is in doubt. Additionally, the now updated set of data makes it possible to compare the quality of the waveforms to the postoperatively upcoming hearing performance that will be collected in the near future when more CI data is available.

Cortical auditory evoked potentials in children with cochlear implants

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Objectives: Cortical auditory evoked potentials(CAEPs) are non-invasive tools that can provide objective information on maturation of the auditory pathways. Our study was designed to investigate the role of cortical auditory evoked potential (P1) in assessment of the benefits of cochlear Implants in hearing impaired children.

Material & Methods: This study was conducted in the Mackay Memorial Hospital, Taipei for cochlear implants recipients. There were total 180 CI recipients patients since 1998 to 2017. In some 19 patients with cochlear implants , cortical auditory evoked potentials were completed to determine the latency of the P1 response. All patients were subjected to history taking, basic audiological evaluation and language assessment. Cortical auditory evoked potential (P1) was measured using synthesized speech syllable as a recording stimulus that was presented binaurally via a loudspeaker.

Results: The study group had two cohorts (Group 1 Younger; Age<6yrs at implant : 11 cases and Group 2 Elder; Age>15yrs at implant: 8 cases) which included candidates with normal inner ear and no syndromes or handicaps. In children implanted early (Group -1) there was a decrease in P1 latency. P1 latency was correlated to hearing loss duration in hearing impaired children and the duration of using cochlear implants.

Conclusion: Our data supports early cochlear implantation to preserve the integrity of the central auditory system. Besides, P1 latencies provide a clinically useful biomarker of central auditory development in young children who undergo cochlear implantation.

Impact of GJB2 gene on progression of hearing loss in patients with semicircular canal dehiscence (SCCD)

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Objectives: One to three in 1,000 infants are affected with congenital hearing loss in western countries. In over 50% of the cases, the cause of the hearing loss is hereditary. One of the most common mutations associated with congenital hearing loss are mutations of the GJB2 gene, which codes for Connexin 26. The phenotype usually is characterized by bilateral sensorineural hearing loss. Very few studies looked at anatomical anomalies or variations in temporal bone structures in patients with GJB2. The incidence of inner ear anomalies in patients with GJB2 mutations was higher when compared to patients with normal hearing.

The purpose of this study was to analyse the correlation of GJB2 mutations with the anatomy of the labyrinth.

Material and Method: In order to identify semicircular canal dehiscence (SCCD) in patients with GJB2 mutation, we examined the computed tomographic scans of 78 patients with GJB2 mutations for the prevalence of SCCD and matched them with a group of patients without GJB2-mutations.

Results: A SCCD was determined radiologically in about 50 % of the patients with GJB2 mutations. By contrast, the incidence is much lower in patients without GJB2 mutations.

Discussion: Identifying SCCD in an increased percentage of patients with GJB2 mutation raises the question about the impact of the GJB2 gene on progression of hearing loss in early childhood. Since molecular or biologically-based therapy is not available yet a putative protective effect of a surgical treatment for the sealing of a SCCD on the residual hearing of these patients needs thorough consideration in further analyses.

Study of Japanese children unable to achieve open-set speech recognition three years after cochlear implantation

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Introduction: Numerous studies have assessed the progress of children with profound hearing loss after cochlear implantation, and have demonstrated that cochlear implantation may provide beneficial inputs for improving speech perception. However the characteristics of the "lower" performers with cochlear implant have not been fully reviewed.

Objectives: To identify characteristics associated with inability to progress to open-set speech recognition in children who are 3 years post cochlear implantation.

Materials: A sample of 121 cochlear implant users who had implant surgery before age 5 and has been followed at Tokyo Medical University hospital was investigated.

Methods: Outcome Measures: To evaluate speech perception outcomes, open-set word scores were measured using the Japanese CI-2004 word and sentence test. For the analysis, children with 3-year data were grouped according to whether or not they have achieved open-set speech recognition test.

Statistical Analysis: Spearman rank correlation coefficient was used to examine the differences between open set group and no-open set group by categorical variables(unaided and aided pure-tone thresholds prior to implantation, age at onset of deafness, age at first reception of amplification, cognitive status, radiology of inner ear and internal auditory canal, and perinatal complications).

Results: Lower cognitive status, less functional hearing prior to implantation, and inner ear or internal auditory canal malformation were associated with inability to obtain open set speech recognition by 3 years.

Conclusions: Characteristics of a subpopulation of children with CIs that were associated with an inability to achieve open-set speech recognition after 3 years of CI experience were investigated. These data may predict the risk for poor auditory development after cochlear implantation and support the recipients to make decision of cochlear implanatation.

Integration rate into regular schools of children with cochlear implants in 2016. Discussion of favorable factors affecting successful integration based consideration from over 150 school visit experiences of children with cochlear implants

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Objectives: We examined the integration rate into regular schools of children with cochlear implants and considered favorable factors affecting successful integration. Furthermore, We investigated important points in school education of pediatric cochlear implants from my over 150 school visit experiences of children with cochlear implants.

Material and Method: We followed with schools that enrolled children under 18 who underwent cochlear implant between 1998 and September 2016 while attending our hearing rehabilitation centre during the same time period.

Results and Conclusions: 202 children were of school-age or older with 144 attending regular school.

The rate of integration of our children patients with CI was 71.3%. Other than 2015, when more than an average number of children were enrolled in regular kindergarten and nurseries, the rate of integration into regular schools over the last five years has been between 80% and 90%.

The main contributors that account for the high rate of inclusion are newborn hearing screening 84.3%, bilateral cochlear implants 82%, early detection of hearing loss due to gene mutation and viral disease, preoperative auditory verbal 98%/oral 72% habilitation using hearing aids, surgery between 1 and 2 years of age 82-86%and the ongoing interaction with the full-time speech-hearing-language therapist at the school for deaf 69% and at our center 97%.

Having visited over 150 schools to follow how children after CI have adapted to regular education, a discussion of important aspects in school education to cater to these children follows.

Early cochlear implanted children benefit from bimodal provision

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Background/ Objectives: Children with bilateral profound sensorineural hearing loss often recieve CI at very young age. Even though bilateral CI is standard, some children are fitted with unilateral CI and HA on the contralateral side because of moderate hearing loss (on the non-implanted ear). Aim of this study was to determine auditory functions and development of bimodal provided children.

Methods: The cohort includes 12 bimodally provided children (age at CI 14 ± 6 months). 8 children recieved HA at time of implantation, 4 used HAs preoperatively. During rehabilitation process aided thresholds and speech perception of single words in quiet for monaural CI, monaural HA and binaural CI+HA were measured. Additionally, a parental questionnaire (LittlEars) and the Categories of Auditory Performance (CAP) determined at 6, 12, 18 and 24 months after implantation were analyzed.

Results: Average puretone thresholds were 44.8 (7.3) dB for the HA side and 33 (10.1) dB for the CI side. For all children speech perception for monaural CI (Median=80%, Inter-quartile range=20%) was significantly (p=.038) better than for monaural HA (Md=60%, IQR=40%). 63% of the children showed better binaural performance compared to monaural CI, no child showed reduced binaural performance. LittlEars Scores increased for 89% during the 24 months. After six months 90% of the children exhibited scores above the critical value. CAP showed also increasing scores for all subjects. After 12 months 57% of the cohort discriminated speech sounds (CAP ≥ 4).

Conclusion: Our results suggest that children with bilateral hearing loss benefit from early cochlear implantation. The HA improves bilateral speech perception in quiet, but these effects should also be evaluated for speech perception in noise. Auditory functions of bimodal provided children developed efficiently. The validity of these results has to be verified by a larger cohort.

Cochlear implantation in children with auditory neuropathy: lessons from Brown Vialetto Van Laere Syndrome

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Objectives: The decision process for CI in auditory neuropathy (AN) is evolving with increasing evidence of efficacy. We evaluated the benefit of CI in children with Brown Vialetto Van Laere (BVVL) syndrome.

Methods: Retrospective study of 3 children. Primary outcome was auditory perception.

Results: Patient 1 had ASSE levels of 40-45dB HL 1-year postoperatively, and CAP score had improved from 2 to

5. At 2-year review, aided thresholds were 40dB at 2 and 4 kHz. 3-months following CI, Patient 2's CAP score improved from 3 to 5. At 6 months, thresholds were 25-30db at 2- 4 kHz. Single words/phrases are used by both patients. Patient 3 has recently undergone CI, having been previously rejected at another centre.

Conclusion: CI in children with AN complicating BVVL has a variable, but positive effect. Other manifestations of BVVL make measuring benefit challenging, in the absence of a 'bespoke' measurement instrument for children with complex needs.

The impact of electrode type on intra-operative and postoperative telemetry measures in cochlear implant using different surgical techniques

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Cochlear implantation is largely considered successful based on the device's ability to reliably send electrical signals to the auditory nerve fibers, Telemetry (electrode impedance) is a bidirectional communication system. The telemetry system allows us to test the basic functions of a cochlear implant and to detect the electrical problems in each electrode.

The electrode impedance is a method of measuring resistance encountered by electricity passing through wires, electrodes, and biological tissue.

I t is not uncommon to encounter impedance abnormalities such as short circuit or open circuit at the intraoperative or postoperative time periods. These abnormalities can negatively affect patient performance with the device and should be identified as soon as possible for proper clinical management.

CI electrode placement into the scala tympani was first described using the round-window (RW) technique . Then, different approaches have been proposed to improve visualization, ease of electrode insertion, and, more recently, for emphasis on preservation of residual hearing. Surgeons have the options to insert the electrode into the scala tympani through the RW, or through a cochleostomy adjacent to the RW, based on anatomy and/or surgeon preference.

Outcomes of cochlear implantation in children with the narrow bony cochlear nerve canal

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Objectives: To investigate the diameter of bony cochlear nerve canal (BCNC) as a prog-nostic value of cochlear implantation in children.

Subjects and Methods: We collected 327 prelingual deaf children who received coch-lear implantation before five years of age. We reviewed the preoperative temporal bone com-puted tomography (TBCT) and divided into three groups according to the diameter of BCNC: narrow BCNC (Group 1), normal (Group 2), and other anomalies (Group 3). Narrow BCNC group was divided into three groups according to the degree of stenosis: complete stenosis (Group A), less than 0.8mm (Group B), and from 0.8mm to 1.4mm (Group C). For each group, postoperative auditory performances are analyzed according to the diameter of BCNC using the Mann-Whitney U-test.

Results: Among the 327 children, 38 children (11.6%) were found to have narrow BCNC (Group 1), 185 children (56.6%) had normal BCNC and inner ear structure (Group 2), and 104 children (31.8%) had other anomalies (Group 3). Group 1 showed less significant improvement in Category of Audiological Performance (CAP) score compared with Group 2 and Group 3. Open-set monosyllabic words test was more deficient in Group 1 than Group 2 and Group 3. Open-set sentence identification test was lower in Group 1 than Group 2 and Group 3. Among the 38 children with narrow BCNC (Group 1), five children had complete stenotic BCNC (Group A), 21 children had BCNC less than 0.8mm (Group B), and 12 children's BCNC di-ameter were from 0.8mm to 1.4mm (Group C). The CAP score of Group A was poorer than the Group B and Group C, and CAP score of Group B was also lower than Group C.

Conclusion: The improvement of auditory performance was limited in children with nar-row BCNC and the narrower the BCNC, the more severe the limitation. However, gradual im-provement can be expected. Through these, even children with narrow BCNC need early coch-lear implantation and rehabilitation. This study evidenced the speech perception performance in children having BCNC, which are useful information for preoperative counseling of CI candi-dates and family.

Effects of long term use of cochlear implant on e-Evoked Action potential

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ntroduction: Long term use of cochlear implant affect the response of auditory nerve due to plasticity rules. The parameter of evaluation & study of VIII nerve function in users of cochlear implant is e-Evoked Action potential that calls variously base on cochlear implant prothes brand such as NRT , NRI or ART.

In this study we study the eEACP changes during the time.

Materials and Methods: In this study we assessment the eECAP finding in 87 patients that was implanted 58-75 months later in 2 group of pediatric and adults. The brand of CI of this patients was in 2 groups: Advance Bionics , Cochlear

Results:

The results of study indicate that:

ECAP Thresholds in children:
- decrease of eECAP thresholds (13.82 C.L) in cochlear brand
- Decrease of eEAP threshold (12.63 CU) in AB brand

ECAP Threshold in Adults:
- decrease of eECAP threshold (8.26 C.L) in cochlear brand
- decrease of eEAP thresholds (5.13 CU)

ECAP Slope in children:
- shows steeper slope after time spend
- ECAP slope in Adults: shows no change of slope

Conclusion: The results of study shows that long term use of cochlear implant can affect the current field of cochlear and the relation of stimulating electrode and the tissue of nerve that is stimulating by cochlear implant.

Pitfalls in revision cochlear implant surgery and their management - a case based approach

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Audiological results and quality of life in elderly cochlear implant users

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Objectives:
1) To analyze the benefits of CI in a group of elderly patients in relation to speech recognition after 6 months of use.
2) To compare results among younger age groups with over 75 years.
3) Relate these results to the benefits in their quality of life.

Material and Method:

A retrospective analysis of 70 postlingual elderly Nucleus and Advanced Bionics cochlear implant users

4 subgroups were compared: 60-64 years, 65-69 years, 70-74 years and over 75 years.

Data analysis was performed before the implantation and at 6 months postoperatively. Audiological results were then related to the Glasgow Benefit Inventory questionnaire.

Results: Postlingual elderly CI users show benefits in speech recognition in an open set format, there are no significant differences between the groups. The Glasgow Benefit Inventory scores showed positive changes in related quality of life.

Conclusions:,Increase in life expectancy makes more elderly patients CI candidates. The use of this therapy significantly improves audiological performance, a fact that positively impacts their social abilities and quality of life.

Speech perception in cochlear implant users with post meningitis deafness

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The post meningitis bilateral severe/profound hearing loss can have a devastating effect on oral communication even when acquired in the post lingual period. The cochlear implant is well stabilished as an option for the auditory

rehabilitation for this kind of loss, but the surgery should take place as soon as possible by risk of partial or total ossification of the cochlear lumen which may hinder or prevent the full passage the electrode. Incomplete insertion and changes in impedance (short circuit and/or open circuit) may force the shutdown of the electrodes during programming which can influence the speech perception. The purpose of this study is to evaluate the audiological results of 9 post-lingual cochlear implant users with post meningitis deafness. All participants were accompanied in the Hearing Impaired Center from the Federal University of São Paulo. The participants had age between 14 and 65 years old (mean = 41.11 years) being 5 male. The average time of sensory deprivation was 36.55 months. Partial insertion of electrode occurred in 3 individuals (33.33%). Three other patients had electrodes off due to changes in impedance. The average score for recognition of monosyllables, sentences in silence and noise were respectively: 38,22%, 79.77% and 28.31%. The number of electrodes off had a weak negative correlation with the tests of monosyllables (-0.182), sentences in silence (-0.44) and sentences in noise (-0.299).

Correlation between speech perception, age and sound deprivation time in post-lingual cochlear implant users

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The cochlear implant (CI) allows individuals with severe to profound hearing loss to access most of the sounds of speech enabling great improvement in communication and quality of life, but the performance in open set speech perception tests vary greatly between users. Determine the factors that contribute to a better performance in open set speech perception tests can assist in the guidance of applicants and users of CI.

The objective of this study was to evaluate the correlation between time of hearing deprivation and age of patients in the speech perception results in post-lingual CI patients.

We evaluate 43 unilateral post-lingual CI users aged between 15 to 75 years old that are accompanied by our group – The Hearing Impaired Center of the Otorhinolaryngology Department at the Federal University of São Paulo. Speech perception was measured through recognition of monosyllables, sentences in silence and sentences in the presence of noise (signal-to-noise ratio +10 dBA). The speech test results were correlated with patient age in surgery, patient's age at the time of the evaluation, sound deprivation period prior to implant and time of CI use.

The statistical analysis showed correlation ranging from -0.36 (age versus recognition of monosyllables) to 0.32 (CI use versus sentences in noise) showing low correlation between these isolated patients characteristics and their auditory performance.

We conclude then that the expectation of good performance and the decision of the cochlear implant surgery should not be based on isolated features such as sound deprivation period and age of the candidates with post-lingual hearing loss.

Molecular etiology of deafness and cochlear implantation performances in the postlingually deafened cochlear implantees

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Objective: To investigate the molecular etiology of deafness in the postlingually deafened cochlear implantees and determine whether CI performances are affected by the genetic etiologies

Materials and methods: Seventy-four postlingually deafened patients who had undergone CI between January 2010 and March 2017 at Seoul National University Hospital and Seoul National University Bundang Hospital were included in the study. Among them, thirty-nine patients were consented to molecular genetic testing(MGT). Molecular genetic etiologies were assessed by Sanger sequencing in patients with a characteristic phenotypic marker. The rest of patients were tested with either panel sequencing or whole exome sequencing. Patients underwent MGT were allocated to the following groups depending on whether the genetic etiology was disclosed or not; "Genetically diagnosed(GD)", "Genetically undiagnosed(GUD)". Patients who did not undergo MGT and who had a shorter deaf duration than 6 years were identified as controls. Speech perception performance was assessed using K-CID sentence score, pre- and post-operative 3, 6, and 12months. Non-parametric testing was performed using Kruskal-Wallis test with post-hoc testing using Mann-Whitney U test with Bonferroni's correction. $P<0.05$ was considered significant.

Results: Among the thirty-nine postlingually deafened cochlear implantees who underwent MGT, 20 patients (51%) turned out to have a conclusive Mendelian genetic etiology, leaving the other 19 patients (49%) undiagnosed. Such an extreme molecular etiologic heterogeneity as to involve 13 deafness genes was noted for this cohort. To interest, about half of the postlingually deafened genetic cases were due to autosomal recessive variants which were previously thought to causes mainly prelingual deafness. The most frequent causative gene was TMC1 (DFNA36) (3 cases), followed by the next tier of genes (2 cases each) (ACTG1, CDH23, COCH, SLC26A4, TMPRSS3) and the genes that were detected only once (ATP1A3, GJB2, ILDR1, MYO7A, NF2, OTOR and SERPNB6). All of these genes are expressed in membranous labyrinth(ML), except TMPRSS3 which is expressed abundantly in spiral ganglion neurons(SGN). The median ages of the GD, GUD and control groups were all younger than 55 years and the median deaf durations of the GD, GUD and control groups were all shorter than 5 years. Post-operative Spondee, PB

word score and K-CID scores at 3months, 6months and 12months of the three groups overall did not show statistically significant differences, all reaching about at least 70% for K-CID scores at 1 year. Rising trends in Spondee word scores and KCID scores of GD group at 3 months after CI tend to show slightly heavier, albeit statistically insignificant, than those of GUD group. Among the GD groups, there was no significant difference of speech perception performance between the groups of genes expressing in the SGN and genes expressed in the ML. Although most of the genetically diagnosed cases showed relatively good speech perception performances, two patients who had ACTG1 mutation and each one of the patients who had SLC26A4, CDH23, TMC1, TMPRSS3 and OTOR mutations had post-operative K-CID scores below interquartile range of control group. Among them, two patients with ACTG1 mutation and one of the patients with TMC1 mutation who had deaf durations over 10 years showed K-CID scores under 50% a year after CI.

Conclusion: Our genetic diagnosis rate was 51% in postlingually deafened cochlear implantees and a wide variety of causative genes have been found. Cochlear implantees who were genetically diagnosed showed speech perception performances comparable to the control group, even in the genes expressed in SGN. However, even with the same causative mutation, those with significantly longer deaf duration are associated with relatively worse performance, mandating prompt implantation, if indicated.

Prediction of outcomes based on preoperative assessment in CI patients

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Introduction: Postoperative outcome for monosyllabic word perception after cochlear implantation in adult patients with sensorineural hearing loss is known to vary. Aim of this study is to optimize the prediction of the postoperative outcome for patients eligible for cochlear implantation based on the existing data set of patients with cochlear implant of the ORL department, University Hospital Zürich.

In the current publications, the authors rely on parameters such as age of the patient, duration of hearing loss before cochlear implantation and aetiology. However, the study situation is contradictory and therefore not conclusive.

Methods: Retrospective analysis of an existing data set of adult CI patients of the ORL department University Hospital Zurich (N = 660) from 1977 until 2016. The influence of age and duration of hearing loss was investigated, as well as whether preoperative residual hearing improves speech understanding on the implanted side. Finally, it was tested whether an acute or congenital aetiology of hearing loss leads to different postoperative results. Speech understanding was examined by monosyllabic word perception scores. Preoperatively existing residual hearing was determined by pure tone audiogram.

Results: The age of the patients did not have a significant influence on postoperative speech understanding in the population studied ($p = 0.59$). On the other hand, patients with pre-operative residual hearing showed a significantly better performance in the postoperative performed monosyllabic word perception scores than patients with less residual hearing (* $p = 0.025$). A longer duration of hearing loss correlates with a worse postoperative outcome (* $p < 0.0001$). In the aetiology of hearing loss, the congenitally deaf group scores significantly worse in terms of postoperative speech understanding than the acute deafened group (* $p < 0.0001$).

Conclusion: Preoperative residual hearing, shorter duration of deafness, and the etiology of hearing loss have a significant positive impact on postoperative speech understanding in CI patients. On the other hand, the results suggest that age in CI implantation has no impact on future speech understanding.

Impact of duration of deafness and age at implantation on the development of speech discrimination with cochlear implant

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Objectives: Our aim was to determine the impact of age and duration of deafness on the development of speech discrimination after cochlear implantation. Increased age as well as longer duration of deafness have been negatively correlated to the degree of improvement in speech recognition.

Patients and methods: We selected 102 postlingually deaf patients and divided them into groups according to age and duration of deafness: Group I, 10 to 35 years (n=15; mean 25.0), group II 36 to 70 years (n=58, mean 55.5) and group III ≥ 71 years (n=29, mean 77.0), patients with ≤ 10 years (n=50, mean 2.0) and > 10 years (n=52, mean 28.0) history of deafness. Speech discrimination was tested with the German Freiburg speech intelligibility test at 65 dB.

Results: In group I, the speech recognition of monosyllables at 65 dB was 40 % at 1 month (Q1 20.0, Q3 42.5) and increased to 50 % at 12 months (Q1 32.5, Q3 72.5). Group II increased from 30 % (Q1 10.0, Q3 50.0) at 1 month to 42.5 % (Q1 26.3, Q3 63.8) at 12 months. In group III, the speech recognition of monosyllables improved from 15.0 (Q1 0.0, Q3 25.0) % at 1 month to 35.0 % at 12 months (Q1 3.8, Q3 50). Cochlear implant recipients with ≤ 10 years duration of deafness achieved a speech recognition of 27.5 % (Q1 2.5, Q3 57.6) at 1 month and improved to 35 % (Q1 25.0, Q3 65.0) at 12 months. The patients with a duration of deafness > 10 years improved from 22.5 % (Q1 6.3, Q3 42.5) after 1 month to 42.5% (Q1 26.3, Q3 60.0) after 12 months.

Conclusion: The improvement in speech recognition depends on the age of cochlea implantation in postlingual deafness: patients aged 10 - 35 show a descriptively better improvement, while the development was less favorable in patients ≥ 71 years. Longer duration of deafness was not related to poorer outcome in speech recognition. Careful patient selection is necessary to implant successfully in the elderly.

Cochlear Implantation in a children with autism spectrum disorder

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Introduction: Autism spectrum disorder(ASD) is the name for a group of developmental disability that can cause significant communication, social, and behavioral challenges.

Recently the number of pediatric cochlear implant candidates and recipients who have a diagnosis of ASD is increasing.

We report about listening skills and communication abilities in children with ASD receiving cochlear implantation.

Patients & Method: 23 children, 16 boys and 7 girls, who received cochlear implants at our hospital between 1993 and 2013.

The mean age at implantation were 43.6 months. (SD=31.0)

All children were diagnosed as having ASD, either before or after receiving a cochlear implant.

Divided them into two groups, 5 children are severely disabled by their symptoms (Group A), other 18 children are mildly impaired (Group B).

Meaningful Auditory Integration Scale(MAIS) and Meaningful Use of Speech Scale(MUSS) were used to assess listening skills and speech skills.

Reports of parents and teachers were also used to consider mode of communication that children use in daily life.

Results: 65% of children were able to communicate using speech, including cases that using sign language or writing in combination with. Children in group A were unable to communicate with speech.

However, all 5 children were able to recognize or understand some sound in their daily lives, like birdsong, music, or bell ring at the school.

Comparison of two groups with the scores of MAIS and MUSS, the scores of group A were low than that of group B, however, when compared with themselves preoperatively, these children did obviously improve.

Conclusion: Early treatment for ASD and proper care can reduce individuals' difficulties while helping them improve communication abilities and learn new skills.

These results suggest cochlear implantation is an effective intervention for children accompanied with both ASD and congenital profound hearing loss.

Cochlear implantation for children with autism spectrum disorder

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Introduction: Autism spectrum disorder (ASD) is a kind of developmental disorders that would present problems in communication, social interaction and behavior.

Recently more and more children with ASD are receiving cochlear implants.

Here we report listening skills and communication abilities in children with ASD who underwent cochlear implantation.

Method: Totally 23 ASD patients who received cochlear implants in our hospital, were included in this study. All children were diagnosed as ASD either before or after cochlear implantation.

The patients were divided into two groups according to the severity of their ASDs: five severely disabled patients as group A, and 18 mildly impaired patients as group B.

MAIS and MUSS were used to assess listening and speech skills, respectively.

Reports from the parents and the teachers were also taken into account to assess the communication mode in daily life.

Results: The mean age at implantation and the mean fitting period of cochlear implant were not significantly different between the two groups. 15 of 18 children in group B were able to communicate with spoken language, including cases in combination with sign or written language, while no children in group A were able to communicate with spoken language.

However, all children in group A were able to notice and distinguish some sound in their daily lives, for example, birdsong, music, or bell ring at the school.

The scores of MAIS and MUSS were lower in group A than those in group B. However, postoperative scores were better than preoperative scores in all children of group A.

Conclusion: Early intervention and appropriate care would reduce difficulties in children with ASD, by helping them improve communication abilities and learning new skills.

These results suggest that cochlear implantation is an effective intervention for children who both have ASD and congenital profound hearing loss.

Is there any relationship between language intervention mode and the cochlear implanted children's performance in achieving receptive and expressive communication skills??

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Objective: In spite of the fact that various studies have depicted the importance of intervention programs in facilitating language acquisition of cochlear implanted children, till now no specific language intervention approach is recommended as the best one. Hence, the main goal of this study was to compare communication abilities in pediatric cochlear implant users who enrolled in two different language intervention approaches include: auditory-oral and a combination of auditory- oral with a cognitive based educational package on receptive vocabulary development which was established by the authors.

Material and Methods: This prospective experimental study compares the receptive and expressive communication skills of 26 cochlear implanted children who received auditory-oral and a cognitive based educational package on receptive vocabulary development approach with that of a group of 25 participants whose intervention program was auditory-oral only. The language performance of both groups was evaluated through Bayley scales of Infant and Toddler Development- Third Edition, and statistical analysis was done by SPSS-21.

Results: The communication outcomes of the samples who received auditory-oral and a cognitive based educational package on receptive vocabulary development approach was significantly higher than the control group. As the samples were restricted in terms of age, gender and parent's educational level, it could be assumed that the intervention program was the most important predictor of the participant's language performance.

Conclusion: A cognitive based language intervention program played an important role in promoting communication abilities of pediatric cochlear implanted children.

Reading achievement skills in Japanese pediatric cochlear implant users

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Objective: We analyzed reading skills of school-aged children with cochlear implants (CIs) and their developmental changes during the elementary school periods.

Method: We enrolled 88 pediatric CI users. Reading performance of participants was evaluated by the standardized Japanese „Reading-Test". The test is composed of four areas of subtests: 1) kanji and kana reading 2) vocabulary 3) grammar, and 4) reading comprehension. The results are rated from one to five in each subregion and are also shown deviation values of general reading abilities.

We analyzed individual differences of deviation values of general reading abilities. We investigated the involvement of individual attributes in children with special needs (CSN) who showed remarkable delay with deviation values 34 or less.

42 cases were re-evaluated in the higher grades (at the age of 10 to 12 years),and the result was compared with that at the time of school enrollment to examine the long-term development of reading skills.

Results: Average deviation values of general reading abilities was 48.9, and children with deviation value 45 or more remained 62% of the total. Among 12 children considered to be CSN, 7 had apparently influencing factors, such as inner ear malformation, developmental delay, and higher age at surgery, but the remaining 5 had no other remarkable attributes. Kanji and kana reading performance was significantly better than the results of other subregions

There were few cases that showed an improvement in the deviation value at the time of higher grades compared to the time of school attendance. Analyses of subtests revealed significant reduction in the grammatical comprehension scores.

Conclusion: 62% of pediatric CI users achieved the average reading skills of hearing peers at the time of school enrollment. Many of these children still face difficulties in reading at higher grade, which suggest the necessity of long-term study on their reading ability.

Analysis of Japanese monosyllable speech perception in cochlear implant users

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We analyzed Japanese monosyllable speech perception and effect of lip-reading of 300 cochlear implant (CI) users.

We enrolled 200 prelingually deafened pediatric CI users and 100 postlingually deafened adult CI users.

The monosyllable speech perception test (Fukuda,1992) was composed of 50 items separately uttered by a female speaker: 5 vowels (V) and 45 monosyllables composed of consonants and vowels (CV). The test was video recorded and was presented in auditory-only condition (i.e. only the audio of the video was played) and in combination with lip reading condition (i.e. the movie and the audio was played).

Total correct rate, correct rate of each syllables and following vowels (V2 of CV) was calculated. We also investigated the involvement of individual attributes with children with special needs (CSN) whose scores were less than -1SD from the mean.

Average correct rate in auditory only condition was 67.0% (1SD26.9). In combination with lip reading, the correct rate raised by 6.7 percent points. Correct rate of V2 was 90.2% in auditory only condition. Correlation was found between total correct rate and correct rate of V2, whereas there were some cases whose total correct rate was lower than 60% despite their 90% or more V2 correct rate. Correct rate of fricative and semi-vowels was generally good, although we also found that correct rates sometimes differed among syllables composed of the same phonemes.

There was no significant difference between total correct rates in pediatric users and adult users, whereas there were large individual differences in each group. We also found that correct rate of each monosyllables was different between each group and that average V2 correct rate of pediatric group was significantly higher compared to adult group. Among 36 CSN cases, 89% had remarkable factors such as inner ear malformation, developmental delay, and higher age at surgery.

The comparative study of phonological awareness in normal and cochlear implant children in monolingual and bilingual family

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Introduction: This study aims to compare the phonological awareness of preschool cochlear implant children and normal children in monolingual and bilingual families.

Materials and Methods: Method of research was descriptive and analytical one and data were gathered as field method abd is based on sub scales of tests of phonological awareness.

This study was applied on 16 children in 4 groups. The children were male with age range of 5-5/11. To examine the phonological awareness skills, Dastjerdi-Soleimani phonological awareness test (1389) was used.

Results: The results indicate that phonological awareness of bilingual children in both cochlear implant and normal groups is better. In addition, cochlear implant children in monolingual and bilingual group show lower performance in phonological awareness skills than normal children.

Conclusion: According to importance of phonological awareness during learning of writing and reading and given to that children with cochlear implant have difficulties in learning phonological awareness skills, findings of this research may help speaking and language therapists in order to improve phonological awareness. Also these findings may help therapists and parents to identify effects of bilingualism on development of meta language skills and make a true decision in using first language at home.

Determination of the source of sound in patients after cochlear implantation

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Introduction: The aim of our study is to determine the characteristics of sound localization observed in patients with bilateral cochlear implantation. Methods: This study involved 38 participants with bilateral sensorineural deafness of different etiologies. Each of the participants underwent cochlear implantation of Concerto implants (Med-El, Austria). 16 of these participants underwent bilateral implantation and 22 underwent unilateral implantation. The participants' age's ranged from 7 to 21 years, with participants having previous experience of CI use from the ages of 2 to 13 years. 20 patients with intact hearing were included into the control group. In order to determine localization, an acoustic station was utilized consisting of 21 speakers arranged along a horizontal plane in a semicircular orientation. The system was connected to a sound source that generated modulated tones with a frequency of 1,000 Hz, and a sound intensity of 70 dB. Each participant received 105 modulated signals from different speakers randomly, and they had to identify the direction of the sound source. Results: During this study, it was observed that the average number of errors measured in participants with intact hearing ability was 31%, in subjects with two CIs was 84%, and in participants with one CI was 87%. It was concluded that the number of errors recorded in participants with one and with two CIs were almost the same; however, when examining the structure of the errors, a slightly different pattern was observed, whereby the average degree of error in participants with an intact hearing ability was 3,5˚, in participants with two implants was 32.1˚, and it was 61.2˚ for participants with one implant. Conclusion: The results obtained within this study show a significant improvement of the spatial sound localization in participants with two CIs when compared to those with only one CI, which demonstrates the importance of having a second ear cochlear implantation performed.

Poster Session 3

The quality of life in postlingual patients with asymmetric hearing loss before and after cochlear implantation

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Background: The quality of life is a social category expressing the degree of satisfaction all humans need in society with certain cultural, historical, socio-psychological, moral and ethical traditions and economic development. It is individual's perception of his position in life in the context of culture and system of values one lives with according to goals, expectations and norms; is determined by physical, social and emotional factors.

Methods: The quality of life was evaluated in 30 postlingual adults with asymmetric hearing loss before and after cochlear implantation (MED-EL; Innsbruck, Austria) by HHIA (Hearing Handicap Inventory in Adults), which is wildly used questionnaire to assess the effectiveness of auditory-speech rehabilitation. Total score, social and emotional scores were compared in patients before surgery and 12 month post-surgery.

Results: All patients had been using suitable hearing aids for some time before cochlear implantation and the scores of HHIA below give evidence of ineffectiveness of such kind of rehabilitation. Total score was 71,3 ± 8,86, social and emotional scores were 36,9 ± 2,8 and 31,4 ± 4,5 accordingly. 12 month post-surgery data demonstrated decreasing of amount of scores: total score was 32,4 ± 3,1, social score - 18,73 ±1,76 and emotional score - 12,8 ±1,7. The obtained results educe that after cochlear implantation the quality of life improved significantly in contrast with before surgery data.

Conclusion: Consequently, after cochlear implantation the quality of life improved in general (decreasing of total score of HHIA), moreover, an emotional tension reduced and the adaptation in society improved as well (decreasing of emotional and social scores).

Efficacy of speech in Noise using Naida Q90 CI, benefit of speech perception in Noise with the latest noise reduction algorithm

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Introduction: The Naida CI (Q90) sound processor from Advanced Bionics was approved as a medical Device in Japan on December 2017. In order to measure the effectiveness of Naida CI a clinical study was initiated.

Objective: To evaluate the benefit of the Noise reduction features available in Naida CI Q90

Method: 10 recipients who were using the Harmony Speech processor (previous generation) were included in the study. The study was conducted at 0dB SNR. The live speech stimulus was presented from the front (0 degree) and the Noise was presented from the CI side (90 degree). The features of the Naida CI Q90 which were evaluated include ClearVoice, UltraZoom and StereoZoom. The results were scored using a VAS Scale

Results: The patients performed significantly better with the Naida CI Q90 compared to the Harmony system

Accessibility for cochlear implanted patients: how to improve their life?

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Objectives: Deafness is a brake to social and professional insertion. A specific rehabilitation can improve access to a better work and life.

However, some difficulties are still remaining because of the lack of information concerning for example the use of telecoil or the delivery of priority cards for disabled people.

Material and Methods: Our rehabilitation program already includes an information to improve accessibility to work and usual life. It is delivered by both an occupational therapist and a social worker. In order to assess its impact, a questionnaire was sent to 120 adults patients implanted since at least one year. It was screening three fields: Current state of accessibility in usual life and at work, and knowledge about their rights as disabled people.

Results: Participation's rate was 67%. 87% of the answers were made by single side cochlear implanted patients. 57% had had their implant for 5 years or more. Implantations occurred when patients were 50 to 60 year old in 24%, 40 to 50 year old in 18% and 60 to 70 year old in 22%.

More than 73% had their hearing impairment appeared as they were in working ages, 40% of them have never had disabled recognition at that time. 47% of the questionnaires were filled by employees, almost 15% of them had to stop their work because of their deafness.

70% can use telecoil but 83% of these don't (neither for administration procedures or in daily life). Only 42% use it in their social life (movies, theatre, lectures,...).

Priority card for disabled people is known by 81% of patients but only 55% use it for their daily life and 51% daren't using it.

Conclusion: Rehabilitation program axed on accessibility is improving people's daily life however lacks are still remaining as everyone still doesn't use all the means that are offered to them to make their life easier.

On year after surgery, 71% would like a new briefing concerning their rights and possibilities as disabled people.

Changes in quality of life in cochlear implant users

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Objective: This work aims to:

1)Evaluate the changes in the quality of life of patients who became users of unilateral or bilateral cochlear implant

2)Establish comparisons between the changes in the quality of life of: different age groups at the moment of implantation, gender, years of cochlear implant use, unilateral cochlear implantation vs. bilateral cochlear implantation, multi handicapped patients.

Material and Method: A retrospective study of 370 patients implanted in the "Centro de Implantes Cocleares Profesor Diamante" has been made. After three months of cochlear implantation, the Glasgow Benefit Inventory (GBI) was administrated to all the patients of the sample. In the case of children, parents answered the questionnaire. Results were compared between different groups classified as mentioned in the objectives.

Results: In all the patients of the sample, benefits in QoL were found, and this occurred in all groups. All the areas evaluated in the GBI showed positive results regarding changes in QoL post cochlear implantation. Physical health was the less positively evaluated subscale, and the social support subscale was the most positively evaluated by all the studied patients.

Conclusions: This study brings more data about the benefits in quality of life of cochlear implant users. The results obtained in this study are very similar to those of other investigations in other cochlear implant centers in the world. These evaluations of quality of life changes are complementary to cochlear implants results in hearing skills, as they together show a broader view of patients evolution post cochlear implantation.

Towards an international consensus on core outcome measures for clinical trials in adult single sided deafness

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Objectives: Single-sided deafness (SSD) is described by the presence of a severe-to-profound hearing impairment in one ear only. SSD disrupts the spatial aspects of hearing and impairs the ability to understand speech in the presence of background noise. It can lead to functional, psychological and social consequences. A common intervention is to re-route sounds from the impaired ear to the hearing ear using hearing aids. Alternatively, auditory implants can deliver sounds directly to the impaired ear. Benefits and harms for these interventions are documented inconsistently in the literature, using a multitude of outcomes ranging from speech perception tests to quality of life questionnaires. Inconsistencies hinder decisions about the choice of outcome measures for clinical trials. The CROSSSD study will develop a Core Outcome Set (COS) to address these inconsistencies and improve the quality of future trials.

Methods: All outcome domains and instruments reported in clinical trials will be identified through a systematic review of published literature. Opinions on the importance of each outcome will be sought from key stakeholders: healthcare users with lived experience of SSD, audiologists, ENT doctors, patient and public involvement managers, journal editors and academics in the UK, Europe and USA. Stakeholders' opinions will be captured using an online Delphi survey. A subgroup of stakeholders will then be invited to a consensus meeting to discuss the Delphi results and identify what outcomes are relevant to all intervention options and stakeholder groups.

Conclusion: The CROSSSD study aims to identify what is critical and important to measure when assessing interventions for SSD. It will adopt a robust methodology and will pool and integrate stakeholders' opinions internationally. The resulting COS will act as a standard for reporting in future clinical trials and have applications in guiding the use of outcome measures in clinical practice.

Development of auditory verbal skills and maximizing outcome in adult cochlear implant users - A current adult rehabilitation project at the cochlear implant center in Eastern Denmark

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Objectives: The project aims at establishing, describing and documenting the effects of an auditory verbal rehabilitation intervention for adult Cochlear Implant (CI) users.

Methods: A prospective comparative rehabilitation study with 17 adult CI users compares 10 adults CI user's and a control group's outcome after 6 month of rehabilitation. The 10 patients participated in the Auditory Verbal Skills Training (AVST). The CI center developed AVST for adult CI users, and it is an AVT inspired and goal based auditory verbal training for CI users and their close relatives.

The intervention group participates in 10 AVST sessions during 6 months at the CI center after they first got their CI. Both the intervention group and control group also received standard rehabilitation at their local rehabilitation centers in the same period.

Outcome measures in the two groups are focused on speech intelligibility (Dantale I and HINT) and Quality of Life (Nijmegen CI Questionnaire).

Results and Conclusions: Preliminary results prior to publication will be presented comparing the intervention group and the control group on speech intelligibility measures and Quality of Life measures.

Also, the framework and content of the AVST intervention will be presented. Examples of AVST activities will be available.

Heterogeneity in reported outcome measures after surgery in superior canal dehiscence syndrome – A systematic literature review

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Objective: To assess available evidence on the comparative effectiveness and risks of different surgical treatments for superior canal dehiscence syndrome (SCDS), regarding: (1) symptom improvement; (2) objectively measurable auditory and vestibular function; (3) adverse effects; (4) length of hospitalization.

Methods: A systematic search according to PRISMA statement was conducted on Pubmed, Embase, and Cochrane library. Reference lists were searched. Retrospective and prospective cohort studies were included when they investigated the association between a surgical treatment method and the relief of vestibular and/or auditory symptoms. Only studies including quantitative assessment of the pre- to postoperative success rate of a surgical treatment method were included. Case reports, reviews, meta-analysis, and studies not published in English, Dutch, or German were excluded.

Results: Seventeen studies (354 participants, 367 dehiscences) were grouped according to surgical approach. Seven combinations of surgical approaches were identified: plugging, resurfacing, or a combination of both through the middle fossa (middle fossa approach); plugging, resurfacing, or a combination of both through the mastoid (transmastoid approach); round window reinforcement through the ear canal (transcanal approach). Several studies showed high internal validity, but quality was often downgraded due to study design. Outcome measures and timing of postsurgical assessment varied among studies, making it unfeasible to pool data to perform a meta-analysis.

Conclusion: A standardized protocol including outcome measures and timeframes is needed to compare the effectiveness and safety of SCDS treatments. It should include symptom severity assessments and changes in vestibular and auditory function before and after treatment.

Outcomes in a child with bilateral inner ear malformations managed by custom-made electrode arrays

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Objectives: We present the functional outcomes of a child with malformed inner ears who was bilaterally implanted with custom-made electrode arrays

Method: For children who have significant inner ear malformations their speech, language and listening outcomes with cochlear implants are often severely compromised. Functional spoken language is not always an appropriate aim and the family may be advised that the child will need to use sign language as their main communication mode.

Child L had bilateral inner ear malformations. On the right a large common cavity with no differentiation of the cochlear compartment and on the left a very small bud of cochlea present. The child received a custom-made MED-EL common cavity electrode (MED-EL SYNCHRONY CMD) for the right ear and a MED-EL SYNCHRONY Compressed for the left, both implanted during a simultaneous bilateral surgery at 1 year old. The child received the standard post-operative audiological and therapy follow up offered by our service.

Results: At 6 months post-implant, this now 18 month old child is making progress within the normal range expected of a child with normal cochlea anatomy. She has natural intonated babble and is developing single word comprehension, following familiar single word instructions through listening alone.

Conclusions: With custom made electrodes combined with carefully structured therapy, we have found that this child's progress quickly exceeded all expectations. She appears to have the potential for age appropriate spoken language without the need for sign support.

Recurrent bacterial meningitis after cochlear implantation: a case report

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Objectives : Bacterial meningitis following cochlear implantation has become a frequently visited entity in recent years.The peculiar structure of the labyrinth and its closeness to the meninges provides two paths of ascending invasion for bacteria from the inner ear to the subarachnoidal space even in the case of normal Anatomy,The bony labyrinth is connected with the posterior cranial fossa by the vestibular aqueduct and with the skull base by the cochlear aqueduc which promotes repetitive meningitis in cochlear implantation.

Material and method: a child has 3 years old with a history of delayed walking and with eye disorders, Radiology shows dilatation of the aqueduct of the vestibule, of the auditory canal,a cochlear malformation type MONDINI, bilateral and vestibular dilatation, the implantation made by the secondary membrane of the round window, geyser phenomen on occurred following the opening of the secondary membran, immediately a cloggingis performed, 6 months later the first episode of meningitis is installed, 3 others occurred in the 6 months following the first episode, a pneumococcal vaccination was carried out with outstopping the recurrence of the meninigitis, which pushed us to take again the patient 8 months after the implantation, an approach retroauricular and opening of the mastoid and we discovered a labyrinthic fistula and derive from lcr and perilymphatic liquid, clogging the muscular graft of the temporal and apponevrotic muscle, the operative follow-up was very simple, no recurrence of meningitis was observed after this intervention,

Our child was later resumed, a closure of the leak was realized and the operative follow-up was simple

Conclusion : Neuromeningeal complications aftercochlear implantation are rare; they occur mainly in implanted patients with malformed cochlea, the treatment goes through a prevention by advocating a systematic preoperative vaccination and preoperative blocking

Outcome of cochlear implantation in children with Enlarged Vestibular Aqueduct (EVA) and Mondini Dysplasia(incomplete partition type II)

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Background: Congenital inner ear abnormality is a major cause of sensorineural hearing loss in children, about 20% of children with congenital sensorineural hearing loss (SNHL) have associated malformations of the temporal bone, and increased experience in cochlear implantation has led to more children with abnormal cochleo-vestibular anatomy submitted to this procedure.

Aim: To evaluate the outcome of cochlear implantation in cases with enlarged vestibular aqueduct (EVA) and Mondini deformity (incomplete partition type II) following cochlear implantation and comparing the results with those of cochlear implant cases without inner ear anomalies. Patients and methods: 69 children , all less than 6 years of age underwent cochlear implant surgeries of which eight patients were congenital prelingual severe to profound hearing loss with enlarged vestibular aqueduct (EVA) and Mondini deformity (incomplete partition type II). Isolated EVA was detected in four cases, two cases with bilateral incomplete partition type II (Mondini deformity) and

two cases with bilateral incomplete partition II (Mondini deformity) associated with dilated vestibule & vestibular aqueducts bilaterally with short lateral, SCC (semicircular canal),Beside those 8 cases, a random sample (16 control cases) . The ECAP thresholds determined with neural response telemetry (NRT) or Auditory response threshold (ART) software provide a good starting point for locating the behavioral T and C levels.

Auditory skills were evaluated before start of rehabilitation and after 6 months of rehabilitation using LittlEARS Questionnaire and Auditory Checklists and compared to the auditory skills of other cochlear implantees with normal inner ear.

Results: This study showed that the auditory skills and audiological performance of children with congenital ear anomalies developed over a period of 6 months after cochlear implantation, in a similar manner to those of young children with radiologically normal inner ears. Conclusion: Cochlear implantation can be successfully performed in children with enlarged vestibular aqueduct (EVA) and Mondini dysplasia (Incomplete partition type II).

Audiological results, complications and experience of cochlear implant surgery in patients with congenital malformation of the internal ear type incomplete partition type III

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This study makes a descriptive analysis of pediatric patients with radiological diagnosis of inner ear malformation type incomplete partition type III, who were taken to cochlear implant surgery between Jan / 2015 to Jan / 2017, and describes the surgical technique used, the functional results and the complications presented during the pre and post operative period with a minimum follow-up of 06 months. In our series we found 03 (three) patients, a total of 04 ears. All male patients with an average age of 3 years at the time of surgery, and a minimum follow up to 06 (six) months. One patient was taken to sequential bilateral cochlear implant surgery and two received a unilateral cochlear implant. The preoperative diagnosis was made based on the findings of Computed Tomography of High Resolution and pre-implant cochlear acoustic evaluation. In 02 patients there was stabilization of the auditory loss in the contralateral ear and they received auditory rehabilitation with conventional hearing aid. In 1 patient, contralateral ear worsening required sequential cochlear implant surgery. In the radiological evaluation of the immediate postoperative period, we did not find any cases of poor positioning of the electrode. There were no cases of persistence of the cerebrospinal fluid fistula, or meningitis during the 6 months of follow-up. There was no case of displacement of the internal component, or poor positioning of the electrode inside the internal auditory canal. The audiological results after cochlear implantation show similar results to those reported in patients without malformations of the internal ear.

Surgical issues of cochlear implantation in incomplete partition type I

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Introduction: Incomplete partition type I is one of the challenges in cochlear implantation surgery. Our experience during surgery in these patients is introduced.

Materials and methods: Surgical records of 1012 cochlear implant procedures in a cochlear implant center were reviewed and data of patients who had incomplete partition type I were extracted and analyzed.

Results: Seventeen cases (1.68%) had incomplete partition type I. Cerebrospinal fluid (CSF) gusher was encountered during opening the cochlea in 15 patients (88.2%) and was controlled using our customized technique. There were no cases of persistent CSF leak or postoperative meningitis. In 64.7% of patients some additional anomalies were encountered during the operation. Though, intraoperative electrically evoked compound action potential was not measurable in 58.89% of cases, all patients have satisfying hearing after implantation.

Conclusion: Cochlear implantation in patients with incomplete partition type I is challenging for surgeons but still relatively safe.

Cochlear implantation for unilateral profound hearing loss in children after meningitis

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Objectives: To review functional outcomes in children undergoing cochlear implantation for single-sided deafness after meningitis.

Material and Methods: A 7 year old boy developed unilateral profound sensorineural hearing loss after Group A Streptococcus meningitis and septicemia secondary to sinusitis. Hearing in the contralateral ear was normal. Reduced signal intensity in the affected cochlea was noted on T2 weighted MRI images.

Cochlear implantation was performed within 5 weeks of the onset of meningitis. Significant fibrosis of the basal

turn adjacent to the round window was encountered. There was no ossification of the basal turn of the cochlea. As a depth gauge could be fully inserted into the cochlea, a MedEl Synchrony implant with a Flex28 electrode was placed. Excellent waveforms were obtained intraoperatively on Auditory Nerve Response Telemetry (ART).

Discussion: A comprehensive review of the literature supports consideration of cochlear implantation in children for unilateral profound hearing loss after meningitis. Unilateral cochlear implantation has the potential to improve speech understanding in background noise and provide localization ability.

Conclusion: Cochlear implantation has the potential to improve overall auditory function in children with single-sided deafness after meningitis.

Investigating the impacts of cochlear implantation on the happiness and self-esteem of mothers of children with severe hearing loss

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Objectives: Children with severe hearing loss often struggle to communicate. Mothers of children with hearing loss may also suffer psychologically in their caregiving due to this communication barrier. Cochlear implant surgery improves child's hearing sense, parent and children's psychological well-being, and communication between children and their mothers. The aim of the present study is to compare happiness and self-esteem among the mothers of children with severe hearing loss before and after cochlear implantation.

Material and Method: The population under study consisted of mothers of children with hearing loss who were candidates in Imam Hospital, Ahvaz, Iran. Forty mothers of children under 7 years old who had cochlear implant surgery were selected through a convenient sampling method. Subjects who met the study criteria were invited to participate. Inclusion criteria for the project included:

– mothers with children under 7 years old who are candidates for cochlear implants

– mothers did not have psychiatric problems

– mothers are using any psychiatric medications

– mothers were not hospitalized due to psychiatric problems

Before cochlear implantation surgery, mothers completed the Oxford Happiness Questionnaire and Rosenberg Self-Esteem Questionnaire. After 1 year of their child's cochlear implantation surgery and rehabilitation, mothers filled out the Oxford Happiness Questionnaire and Rosenberg Self-Esteem Questionnaire a second time.

The Rosenberg Self-Esteem Scale (1965) measures the overall self-esteem and self-worth. This scale consists of 10 general items which measure the life satisfaction and positive feeling about oneself (Burnett and Wright 2002). The Rosenberg Self-Esteem Scale (SES) was created in order to provide an overall picture of positive and negative attitudes about oneself (Burnett and Wright 2002). The SES scale has a high validity in measuring levels of self-esteem (Burnett and Wright 2002). Retest correlations ranged from 0.82 to 0.88, and internal consistency coefficient or Cronbach's alpha ranged 0.77 to 0.88 (Alizadeh et al. 2005). This scale has a satisfactory internal reliability (0.77). It has also high correlation with Gutmann and New York National Questionnaire in measuring self-esteem (Alizadeh et al. 2005). The SES' reliability has been estimated by split method between two Persian and English versions at 0.73, which was statistically significant (Vahdatnia 2005). The reliability of the Persian version has been also calculated by retest method within 10 days by Vahdatnia (2005), with a correlation coefficient of 0.74. Erjil and colleagues proposed a 29-item questionnaire to measure happiness. Using the factorial analysis of the questionnaire's results, 7 factors emerged: positive cognition, social commitment, positive mood, sense of control over life, physical health, and satisfaction of self and mental awareness (as cited in Allen 2006). The validity of this scale has been confirmed in various studies including Hills and Argyle (2002) with an alpha coefficient of 90 % with 347 subjects, Liaghatdar et al. 2008) with an alpha coefficient of 87 % with 101 subjects, Francis et al. (1998) with an alpha coefficient of 84 % with 180 subjects, and Alipour and Noorbala (1999) with an alpha coefficient of 93 % with 101 participants in Iran. The Oxford Happiness Inventory for measuring happiness among Iranians has been shown to have appropriate reliability and validity (Lu and Argyle 1992). Kolmogorov-Smirnov test was initially performed to determine the distribution of the data in order to analyze the variables of happiness and self-esteem. Paired t-test and Wilcoxon tests were used to compare these variables before and after cochlear implantation. The significance level for the above tests was considered 0.05.

Result: A significant difference was observed between the happiness and self-esteem scores before and after surgery ($p<0.001$). Cochlear implantation surgery increases happiness and self-esteem in mothers of children with hearing loss. When a child with hearing loss goes through cochlear implant surgery, all family members will benefit from the improved hearing in their child and thus, improved family communication overall

Results in pre-and post surgical hearing tests in patients over 65 years old with diagnosis of unilateral neurosensorial hypoacusia handled with cochlear implant at San Rafael Clinical University Hospital during the period 2006 - 2016

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Determine the differences in the results of the audiometry and logoaudiometry tests before and at 6 and 12 months after the cochlear implant in patients over 65 years of age. Methods: Data from the electronic medical history was analyzed from 2006 to 2016 in 33 adult patients (> 65 years old) with diagnosis of unilateral severe / profound sensorineural hearing loss and who were taken to surgical treatment with a cochlear implant; We analyzed variables such as age, laterality, etiology, audiological tests (audiometry and logoaudiometry) before and after surgery (6 and 12 months). Results: The median age was 68 years with a RIQ of 5 years. The median for the pure tone average of all pre-surgical was 90 Db with an RIQ of 13, while at 6 months it was 31 Db with an RIQ of 9 and at 6 months of 30 Db with an RIQ of 5. The percentage of pre-surgical language discrimination had a median of 20 % with a RIQ of 20, at 6 months of 85.13 % with a RIQ of 4.07, and at 12 months of 90.9 % with a RIQ of 2.65. The Pearson correlation showed statistically significant differences between the mean values of all pre-surgical PTA and at 6 and 12 months ($p = 0.004$ and 0.028 respectively) and between the values of the discrimination percentage of the pre-surgical language and the 6 and 12 months ($p = 0.000$). By means of a linear regression it was found that 22% of the variance of the average value of all PTA at 6 months is explained by the etiology of the disease for ($p = 0.048$), while 29% of the variance of the Percentage discrimination of pre-surgical language is explained by the type of device ($p = 0.004$). conclusions: we concluded that the cochlear implant improves the results of audiological tests in patients older than 65 years with sensorineural deafness. The results of the present study show that the improvement of the results is maintained during the time (12 months) and is not influenced by socio-demographic variables.

The quality of hearing after cochlear implantation – evaluation of adult patients from years 2012-2017

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Introduction: IROS - the Cochlear Implanted Recipient Observational Study is an international, multicenter, prospective and long-term study and the main aim of it is to collect subjective data of auditory implant users at regular time intervals (at the time between surgery and the first fitting of sound processor; at 1, 2 or optional 3 years after implantation). The ENT clinic in Lodz participates in this project since June 2012.

Methodology: To evaluate patients outcomes two self-assessment scales were used in the study: Health Utility Index Mark 3 (quality of life) and Speech Spatial Qualities of Hearing questionnaire (hearing-disease specific). A demographic profile of patients was created by a general questionnaires for clinicians and for patients. Other data like the usage of device and mobile phone, tinnitus, employment or dizziness were also collected.

Results: In the clinic in Lodz there are 19 patients with cochlear implant under observation (in Poland – there are 189 subjects). An average age of implanted patients is 47 years (min 24, max 62). The etiology of hearing loss was most commonly unknown (9), there were 3 patients with sudden deafness, 2 subjects with chronic otitis media, and individual cases of Measles Rougeole, noise exposure, trauma, rubella and meningitis. Six patients were using their hearing aids on the left ear and 11 on the right ear before surgery. The results of follow up questionnaires show an improvement in each area: speech understanding, spatial hearing and quality of hearing.

Conclusion: Cochlear implantation increases the ability and quality of speech understanding and spatial hearing already after 1 year of the implant device usage. This kind of database of all implanted patients is important and helpful for the clinic to manage the patients on the clinical, administrative and reimbursement level and also to see how effective a treating method like cochlear implantation is.

Outcomes of cochlear implantation in post-lingually deaf patients: a report from Baqiyatallah hospital

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Objective: To assess hearing improvement of post-lingually deaf patients after cochlear implantation.

Methods: in this cross-sectional study all the post-lingually deaf patients who had undergone cochlear implantation (CI) surgery between December 2010 and February 2016 were assessed. Patients were recalled and after explaining the study process and signing an informed consent form, an audiometry was done by a single audiologist. In addition, demographic information, cause of hearing loss, age of onset, history of hearing aid use and surgical complications were recorded in a pre-designed checklist.

Results: 50 patients (29 male and 21 female) with a mean age of 22.52±19.45 years underwent analysis. A majority of patients (80%) reported that their condition has progressed since childhood. Sudden sensorineural hearing loss (SSNHL) was the most prevalent (10%) known etiology of deafness followed by meningitis (6%), Trauma (2%) and ototoxic drugs (2%) in the remaining 20% of the patients. Patients had the highest mean (37.1±12.61 dB) in 4000 Hz frequency and the lowest mean of hearing threshold level (32.6±8.37 dB) was for 1000 Hz frequency. Mean hearing threshold level was significantly lower in patients with lower ages of cochlear implantation (p=0.435). There was no significant difference between two genders for hearing improvement after cochlear implantation (p=0.927). Patients with higher ages of deafness onset showed lower degree of hearing improvement (p=0.462).

Conclusion: In conclusion, the results of our study suggest that cochlear implantation significantly improves hearing function of post-lingual patients and can be considered as a certain cure for these patients in Iran.

Electrocochleography recorded via the Advanced Bionics cochlear implant system

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The University of North Carolina has demonstrated the ability to record ECochG via the intra-cochlear electrode array for an acoustically delivered low-frequency sinusoidal stimulus. This study examines the recording of ECochG via the complete Advanced Bionics cochlear implant system.

ECochG was recorded from 20 adult subjects during and following implantation of the Advanced Bionics HiRes90K and Ultra implants. Subjects had at least one pre-operative threshold of better than 80 dBHL. During insertion of the array, recordings were made for 50 ms 500 Hz tone burst. Following insertion, recordings were made, for 125, 250 and 500 Hz tone bursts. Typically 64 averages were used for each individual measurement. Subtraction of recordings allowed extraction of the cochlear microphonic (CM) signal. Comparisons were made between the CM and behaviourally measured hearing thresholds. Analysis was also made of CM amplitude during insertion of the electrode array and correlated with the surgical reports.

It was possible to record ECochG in all cases for at least one stimulus frequency. The average electrode insertion took approximately 30 seconds. A highly significant correlation ($r^2 = 0.75$) was found between ECochG and behavioural estimates of low-frequency hearing threshold. Changes in CM amplitude during electrode array insertion were very largely in line with surgical comments and surgical video review. Correlations between ECochG and post-implant speech perception are currently being accumulated.

It appears practical to record ECochG both intra- and post-operatively using the standard Advanced Bionics cochlear implant system hardware. Recording speed is sufficient to give surgical feedback during electrode array insertion. A strong correlation exists between objective and behavioural estimates of low-frequency hearing thresholds. Future work should correlate the intra-operative ECochG time sequence and any change in hearing over time.

Cochlear implant in ear with profound congenital hearing loss in patient with post lingual asymmetric hearing loss. Our experience.

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Introduction. The cochlear implant (CI) today is highly accepted in unilateral hearing loss; therefore, if it is used

in asymmetric bilateral hearing loss should not be questioned. The time of evolution of hearing loss and discrimination skills are predictors for successful IC, but use in ears with congenital hearing loss in post lingual patients is still controversial.

Objectives: To describe our experience and results in implanted patient with asymmetric postlingual hearing loss.

Materials and Methods used: Case Summary: woman, 32 years old, with right congenital profound hearing loss, hearing aid never implemented, with normal language development. In January 2013 she suffers sudden left hearing loss, severe to profound, without recovery and progressive, without satisfactory performance with hearing aid.

Results: Cochlear implant was carried out in March / 2015 and was derived to rehabilitation therapy. Prior to cochlear implant she had Geers and Moog category 1 and after therapy for 16 months, she has Category 5, only using CI. Now, if she use hearing aid and CI, she reach Geers and Moog 6.

Conclusion: the side to make the surgery was a difficult choice. We didn`t surgery in the recently deaf side because it still has gain with the use of hearing aid. Cochlear implant was introduced in her right ear, with congenital hearing loss without prior stimulation. As carrier of post lingual hearing loss, we can analyze and compare hearing results with researchs that focus in CI and unilateral hearing loss, because she always had a stimulated central auditory pathwayn by her left ear until five years ago. In that way, her late implantation does not affect the positive final results. Until now, CI has given a significant improvement in the understanding of language, especially in situations with more than one speaker, bring to her a better quality of life.

Hearing preservation in patients after CI532 implantation - First results

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Objectives: Hearing preservation is an important touchstone in cochlear implantation influencing speech understanding, music perception and quality of life. Patients with functional residual hearing benefit in complex hearing situations, such as noise, as well as speech recognition and understanding. Here, we investigated to which extend the CI532 electrode (Cochlear®) can preserve hearing assuming a reduced insertion trauma due to the thin, flexible and modiolus-close electrode characteristics.

Methods: In this study patients were divided in two groups with (experimental group, RH) and without residual hearing (control group, no RH) prior to implantation. RH was defined as a hearing threshold above 85 dB for pure tone audiogram (PTA) frequencies 125-500-1000-2000 Hz, and/or hearing loss for Freiburger numbers of less than 60 dB and maximum Freiburger monosyllables better than 50%. Data of PTA, Freiburger speech test and neural response telemetry (NRT) were compared prior to, one day and three months after surgery. Intraoperative position check performed by 3D C-arm imaging was evaluated.

Results and Conclusions: A total of 27 patients received a CI532 electrode, 13 with and 14 patients without RH. Within the first three months PTA showed a decline especially in lower frequencies (125-250Hz) from 45dB to 65dB, whereas higher frequencies (500-100Hz) remained consistent at a mean of 60dB. NRTs showed comparable results: during surgery 187 (RH) vs. 185 (noRH), 3 months post 172 (RH) vs. 169 (noRH) und 6 months following surgery 162 (RH) vs. 168 (noRH). The intraoperative position control demonstrated regular electrode positions in 25 patients and tip fold over in two patients.Hearing results of CI532 implanted patients with and without RH seem to align postoperative. These first results suggest that preservation of residual hearing is not only influenced by the electrode shape. Thus alternative pathways have to be evaluated for long term hearing preservation.

Cochlear implant in patients after meningitis

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Introduction: Bacterial meningitis is the most common cause of acquired sensorineural hearing loss and ossifying labyrinthitis. This condition commonly demands cochlear implant (CI) as a method of auditory rehabilitation. Objectives: To describe the clinical characteristics of patients with hearing loss as a sequela of meningitis and whose therapeutic approach was CI between 2005 and 2017. Methods: Observational and retrospective study based on the analysis of medical records in a Brazilian referral hearing impairment center, including all patients with hearing loss due to meningitis. Results: 13.8% of 159 patients who were submitted to CI in this service presented meningitis as the cause of severe or profound bilateral hearing loss. The mean age of diagnosis of meningitis was 19.8 years. 72.6% of the patients had meningitis during the postlingual period. The mean age of onset of follow-up in this specialized center was 23.8 years. The mean age of CI indication was 26.2 years. Regarding the age at which the CI was performed, the mean was 27.5 years. The mean of time of sound deprivation was 3.9 years. 50% of the patients had the right ear implanted. The round window was chosen as the insertion path of electrode array in 61.5% of patients, while the cochleostomy was used in 38.5%. Total insertion of electrodes was possible in 64% of cases. Major intercurrences occurred in 3 subjects (fracture of the cochlea; need for further surgery to introduce double-array CI; facial palsy). Minor complications affected four people and were resolved quickly. 42.3% of patients presented alterations in radiological exams and the most common change was partial ossification of both cochlea. Conclusion: The hearing loss caused by meningitis whose management involved CI occurred

in 13.8% of patients. Round window electrode insertion was possible in the majority of cases with predominance of complete insertion of the electrodes.

A cochlear implanted teenage girl with hydrocephalus

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Objectives: Hydrocephalus can be defined broadly as a disorder of cerebrospinal fluid (CSF) formation or absorption, leading to an increase in volume occupied by this fluid in the central nervous system (CNS). Birth defects or acquired other things in later life can cause Hydrocephalus. Birth defects arise from neural tube defects or aquaductal stenosis. Other reasons include meningitis, brain tumors, intracerebral hemorrhages, subarachnoid hemorrhage, traumatic brain injury. Hydrocephalus is generally treated by the surgical intervention of shunt system.

The aim of this report of case with hydrocephalus is to demonstrate early outputs in pursuit of cochlear implantation in the same side with shunt system in teenage girl. We investigate whether the shunt system suitable or not when thought together with other complications.

Case Presentation: There are not any risk factors at prenatal medical history of the 14 year-old girl who suffers from Hydrocephalus. At natal medical history low birth weight, premature birth and anoxaemia problems are observed. Also, the mentioned patient was born via in vitro fertilization and her twin sister was born as dead. Considering the postnatal medical history, the patient has undergone the highest increased level of bilirubin and throughout 2 months she has been treated with phototherapy at newborn intensive care unit. She had a shunt surgical operation at the right side when she was just 3 months because of hydrocephalus as craniofacial abnormality. Up to 13 years old, she had hypothyroid treatment, epilepsy treatment, laser eye surgical operation and now, she has only hearing and communication disorders. Her hearing loss was recognized by her teacher when she was 6 years old and then she has been bilateral hearing aid user. In addition her hearing loss progressed in time, we determined bilaterally profound hearing loss at last assessment. And also her hearing aids are not sufficient for hearing performance and language development. Gains of left hearing aid were better than right one so when the cochlear implantation was planned, it should be operated on the right side. Language performance was assessed with PLS-4 and receptive-expressive language age was detected as 5,5-6 year-old and she lives many difficulties at her academic progress. On the other side there aren't any complications with regards to cochlear implantation at brain diffusion and temporal bone magnetic resonance imaging and computerized tomography. In accordance with these findings, she was followed as a cochlear implant candidate and eventually she underwent surgery at last March. Med –El Synchrony implant was implanted and Sonnet sound processor was preferred. Because of the shunt system has not an electromagnetic feature, there were not any complications during the surgical placement. Also during follow-up, she was assessed and supported through therapies in the sense of auditory perception.

Conclusion: The most comfortable levels with cochlear implant were adjusted via auropalpebral reflexes at the first post-op fitting whereas the threshold levels were regulated according to automatically %10 of most comfortable levels. We determined free field thresholds with cochlear implant at post-op first control approximately 40 -50 dB HL.

In conclusion, she has better hearing performance and enhanced quality of life according to before. We will continue intensive auditory verbal therapy and following for the best outcomes from implantation.

Music therapy and auditory habilitation for a deaf child having very severe inner ear anomaly using cochlear implant

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Objectives: We performed cochlear implantation (CI) for a deaf child with the severely malformed cochlea. Music therapy likely is a contributing factor to the development for severely hearing impaired children. Cochlear aplasia is considered as a contraindication or very difficult indication for CI . This is likely a case of cochlear aplasia using Sennaroglu Classification.

Case: A 5-year-7-month old girl's Newborn Hearing Screening (NHS) was refer. Her ABR, ASSR (MASTER) showed No Response. Preoperative CT findings revealed 'Aplastic Cochlea and Facial nerve anomaly'. We implanted the first CI on 2011, and the second CI on 2013. I inserted a whole medium electrode into her left ear and a whole compressed electrode into her right ear of Med-EL. Her postoperative progress has been encouraging in that her speaking ability as well her speech understanding have steadily improved. As her parents wished for her to sing nursery rhymes, we enrolled her in musical therapy.

The Music Therapist at our center performed a family participation type session for about 40>50 mins. once a month. Our therapist used multiple musical instruments in conjunction with a piano and also interacted with her in related activities, for example playing, singing songs and playing musical instruments jointly with her. After a 3-year period, her WTH with CI shows 35dBHL. Her IT-MAIS score improved from 1 to 40 (maximum score). Her LittleEARS results increased from 7 to 35 (also maximum score). Upon repeated sessions, her initially monotone

singing voice dramatically improved to the point she was able to confidently perform the songs. Auditory-Oral communications improved in various situations. She enrolled into a 1st grade class at a regular elementary school. The music therapy brought not only musical benefits to the child, but also contributed to the development of speech language, phonation as well as her social skills.

Bimodal hearing for cochlear implant recipients: capturing experiences

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Objectives: All bilaterally profoundly deaf children now have the opportunity to benefit from two cochlear implants (CIs). However, for various reasons some children have a unilateral implant. The Naida Bimodal Hearing Solution from Advanced Bionics allows the the Phonak Naida Link hearing aid to connect to the Naida CI (Q70 or Q90) sound processor to optimise binaural hearing. The Naida Link hearing aid is intended for unilateral AB recipients with aidable residual hearing in the non-implanted ear. For those recipients with no hearing in the contralateral ear, the Naida Link CROS aid is available. The Naida Link CROS picks up signals presented to the "non-hearing" ear and instantaneously transmits them to the Naida CI sound processor on the "hearing ear." This helps to improve speech understanding in quiet and noise and a better overall hearing experience.

Method: 4 children fitted with the Naida Link hearing aid and 4 children fitted with the Naida Link CROS aid will be included in the review. A sound quality ratings questionnaire will be administered to parents and carers of the children fitted with the devices asking them to rate their experiences before and after fitting.

Results: The ratings questionnaire will capture the listening experiences and challenges of unilateral recipients in different environments, such as listening in quiet and noisy situations, listening on the 'deaf' side, and the amount of listening effort involved with unilateral recipients.

Conclusion: Listening with one ear presents great challenges for communications. For individuals relying on a single CI, the Naida Link hearing aid and the Naida Link CROs offer a great opportunity to provide a better overall hearing experience.

Programming of the speech processor for patients with deafness after meningitis

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Objectives. One of the acquired deafness causes at any age may be meningitis. After meningitis some changes in the cochlea appear, that may cause problems during surgery and in the following fittings of speech processor.

Purpose of the study - fitting features determination of speech processor for patients with cochlea obliteration.

Material and Method. 6 patients (2 adults and 4 children) aged from 3 to 34 years with deafness after bacterial meningitis were examined. Cochlear implantation (CI) was made in 5-6 months after meningitis. Three patients were diagnosed with cochlea obliteration, and implants with dual Split-electrode by Medel were used in these cases.

Results and Conclusions. In two years after CI it was revealed that two patients with cochlea obliteration had a growing resistance on three channels that was more than 20 kOhm, the channels were disconnected. Probably, it happened due to the growth of connective tissue around the electrode in the cochlea. The resistance on six channels was up to 12-20 kOhm. We increased the stimulus duration on these channels up to 70μs (standard is about 26μs) and reduced the volume of the most comfortable level. It permitted to obtain good auditory sensations.

Contralateral stapedial reflex was used to determine the most comfortable level for children.

Frequency scaling was used to determine stimulus frequency for adults. According to its data, electrodes programming was made in a definite order.

The Split-electrode usage allows to implant patients with cochlea obliteration. However, obliteration can progress and worsen the auditory sensations.

When there is a growing resistance and absence of auditory sensations, the stimulus duration should be increased and the volume of the most comfortable level should be reduced.

In case of a significant resistance growth on certain channels, electrodes need to be disconnected.

Satisfaction and quality of life in young Romanian cochlear implant users

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Objectives: Cochlear implantation has a significant impact on patients' social and professional life.

The primary objective was to evaluate the validity of Quality of Life (QoL) questionnaires and the Hochmair-Schulz-Moser Sentence Test (HSM) translated into the Romanian language and the secondary goal assessed the QoL and Satisfaction of young Romanian Cochlear Implant (CI) users.

Material: To decipher broader multidimensional effects of CI treatment, generic and hearing-specific questionnaires were administered (Assessment of QoL questionnaire

(AQoL6d) and Speech, Spatial and Qualities of Hearing questionnaire (SSQ12), respectively) and correlated with the outcomes of the translated HSM test. The AQol6d is particularly interesting as the resulting utility score can be used for Cost Utility Analysis (CUA), relevant for stake holders and insurances. CUA permits the comparison of diverse health services by measuring outcomes in comparable units.

47 children with a mean age of 9.6 (range 2-19) years were assessed.

Results clearly indicate the importance of early implantation (< 2 years, correlation of age vs HSM % score, $P<0.05$). The mean utility-score was 0.80 (±0.12) which is comparable to the literature, reporting for the average healthy public a mean utility score of 0.83 (±0.14)(Richardson et al. 2015). All dimensions of the SSQ12 questionnaires resulted in a high degree of satisfaction. When comparing the results to adult CI users the obtained results of this study showed better outcomes for the adolescent cohort investigated here (ie.: Overall Dimension: 4.25 ± 1.65 vs 6.14 ± 1.72 respectively)(Mertens et al. 2013).

Conclusion: This study on a young Romanian cohort shows for the first time the importance of cochlear implantation and confirmed the validity of the translated study measures. It enables the development of listening and communication skills, allowing the child's progress in school and the ability to obtain, maintain and carry out the life of a non-hearing impaired person.

Using the little ears auditory questionnaire to promote parental confidence in the assessment process: capturing experiences

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Objectives: Children with cochlear implants are often assessed using a range of measures at regular intervals post-implant. This process can result in increased parental anxiety, lack of confidence and frustration that the assessment tool is not reflecting what they are observing / experiencing at home. The assessment is a snap-shot in time, a one-off moment where the carers can perceive they or their child is failing. Every one of the assessment appointments needs to be managed carefully by the therapist to maintain parental confidence and reflect parental perspectives.

Method: 50 children were assessed at different intervals between 6 and 24 months post-implant. All children and their families are seen for regular therapy by the therapist performing the assessment and all are reported to have a positive therapeutic relationship with the therapist. A combination of assessment tools including the MED-EL Little Ears Auditory Questionnaire, the Pre School Language Scales (UK 5) (PLS) and therapist rating scales CAP, SIR and CEP were used. At the end of the assessment appointment, parents and carers were asked to complete a questionnaire focusing on how the assessment made them feel.

Results: This presentation will illustrate the challenges in assessing children's progress after cochlear implantation and managing parent's thoughts and feelings to make this a positive, rather than anxiety-inducing experience.

Conclusion: The Little Ears Auditory Questionnaire is a useful tool to use with families during the post implant journey to report and acknowledge progress alongside traditional assessment tools that require the child to participate and perform. In the early post-implant stages, parents experiences of the Little Ears Auditory Questionnaire is generally more positive than formal assessments such as the PLS.

Comparison of auditory and speech performance of hearing impaired children after cochlear implant

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Introduction: Rehabilitation after cochlear implant emphasizes the acquisition of communication skills based on hearing and speech. The aim of this study was to compare the auditory and speech performance of such children in the first year of cochlear implant.

Materials and Methods: A total of 50 children aged 15 to 71 months old with an average cochlear implant age of 40 months was studied from cochlear implant center at Loghman Hospital. The subjects were evaluated at the device delivery, 3, 6, and 9 month after cochlear implant with CAP, MAIS, MUSS, SIR and APCEI scales. Data were analyzed by descriptive methods, visual analysis and repeated measurements.

Results: Data analysis showed upward trends in mean scores of children in all scales during the four evaluations. Significant differences were found in mean scores of subjects in each scale during the four evaluations. Visual analysis of the charts showed a higher slope of the auditory performance chart than the speech.

Conclusion: According to the results, children's auditory-verbal performance showed increasing trends and the children approached the maximum scores of each scale by the end of the first year of implant. The progression of hearing skills in the first year was faster than speech skills. It seems that more time is needed to improve speech skills to higher levels of the scales.

Three dimensional analysis of Turkish ling sounds

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Background: Ling sounds are important not only for initial audiological evaluation in children but also following gains in hearing aids- or cochlear implant-users. To provide appropriate access to verbal instruction, the frequency range of these phonemes is important. We previously documented formant frequencies of /a/, /e/, /i/, /o/, /u/, /m/, /s/ and /ʃ/ sounds emitted by Turkish ladies. Since all the rest have at least one meaning in Turkish with the exception of /i/, the subjects were ordered to emit all sounds in its one meaning in the previous study.

Objective: In this study we aimed to look for importance of chance of meaning on prosidy by using three dimentional analysis and modeling of /a/, /e/, /ʃ/ and /m/ to demonstrate amplitude and frequency changes in time.

Material and Methods: Twelve female (mean age: 31.83, min: 21, max: 44 years) native Turkish speakers with normal hearing emitted /a/, /e/, /m/ and /ʃ/ sounds in two different meanings as if they were calling a child almost 3 meters away. All recordings were analyzed by a custom-made Matlab-based software (3BKAP) for three dimentional modeling of the sound samples in addition to the formant analysis performed by Pratt sound analysis program

Results: It was found that meaning changed all 3 dimentional models, not only frequency composition but also amplitude ranges. Visuals of 3 dimentional models of all Ling sounds sounds meanings will be presented in the poster.

Conclusion: Acoustic data of Ling sounds is important to find out affected frequency bands and improvement by fitting. In this study we found that emitting the sound by giving a meaning and intention there are variations related with meaning in addition to interpersonal variations. Although these variations are within the scope of each speech sound, they could effect perception of the children with hearing loss.

Loudness function for bone conducted sound in subjects with pure conductive hearing loss

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Background: A study made by Stenfelt and Zeitooni (2013) showed differences, mainly for low frequencies, in the loudness function for bone conducted (BC) sound and air conducted (AC) sound in normal hearing subjects. For BC sound the loudness function was steeper than for AC sound. The method used in that study was Categorical Loudness Scaling, (CLS).

Loudness function is an important factor in prescription methods for hearing aids. Bone conducted devices that transmit the sound through the bone are largely used by persons with conductive hearing losses and knowledge about the loudness function in this group is needed.

Purpose: The aim of this study was to compare the loudness function for AC and BC sounds in two groups of subjects with a pure conductive hearing loss and normal hearing.

Method and materials: The participants in the study consisted of two groups, one with pure conductive hearing loss (N=18) and one with normal hearing (N=20). A loudness function measurement was done, unilaterally for both AC sound and BC sound, using the same methodology as in Stenfelt and Zeitooni (2013): Categorical Loudness Scaling. The subjects were asked to indicate the loudness of a given stimuli on a response scale from Inaudible to Too loud. According to the ISO standard for CLS, 4 frequencies with narrow band noise were evaluated; 0,5 kHz, 1 kHz, 2 kHz and 4 kHz.

Results: Results confirm the earlier findings of a steeper loudness function for bone conducted sound. Furthermore, results show interesting differences between the two groups, which may influence the prescription of bone conduction devices. The group with conductive loss demonstrated a smaller total dynamic range and steeper loudness function than the normal hearing group, both for AC and BC sound.

Audiometric gain in patients using cochlear implant after speech processor upgrade

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Introduction: The new speech processor technologies were created to improve the quality of sounds and eliminate competitive noise, aiming to improve the oral perception and quality of life of patients using cochlear implant (CI). Such technological advances have maintained the compatibility of the speech processors with the previous internal units, dispensing new surgical procedures. However, quantifying the benefit of using these technologies is of great value.

Objective: To compare the open field thresholds of patients with cochlear implants, before and after external speech processor upgrade.

Method: This is a cross-sectional, historical cohort study whose sample was extracted from a reference service for hearing impairment in Brazil. Two groups were created

according to deafness installation: prelingual and postlingual hearing loss. The SPrint processor users had the equipment replaced by Nucleus5, just as the Tempo Plus model was replaced by Opus 2. Speech tests were performed with sentences in open presentation in silence and free field thresholds measurements with both speech processors. Statistical analysis used non-parametric tests.

Results: The mean SRT / SDT speech thresholds, isolated thresholds and the mean of 500Hz, 1000Hz, 2000Hz and 4000Hz, and the open set speech perception tests of groups 1 and 2 were considered. Statistically significant change was found only on postlingual group, evidencing worsening audiometric gain after speech processor replacement.

Conclusion: Despite the incorporation of new technologies, in our sample, the processor upgrade did not lead to an improvement in auditory performance.

Acceptable noise levels in cochlear implants and bimodal hearing users

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Introduction: People with cochlear implant in one ear, often in the opposite ear have enough hearing sensitivity to use hearing aids. This study has followed two aims. 1. To check speech performance in noise in cochlear implant users and 2. to see any changes in speech performance in noise by addition of hearing aids to the opposite ear due to its low frequency amplification (to study weather low frequency amplification in opposite ear would worsen speech perception or not?).

Materials and Methods: Tests were performed in Loghman CI center and Pejvak rehabilitation clinic. 16 patients were tested with mean age about 16 years old. First unaided and aided audiometry was performed and mean pure tone average thresholds in implanted ear was 110 dBHL and 5 dBHL with prosthesis. In the opposite ear mean unaided thresholds was 90 dBHL and 45 dBHL with hearing aids. ANL test was performed then. Once with CI and then in Bimodal situation. Mean MCL with CI was 42.33 dBHL and with Bimodal amplification was 42.66. Mean tolerable background noise level (BNL) with CI was 38.5 dBHL and in bimodal was 39.22. Mean ANL, which is subtraction of BNL and MCL, was 4 with CI and 3 in bimodal.

Results: There is no significant difference in ANL results between cochlear implant users and cases with bimodal hearing.

Conclusion: Cochlear implant users have very good speech performance in noise. Their ANL result is within normal range and adding hearing aids to opposite ear, doesn't worsen the performance and virtually in clinical point of view, could cause improvement.

Auditory brainstem implant in children

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Objectives:
- To evaluate and characterize life quality of children with ABI.
- To acknowledge the changes produced after the auditory acquisition, also in the behavioral area.
- Previous work with the patient and family is considered fundamental. It is very important to provide accurate and clear information about the ABI in all its implications, cares, long-term rehabilitation and potential benefits.

Material and Methods: Within all deaf population a reduced group exists, 2%, which are not candidates of receiving a cochlear implant (CI). Causes vary between auditive nerve and/or cochlea agenesis, major malformations of the internal ear, post meningitis ossified cochlea with bad results with CI, etc

The ABI program in the Professor Diamante Cochlear Implant Center performed the first surgery in America in the year 2007, implanting a three-year-old girl with cochlear agenesis. Up to this date, ten children have been implanted.

To be able to evaluate the development of auditory and linguistic abilities accurately, these children are evaluated with standard tests every three months.

Results and Conclusions: The ABI in children has allowed the perception of environmental sounds and speech. A reduced percentage of patients reach perception in an open format, all of them develop a fundamental improvement in lip reading. The access to speech recognition in open format without visual clues, is possible in this children and has given as a result beneficial changes in their lives and families.

This implant produced audibility in all implanted cases within our center, obtaining aurally results similar to the cochlear implant.

The development of these children is widely favorable. Some of them achieved to develop auditory abilities telephonically, four of these ten children developed auditory abilities within a distance of 3 meters.

Deafness etiology in patients submitted to cochlear implant

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Introduction: Hearing impairment is the most common sensorial disorder. There are several etiologies for deafness and it is important to investigate them, not only because

some may lead to lower performance with cochlear implant, but also to define preventive strategies.

Objectives: To determine deafness etiology among patients submitted to cochlear implant.

Material and Methods: Cross-sectional sampling of all patients submitted to cochlear implant between January of 2006 and June of 2017 in a Brazilian referral hearing impairment center. Patients were grouped into post-lingual or pre-lingual deafness and an etiological profile was described for each group.

Results: 159 patients were evaluated, 74 post-lingual and 85 pre-lingual. In post-lingual group, the most common cause of hearing impairment was meningitis (n=16 / 21,62%) and other etiologies were non-syndromic genetic hear loss (n=12 / 16,22%), Alport syndrome (n=2 / 2,7%), otosclerosis (n=7 / 9,46%), viral infections – parotiditis and measle (n=3 / 4,05%), autoimmune (n=5 / 6,76%), Menière's syndrome (n=2 / 2,7%), ototoxicity (n=2 / 2,7%), enlarged vestibular aqueduct (n=2 / 2,7%), complication of otitis (n=2 / 2,7%), trauma (n=2 / 2,7%), lues (n=1 / 1,35%), vestibular schwannoma (n=1 / 1,35%), stroke (n=1 / 1,35%), auditory neuropathy (n=1 / 1,35%) and 15 patients (20,27%) had undefined etiology. In pre-lingual group, non-syndromic genetic hear loss was the most common cause (n=22 / 25,88%), followed by perinatal complications (n=20 / 23,53%), congenital infections – cytomegalovirus, rubella and parotiditis (n=8 / 9,41%), genetic syndroms such as Waardenburg (n=5 / 5,88%), meningitis (n=5 / 5,88%), malformation – most Mondini (n=3 / 3,53%), auditory neuropathy (n=3 / 3,53%), ototoxicity (n=2 / 2,35%) and 17 patients had undefined causes (20%).

Conclusion: In our sample, the most common etiology for post-lingual deafness was meningitis and for pre-lingual deafness was non-syndromic genetic causes.

Causes of surgical reintervention in cochlear implants

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Introduction: With the increase in the number of patients implanted and the time of use of the devices, a bigger number of failures is also expected. Revisional cochlear implant (CI) surgery is infrequent, but not uncommon. There are several causes that may lead to reintervention, as device failure and medical complications. This study's purpose is to review cases of CI that needed to be reassessed with emphasis on the causes that led to reintervention.

Methods: Retrospective study developed at the Hearing-Impaired Center of the Federal University of São Paulo (UNIFESP) with data from patients with cochlear implant that needed to undergo surgical reintervention.

Results: In a total of 168 patients submitted to CI from 2006 to 2017, 5,9% (10) needed reintervention, being six children and four adults. 70% of them were reimplanted, and the causes were: hardware failure (2), soft failure (1), CI extrusion (3) and electrode misplacement (1). Reimplantation occurred in 7 patients and was possible in the same ear in 42% (3) and contralateral in 4 (57%). The postoperative complications after the second CI were mild and present in only two cases. The time between the first CI and the reimplantation varied from 3,5 months to 7 years. Two patients underwent explantation only, and another one was reapproached to electrode reposition.

Conclusions: The main causes of revisional surgery in cochlear implanted patients in our sample was: internal device extrusion, hardware failure, soft failure and electrode misplacement.

Wireless connectivity in cochlear implant users in challenging auditory situations

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Introduction: The results of cochlear implant (CI) is individual but in everyday listening situations, the combination of reverberation, background noise and speaker distance results in poor listening conditions and the impact is even greater for the hearing impaired. The Roger system is an adaptive multichannel remote microphone technology with a digital modulation that is indicate for use in difficult communications. Objective: The purpose of the study is to evaluate the benefits of the Roger system in CI users. Method: It is a prospective cross-sectional study in which 13 adults post-lingual deafness, Medel recipients were randomly chosen. For the evaluation of the benefit of the Roger system, the participant was positioned in the center of a room with eight speakers, with reverberation time (T60) measured at 429.40ms. Words or sentences recognition was evaluated at zero azimuth at one meter of the subject's head at 65 dB SPL, and the multi-talker babble noise was presented in the other speakers at 55 dB SPL. The contribution of Roger to reverberant environments was evaluated in silence (S0) and Roger's contribution to noise in 2 positioning situations (S0N0-signal and noise at zero azimuth and S0N315-signal at zero azimuth and noise at all directions). The difficulty of the speech material was chosen according to the performance in the silence. The percentage of correct answers in each test was compared between the test situations. Results: Roger's contribution to reverberant environments was identified in 46% of patients with a 26% improvement in performance. Roger's contribution to noise with zero azimuth positioning was identified in 30% of patients with a 9% improvement in performance. Roger's contribution to noise from all directions was identified in 61% of patients with a 20% improvement in performance. Conclusion: The Roger system contributed to speech recognition in reverberant environments and when noise is surrounding.

The relation between cochlear implants performance and scala position of electrodes array

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Objective: To investigate the relation between cochlear implants performance and scala position of electrodes array.

Methods: Retrospectively analysis of thirteen patients from January 2016 to December 2016 underwent cochlear implantation with LISTENT (LSP-20). The preoperative and postoperative Computer Tomography images were collected for 3D reconstruction of electrodes array by ITK-SNAP and CloudCompare. Their speech discrimination scores (SDS) at 1 year were documented.

Results: The electrodes array, basal membrane and cochlea could be reconstructed in 3D mode. The scala position of electrodes array could be intuitively recognized. Eight electrodes arrays (61.5%) were fully inserted in scala tympani (ST), 5 (38.5%) crossed from ST to scala vestibuli (SV). Patients with full ST insertion presented better outcomes; the mean monosyllabic, bisyllable and sentence SDS were respectively 61%, 69% and 99%. The data were 57%, 60% and 80% in patients with electrodes array crossed to SV.

Conclusion: 3D reconstruction is a useful method to recognize the position of electrodes array. Full insertion in scala tympani is important for achieving better cochlear implantation outcomes.

Prospective study of sound localization in cochlear implantees – Measured with a modified clinical diagnostic setup using virtual sound sources (ERKI-Method)

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The task of localizing a sound source is a fundamental characteristic of binaural hearing, because the perception of acoustic space is based on processing sounds with two ears. While normal-hearing listeners can pinpoint and discriminate different sound sources very accurately localization accuracy of the Cochlear Implant (CI) users are unclear as well as factors such as the period of deafness or implantation, and implantation age.

To explore the binaural localization ability in the free-fied we used the ERKI-setup consisting of the "Mainzer Kindertisch" with five loudspeakers in a semicircular position (angular resolution = 45° between speakers). To archive a higher angular resolution in the horizontal plane we modified the setup. We generated virtual sound sources by LoudSpeaker Level Differences (LSLD) between two adjacent loudspeakers. This sources obtaining 37 discriminable reference angles (five real and 32 virtual sound sources) in 5°-steps in a total frontal range of ±90°. We used different stimuli with a length of 300ms. The responses were recorded by a control dial and a LED-light strip to give visual feedback.

In an exploratory long-term study we measured localization patterns in three different groups: SSD, bimodal and bilateral CI implantees. The aim of our project was to document the development of the localization ability in adult patients after fitted with CIs, using the ERKI-Setup.

The results revealed that it is possible to measure the directional hearing by using a mixture of real and virtual sound sources with CI-users. Our modified setup can help to track the development of directional hearing in CI implatees. However, the improvement of localization ability over a period of several months is different for each patient. The localization patterns show a broad variety of different localization accuracy.

Cochlear implant for adults with sporadic vestibular schwannoma in the only-hearing ear: ipsilateral, contralateral or bilateral?

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Objective: To investigate consideration and performance of cochlear implantation (CI) for patients with sporadic vestibular schwannoma (VS) in the only-hearing ear.

Methods: A retrospective analysis of four cases, who had a long history of hearing loss on the one side and a newly-presented symptom of a gradual hearing loss due to VS on the other side, and then received ipsilateral, contralateral or bilateral CI between January 2015 and December 2016 is carried out. Imaging examination and audiological tests were performed before operation. Hearing outcomes were measured by the pure tone audiogram (PTA) and the open set speech discrimination score (SDS). Mean follow-up time was 15 months.

Results: There were four patients recruited in this study: one patient implanted on the ipsilateral side, two on the contralateral side, and the other one on bilateral sides. During follow-up period, three of all had a satisfactory improvement in their speech recognition. PTA showed positive results in all four cases, which conferred an awareness of environmental sounds and was an adjuvant to lip

reading. The patient with bilateral CI showed significantly better performance on the open set speech perception compared to the other three patients with unilateral CI, especially in noise.

Conclusions: Consideration of CI for patients with sporadic VS in the only-hearing ear is complicated. Side selection or bilateral CI needs to be well discussed. The performance of CI depends on several influential factors. Obviously, bilateral CI is more beneficial than unilateral CI on either side.

Universal newborn hearing screening in Algeria

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Objectives: To evaluate the prevalence of hearing loss in the neonatal population and their risk factors.

Identify the best way to practice hearing screening.

Materials and methods: It is a prospective study over a period of 22 months, using a universal hearing screening in a maternity of high level of birth.

Results: From June 2011 to March 2014, 17912 alive newborns were born in the maternity ward. We have chosen a three stages screening protocol. At the 1st stage, 15382 newborns were screened by analysis of distortion product of otoacoustic emissions (DPOAE) with a coverage rate of 85.9%. The DPOAE were absents of DPOAE for 1915 newborns. At the 2nd stage of the screening protocol after 1 month of birth, 1516 infants were screened and 399 infants were lost. After this 2nd stage, 76 infants were suspected to have hearing loss and addressed to the 3rd stage of the screening Protocol. In this last step, 14 children have been lost and we tested 62 infants for the hearing threshold by analyzing auditory brainstem response. The results of the 3rd stage are 49 children with a hearing threshold level greater than 30 decibels. The prevalence of neonatal hearing loss in the maternity is 3.2‰. They were 27 males and 22 females among whom 29 of them had bilateral hearing loss and 20 children a unilateral hearing loss. On the other hand, the study of the hearing loss risk factors identified the prevalence of hearing loss among newborns admitted in neonatal intensive care unit (NICU) which was 2.14%. The risk factors most associated with deafness in our study are those contained in the Principles and guidelines of EHDI 2007.

Conclusion: Newborn hearing screening by a three stages protocol is feasible. The prevalence of neonatal hearing loss was 3,2 ‰ in neonates and 2,14 % in NICU.

Early complex diagnostics of hearing impairment in children

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Background: Improvement of efficiency of early diagnostics of bradyacusia and deafness in children.

Material and methods: 610 children in age from 10 days to 18 years with hearing impairment of different etiology and severity were examined. Complex algorithm of the examination included anamnestic and medical and pedagogic testing, expanded audiologic testing, evaluation of other organs and systems condition.

Results: Acquired sensorineural hearing loss was diagnosed in 64 patients: and induced by neuroinfection in 24, by autoimmune inner ear diseases in 12, by impairment of brain and cervical blood circulation in 12, by otosclerosis in 4, oncological diseases in 4, by administration of ototoxic drugs in 4, by chronic suppurative otitis media in 4. Congenital sensorineural hearing loss was diagnosed in 506 patients and induced as follows: by inheritable genetic mutations in 293, syndrome-based pathology in 84, by prenatal infection in 39, by antenatal and intranatal fetal hypoxia in 31, by congenital internal ear anomalies in 18, by extremely preterm neonate in 12, by external and middle ear development anomalies in 17, by ototoxical drugs administration by mother during pregnancy in 6, by hemolytic disease of newborn in 4, by mitochondrial pathology in 2. Reason of hearing impairment was not detected in 40 children. Acoustic analyzer was combined with complex and multiple development disorders in 228 children: pathology of central nervous system in 172, vision in 32, cardiovascular system in 12, endocrine system in 6, oncology in 4, blood diseases in 2. In 56.4% psychospeech delay was detected in children with multiple development defects.

Conclusion: System approach to hearing impairment diagnostics in children, early detection of these or combined pathologies in the examined children will allow early definition of leading defect and potential abilities of a child, and timely corrective updating of individual rehabilitation programs.

Hearing screening in newborns at risk : which factors to recommended ?

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Objectives: Study of risk factors associated with newborne hearing loss (NHL)

Materia and Methods: If NHL screening is routine in industrialized countries, it's still reserved for newborns at-risk in many countries. We conducted a NHL screening by Transiently Evoked otoacoustic emission in neonatal unit of Tlemcen's mother-child hospital . we sellect the risk factors rocommended by the Joint Committee on Infant Hearing and some recommended by other authors (Maternal Diabetes, Prematurity, Dystocic delivery with obstetric head trauma, Neonatal intensive care unit(NICU) stay > 5 days, Neurological, endocrine or metabolic diseases and Infectious diseases of the middle and / or inner ear in the neonatal period).

Diagnosis confirmation was made by Auditory Brainstem Responses and Auditory Steady-State Response.

The analysis of the statistical results was done by bivariate mode then in multivariate.

Results and conclusions : The study involved 544 neonates at risk, the prevalence of NHL was: 5.51%, sensorineural NHL 4.96% and profound NHL 1.1%.

The significant risk factors in bivariate analysis were: Presence of a defect, cephalic defect, polymalformative syndrome(P=0.000 for each one) neurological diseases P = 0.002, meningitis P=0.000, NICU stay P=0.000 , inbreeding parental P = 0.003, birth weight < 1.5 kg P=0.000 , intrauterine infection P=0.000 and the presence of deafness risk factor P=0.000. Significant risk factors in multivariate analysis were: polymalformative syndrome, meningitis, birth weight < 1.5 kg with P=0.000 for each of them, neonatal jaundice need intensive phototherapy or exchange transfusion P = 0.011 and stay in NICU P = 0.013. Only one newborn presented neonatal labyrinthitis, which was complicated by profound deafness.

The risk factors recommended in NHL screening should be extended to other factors such as: inbreeding parental, infectious diseases of the middle and / or inner ear in the neonatal period and other neurological diseases.

The newborn hearing screening program: achievements and challenges

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Introduction: Newborn hearing screening programs allow to identify infants with permanent congenital hearing impairment and to achieve an early intervention to minimize the consequences on language development. Hearing loss is one of the most common congenital anomalies, occurring in 1- 3 per 1000 newborns in the well-infant population and 2-4 per 100 in an intensive care population.

This study aims to present the organizational model of the NHS program in Modena hospital and to evaluate its efficacy through the results of the first two years of activity.

Materials and methods: Modena county has about 700,000 inhabitants, with at least 6500 newborns per year. The neonatal hearing screening follows the regional resolution approved in 2011 (Emilia Romagna Region, 694/2011) and involves all the neonatal facilities. The screening has been carried out by means of TEOAE test, using for well babies, a two stage protocol: first screening stage on the second day after birth, followed by re-screening before discharge if a pass response was not obtained from both ears and a a second follow up screening within 3 weeks later in case of failure. In case of a persistent failure response an audiological evaluation was performed.

Results: During the period of the study 6354 babies were born and 6299 underwent newborn hearing screening with a coverage around 99.% 55 babies were transferred in other hospitals before the TEOAE test. In 43 cases an audiological evaluation was performed for persistent bilateral failure of the screening. All except 2 , who migrated in others counties, completed the examination and in 29 cases hearing loss was confirmed

Conclusion: An active collaboration between audiologists/ ENT specialists and pediatricians is important to identify infants with hearing loss as early as possible in order to implement earlyy interventions.

Cochlear implant in children with congenital hearing loss: time elapsed between the suspicion and the diagnosis of hearing loss and the performance of the surgery in a public service of high complexity in Brazil

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Hearing is the sense by which oral language is acquired. Auditory sensory deprivation in children without adequate rehabilitation compromises communication, language acquisition, school performance, and emotional and social development. Many studies have shown a better prognosis when intervention occurs beneath the second year of life. Cochlear implantation (CI) is an option in cases of severe and profound sensorineural hearing loss, when conventional hearing aids become ineffective, thus enhancing the ability of oral communication. The objective of this study is to evaluate the time elapsed between the suspicion and the diagnosis of hearing loss (HL) and the time between the search for medical care and cochlear implantation in children with congenital HL. Data were collected from the medical records of all patients under 18 years of age who underwent CI surgery at CDA/ UNIFESP, from January 2005 to December 2016, regarding: Universal Newborn Hearing Screening (UNHS) achievement and outcome, time between suspicion and diagnosis of HL and the time between the search for care and the performance of the

CI. Results: 91 children were implanted, 28 (30.76%) with congenital HL. Of these children, 12 (42.85%) were submitted to UNHS with PASS results in 3 (25%) and FAILURE in 9 (75%). In cases of FAILURE, the mean time between the suspicion and the diagnosis was 11 months and the mean time between the demand for medical care and the performance of CI was 14.9 months. In cases of PASS the intervals were 14.3 and 14.8 months, respectively. For the 16 children without UNHS, those measures were 23.6 and 15.9 months, respectively. Conclusion: The results of the present study show that, in developing countries, the time to diagnosis of congenital HL is still long. Even though it occurs within the first 2 years of life, such delay may compromise therapeutic outcomes and rehabilitation.

Non-syndromic neurosensorial hearing loss:auditory performance and treatment in patients with mutations in Connexin 26 and 30

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Introduction: Hearing loss due to mutations in the DFNB1 locus is characterized by being of pre-consecutive onset, by a degree of severity that varies generally from moderate to profound. Objective- Study deafness related to GJB2 associated with Cochlear.- Analyse results from our population Method: An rretrospective study of patients studied in the Garrahan pediatric hospital with connexin and who received a cochlear implant. Results: Despite the genotype-phenotype correlations observed, there is a significant phenotypic variability that can be the reflection of environmental factors and / or modifying genes that lead to a variable expression. Of the population studied in the Hospital (270 children), 75 patients with two connexin 26 and / or 30 mutations could be identified. Of the total of patients with mutations, 72 has bilateral profound sensorineural hearing loss and only 3 moderate to severe loss. The indicated treatment was a cochlear implant for profound losses and hearing aids for minor hearing losses. In four families, it was possible to act early when detecting in newborns the mutations present in the affected brother and in three families the presence of mutations in newborn siblings was ruled out. In homozygous 35delG patients, a hearing impairment in the first year of life with progression towards severe bilateral profound or profound hearing loss, unlike patients with a homozygous deletion in the GJB6 gene who presented a bilateral deep sensorineural hearing loss from the beginning. We have also observed that all 35delG homozygous patients showed a degree of severe to profound deafness while patients with moderate deafness had at least one non-35delG allele. Conclusion: Deafness related to GJB2 associated with Cochlear Implant is significantly better prognosis compared to the loss of acquired hearing caused by environmental etiologies. However, it was shown that the age of implantation was a better indicator of implant performance than the genotype.

Treatment of deafness using cochlear implant in patient with extremely rare genetic syndrome: branchio-oculo-facial

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Objectives: Branchio-oculo-facial syndrome is a very rare autosomal dominant congenital disease. The cause of the syndrome arises from a mutation in the TFAP2A gene. Symptoms most often include skin abnormalities of the head and neck, deformities of the ears and eyes, and other facial features. These children have also associated various hearing problems including profound sensorineural hearing loss. The aim of the study was to show the surgical technique used for cochlear implantation in a patient with BOF syndrome (branchio-oculo-facial) and discuss the results obtained after surgical treatment.

Materials and Methods: One male patient with BOF syndrome was qualified for CI treatment because of the bilateral sensorineural hearing loss and no effect with hearing aids. There were several problems during the operation, the most severe was the congenital deformation of the temporal bone. We used Med-El implant system. The technique of cochlear implantation was facial recess.

Results and Conclusions: The operation went without complications. There were not any late complications also. After several months of rehabilitation, we achieved satisfactory hearing results.

We point that even in cases with complicated anatomy there is a possibility to improve hearing using cochlear implants. It is of crucial importance to focus on hearing improvement to maintain appropriate hearing level and to give chance for the children with complex congenital deformations to be active society members.

Congenital sensorineural hearing loss with anomalous vestibular nerve complex: rare radiological findings

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Radiological assessment is an essential tool for pre-operative assessment of cochlear implant (CI) candidates with congenital sensorineural hearing loss (SNHL). It gives crucial information of the inner ear, vestibulocochlear nerve, facial nerve and brain. Hypoplasia of the cochlear nerve bony canal is commonly associated with profound SNHL whereby 88% of this abnormality was found in 95% of CI candidates. This finding may be associated with internal auditory canal (IAC) hypoplasia or other cranial nerve abnormalities. Objective: To present a rare case of a patient diagnosed with congenital sensorineural hearing loss exhibiting an interesting radiological finding of an anomalous vestibular nerve course alongside hypoplasia of the cochlear bony canal. Result: There are two bony canals originating from the internal auditory canal (IAC) represents labyrinthine segment of facial nerve with another bony canal more posteriorly with cochlear aperture stenosis. The patient is a 3.5 year old Malay girl successfully underwent cochlear implant. Conclusion: Constructive Interference in Steady State (CISS) Magnetic resonance Imaging (MRI) is very helpful to determine the size of cochlear nerve in a cochlear aperture stenosis.

Auditory evaluation in children and adolescents with Turner syndrome

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Objectives : Turner syndrome (TS) is characterized by short stature and hypergonadotrophic hypogonadism, associated with typical somatic features. Although hearing loss (HL) was not reported in Henry Turner first description of the disease, it has been brought to attention in the last decades in many studies. But the true nature of this problem is still unknown due to inconsistent data resulting from different study methodology. The purpose of this study is to evaluate hearing of TS girls using Audiometry and Otoacustic emissions, both Distortion product (DPOAEs) and Transient (TOAEs).

Materials and Methods: Prospective cross-sectional study of TS girls aging from six to 19 years old, who were evaluated and compared to healthy controls matched to age and sex.

Results and Conclusion: Twenty six ears (13 girls with TS) were compared to 12 ears (6 controls). TS patients showed in Audiometry: normal hearing in 14 ears, neurosensorial hearing loss (NSHL) in three ears, conductive in seven and mixed HL in two ears (12 alterations). In the DPOAEs: 19 absent responses (73.1% of cases) in at least one frequency, and in TOAEs: 16 absent responses (61.5%). 15 absent responses in both tests (57.7%). This occurrence was significantly higher than matching controls for age and sex. The presence of auditory alterations in TS patients assessed by OAE was high. They were significantly higher than the control population, and were higher than those present in audiometry. Future research should evaluate these absences in OAE in patients with normal audiometry.

Friday 29 June 2018

Keynote Lectures

Hearing Preservation after Cochlear Implant Surgery in Postlingual Patients with Partial Deafness

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Cochlear implants (CI) are no longer just a solution reserved exclusively for the treatment of severe-to-profound hearing loss. Due to the continuous development of technology and medicine, the eligibility criteria for cochlear implantation are subjected to gradual expansion. The treatment of partial deafness using a cochlear implant is based primarily on the need to preservation of intact inner ear structures and preservation of pre-operative hearing threshold after insertion electrode of implant into the cochlea.

The purpose of the retrospective study was to evaluate the hearing preservation after CI surgery in postlingual patients with partial deafness.

Medical record of over 6,000 patients who were undergone surgery of auditory implant's at the World Hearing Center of the Institute of Physiology and Pathology of Hearing were retrospectively screened to identify postlingual patients with partial deafness. Collected a very large material of CI users and long follow-up period allowed to extension of the previous classification proposed by Skarzynski for a new group of patients with electro-natural stimulation (ENS).

The cochlear implantation in Partial Deafness Treatment (PDT) is conducted according to ‚Six Step Skarzynski Surgical Technique' which take into account the approach through the round window as the least traumatic way of insertion the electrode of implant into the inner ear. Pre- and postoperative audiometric assessment was performed in all group of patients. Speech understanding was evaluated using ‚Pruszewicz Monosyllabic Word Test' in the free field. Furthermore, hearing preservation was assessed using the Hearing Preservation Calculator developed by the HEARRING group.

In conclusion, cochlear implantation in group of patients with partial deafness (which achieve unsatisfactory benefits from traditional sound amplification with hearing aids) seems to be a safe and effective method of restoring hearing ability.

(Re)Habilitation for Children with Cochlear Implants

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Now, next or dare I say never?

What accounts for differences in spoken language outcomes? Research shows younger the better and two is better than one . Also, children do better without additional disabilities and with a higher non-verbal IQ .

We're often left with one more significant variable, mothers education . Used as a measure of social advantage, or more importantly social disadvantage. So, if this is a social, not a cochlear problem does rehabilitation have a role at all? From children into adulthood, we'll explore the language learning cycle of disadvantage. And ask the question, what should our services look like to meet this need?

What about the children who are doing ‚well'? Talk to their parent's and you'll hear the same story. They struggle in groups, miss the jokes and are technology dependent. Children are more than just spoken language machines, so we'll explore literacy, academic and psychosocial outcomes and you'll get to see best practice in action. Our expert multi-professional panel will identify current challenges so, we can ask the question for rehabilitation what's now, next or dare I say never?

1 Geers et al. 2008, Tobey et al., 2013, Ching 2015, Valimaa et al 2017
2 Boons et al., 2012; Sarant et al., 2014; Sarant et al., 2015
3 Ching 2015
4 Tobey et al., 2013
5 Ching 2015, Valima et al. 2017

WNT activation and notch inhibition extends the regenerative time window for sensory hair cells in the mammalian cochlea

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The mammalian cochlea is comprised of sensory hair cells (HCs) that detect sound and intervening non-sensory supporting cells (SCs). HCs can be lost due to aging and noise exposure and do not regenerate in the mammalian adult, resulting in permanent hearing loss. In contrast to adults, SCs of the neonatal mouse cochlea can function as endogenous stem cells and directly transdifferentiate into HCs when Notch signalling is inhibited. However, this transdifferentiation occurs only up to postnatal day (P) 3 and comes at the cost of SC loss.

Canonical Wnt/β-catenin signalling plays important roles in development and homeostasis and regeneration of stem cells. Moreover, since this pathway is necessary for prosensory cell proliferation and HC differentiation during cochlear development, we examined the effects of exogenous Wnt activation on HC regeneration in the postnatal cochlea. Using a cochlear in vitro model, we demonstrate that exogenous Wnt activation within a critical developmental window drives mitotically quiescent neonatal SCs to re-enter the cell cycle. We report that a subset of these newly proliferated SCs are competent to transdifferentiate into HCs when Notch signalling is inhibited up to at least P8, thus replenishing the SC population and extending the window of transdifferentiation in the maturing cochlea. Furthermore, we identify the Wnt and Notch pathway genes which are modulated by Wnt activation and potentially play a role in conferring competency for SC proliferation and transdifferentiation in the postnatal cochlea. Thus our results indicate that modulating Wnt and Notch signalling cascades has therapeutic potential for hearing restoration.

Insertion depth impacts speech perception and hearing preservation outcomes for lateral wall electrodes

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Objectives: Determine the impact of angular insertion depth (AID) on post-operative speech perception and hearing preservation with implantation of lateral wall electrodes.

Materials and Methods: Post-lingually deafened adults undergoing cochlear implantation with Flex

24, Flex 28, and Standard electrode arrays were identified. Patients underwent pre-operative and post-operative CT scans, such that AID could be determined.

Results: Forty-eight implants were included. The median AID was 408°(IQ range 373-449°) for Flex 24, 575°(IQ range 465-584°) for Flex 28, and 584°(IQ range 368-643°) for Standard electrode arrays. The mean post-operative CNC score was 43.7%±21.9. A positive correlation was observed between greater AID and better CNC performance ($r=0.48$, $p<0.001$). Excluding patients with preserved functional hearing, a strong correlation between AID and CNC score persisted ($n=38$)($r=0.57$, $p<0.001$). Deeper insertions were associated with greater loss of low-frequency hearing ($r=0.41$, $p=0.04$).

Conclusions: A significant positive correlation between greater AID and CNC score was noted regardless of post-operative hearing status. In patients with residual hearing, a shallower insertion was associated with better hearing preservation. This highlights the clinical dilemma of whether to use a shorter electrode and increase the likelihood of hearing preservation, or choose a longer electrode and maximize cochlear coverage in patients with substantial residual hearing.

First-in-human safety and preliminary efficacy results for the MVI™ Multichannel Vestibular Implant

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Purpose: In rodents and nonhuman primates with bilateral vestibular hypofunction, we previously demonstrated that motion-modulated current pulses delivered via electrodes in the ampullae can partially restore the 3D angular vestibulo-ocular reflex (VOR) while partially preserving hearing. Based on those studies, we initiated a first-in-human clinical trial of continuous motion-modulated prosthetic stimulation using the MVI™ Multichannel Vestibular Implant system developed by Labyrinth Devices LLC and MedEl GmbH.

Methods: Four subjects underwent unilateral implantation; two were observed overnight and two were discharged the same day. VOR responses to 0.5-5 Hz passive head or whole-body rotation and prosthetic stimulation; pure tone and speech audiometry; and metrics of posture, gait, dynamic visual acuity and quality of life were assessed during 2-14 months of continuous MVI™ use.

Results: Electrically-evoked VOR responses typically ranged from 5-40°/s and aligned approximately with the stimulated canal for ≥1 electrode in each of 3 canals in each implanted ear. VOR responses were typically smaller than those for similar currents in animals, but significantly greater with motion-modulated stimulation than without. Motion perception thresholds are below VOR thresholds. Hearing sufficient for unaided communication was preserved in all subjects. At >12 months postop, subjects 1-3 have preserved hearing except for high-frequency SNHL; as of 3 months post-op, subject 4 has a high frequency SNHL and 25dB speech reception threshold change.

Conclusions: The MVI™ system can be implanted in outpatient surgery with preservation of useful hearing, and it generates motion perception and 3D binocular VOR responses consistent with selective stimulation of 3 implanted canals.

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under an investigational device exemption (US FDA IDE Case #130248). All research was conducted under a protocol approved by the Johns Hopkins University Institutional Review Board (IRB Study Number NA_00051349). This trial is registered as ClinicalTrials.gov #NCT02725463. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. PJB was supported by NIDCD 2T32DC000023-31 through the Johns Hopkins Center for Hearing and Balance. CCDS holds an equity interest in Labyrinth Devices LLC. The terms of this arrangement are managed in accordance with university policies.

Developmental plasticity of cortical oscillations

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Cochlear stimulation activates the auditory cortex via thalamocortical inputs. Cortical responses are subsequently embedded into ongoing cortical processing via corticocortical connections, providing information on the context of the stimulus. Stimulus related activity is reflected in local field potentials (LFPs) in the form of evoked (phase-locked to the stimulus, reflecting the thalamic input) and induced (sensory-related, but non-phased-locked activity, representing corticocortical processing) responses. We investigated the effect of auditory experience on evoked and induced responses in the primary auditory cortex (A1) and a higher-order auditory field (posterior auditory field, PAF). We evaluated time-frequency representations (TFR) of auditory responses in adult hearing controls (HCs) and congenitally deaf cats (CDCs), the latter in absence of developmental hearing experience. Evoked and induced TFR power was calculated using wavelet analysis, while coupling strength between A1 and PAF was estimated using the weighted phase-lag index. Moreover, we determined the directionality of the coupling using the non-parametric reversed Granger method.

The evoked responses appeared mainly at early latency (<100ms) while induced responses appeared more abundant at long latencies (>100ms), corresponding to their assumed role in thalamocortical vs. corticocortical processing, respectively. In HCs, electric stimulation resulted in reduced induced activity compared to acoustic stimulation, indicating the effect of the stimulation mode on the induced responses. The comparison of electrically elicited responses between HC and CDC showed no significant effect of deafness on A1 evoked responses, but a near loss of A1 and PAF induced responses in CDCs, particularly at longer latencies. Furthermore, the coupling between two recorded fields were decreased in CDCs, potentially in the top-down (PAF-A1) directed-connectivity. This finding supports the concept that developmental hearing experience is essential for integration of thalamocortical and corticocortical activations in the auditory cortex, and thus integration of the stimuli into stimulus context and internal model of the environment.

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Poor performance in adult cochlear implant patients and its remediation

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Multiple factors contribute to poor outcomes in adult cochlear implant patients: We established a mathematical model to predict sentence recognition scores at one month post-activation based on patient-related and electrode array position factors (details presented elsewhere in this conference). We also established that one-month scores are predictive of longer term outcomes such as speech reception thresholds in noise at 12 months post-activation.

Firstly electrode position can be optimised by improved planning of surgical technique or by programming at activation based on imaging. We are then able to provide to CI candidates an indication of their probable short and long term performance based on duration of deafness and etiology: Congenital hearing loss generally produced poorer outcomes in the short term and labyrinthitis generally produced poorer outcomes in both the short and long term.

Patients' sentence scores at 1 month post-activation can be compared to the predictions of the model. Where performance is below predictions electro-physiological testing is indicated which may allow remediation based on reprogramming. Where no physiological problems are found, or they cannot be remedied, an early rehabilitation plan can be established involving intensive training or self-training. Conversely for patients performing well or above expectations the number of follow-up visits can be reduced or replaced with remote consultations.

An initial step in our centre is to use the predictive model to identify poor performers. We will discuss the additional research required to optimise physiological testing and to define appropriate auditory or other training to optimize outcomes. The model based approach allows for optimized use of clinicians time across the rapidly increasing number of adult CI patients attending our centre.

Main Sessions

MS 23: Hearing Preservation CI in Postlingual Residual Hearing

Long-term outcomes in partial deafness treatment

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Objective: Treatment of the partial deafness is a great challenge in terms of preserving the preoperative hearing and complementing this hearing ability with an implant. It concerns the situations when hearing in low frequency range is normal or fully functional and it is only necessary to complement it electrically in the medium and high frequency ranges. The first in the world surgery during which an existing normal hearing had been electrically complemented was performed in 2002. It has shown a fresh direction in treatment of various partial hearing impairments. This achievement was possible due to our previous works on hearing preservation in the group of patients with marginal residual hearing. The long term observation (almost 15 years) and large material of more than 1500 cases allow us to present the strategy of the partial deafness treatment and its results.

Method:During the ESPCI conference in Warsaw in 2009, PDT concept was announced, indicating groups for Acoustic Stimulation (AS) and Electric Stimulation (ES). ES patients can be divided on the following groups: Electrical Complement (PDT-EC), Electric Acoustic Stimulation (PDT-EAS), Electric Modified Stimulation (PDT-EMS), Electric Stimulation (PDT-ES).

Results and Conclusions: The differentiation between the groups is very important, because the groups are not equal and their goals in treatment and therapy are different. Concluding we can say that hearing was preserved in over 94% of cases, however, the results differ between the groups. Implementation of the partial deafness treatment (PDT) is connected with development and elaboration of special rehabilitation program for the specific groups of patients.

Longterm hearing preservation outcome with different flexible lateral-wall cochlear-implant electrodes

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Objectives: In recent years it has been possible to preserve low frequency hearing after cochlear implantation (CI). Due to the characteristics of lateral- wall cochlear implant electrodes, MED-EL Flex 20®, MED-EL Flex 24® and MED-EL Flex 28®, can be used to preserve residual hearing. The aim of this analysis was to determine the development of hearing preservation over a longitudinal postoperative period for a large consecutive cohort of implanted patients and its relation to electrode length after CI.

Material and Methods: 222 adult patients were included in this retrospective analysis. All patients reached preoperative air conduction thresholds better or equal than 80 dB between 125–1000 Hz. They underwent CI using MEDL-EL Flex 20 mm (n=62), Flex 24 mm (n=63) and Flex 28 mm (n=101) MED-EL electrodes. Pre- and postoperative (initial fitting, twelve and twenty four month) pure tone audiometry (125 Hz – 1500 Hz) was performed and median hearing loss (HL) was determined. The preto postoperative pure tone average difference was scaled into 3 groups (≤ 15 dB, >15 dB to ≤ 30 dB, > 30 dB) for each patient.

Results: At initial fitting, median HL of 17dB (Flex 20), 19dB (Flex 24) and 28dB (Flex 28) was observed. After 24 months, 20dB, 26dB and 33dB mild progressive median HL was observed for Flex 20 (n=37), Flex 24 (n=33) and Flex 28 (n=47) patients. Good hearing preservation was achieved in 42% (Flex 20), 36% (Flex 24) and 12% (Flex 28) of patients after 24 months.

Conclusions: Stable hearing preservation is possible over a long postoperative period in the majority of patients implanted with all flexible lateral-wall electrodes of different length. Higher percentage of good hearing preservation was found for shorter electrodes and lowest median hearing in patients with the shortest electrode.

Structure preservation surgery with different insertion angles – Indication for electric or electric-acoustic stimulation

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Objectives: After cochlear implantation (CI) using the structure preservation technique, patients can either utilize electric stimulation (ES) or combined electric-acoustic stimulation (EAS). This retrospective study reviewed outcomes after CI depending on the angle of insertion (AOI).

Patients and Methods: 91 patients with different degrees of preoperative low-frequency residual hearing who had been implanted with a free-fitting lateral-wall electrode array (MED-EL Flex) were included in this study. Array lengths ranged from 20.0 to 31.5 mm. Individual AOIs were estimated using postoperative modified Stenvers' projection. Freiburg monosyllable test in quiet (65 dB SPL) and pure-tone averages for low frequencies (125, 250, and 500 Hz; PTAlow) were evaluated during a follow-up period of 12 months after implantation. Patients were either fitted with ES or combined EAS.

Results: Two AOI groups were distinguished: shallow insertion (mean value 377°) and deep insertion (mean value 608°). Speech test scores after 12 months were comparable between AOI groups, but EAS users had significantly better scores than ES users. In cases of preserved residual hearing, both AOI groups showed significant but comparable postoperative PTAlow shifts with mean of 17.8 and 21.6 dB, respectively. No further significant shifts were observed in follow-up intervals. The ES group showed a positive correlation (r = 0.293) between speech test score and AOI. Audiometric indication for shallow insertions and subsequent EAS are proposed up to 65 dB HL.

Conclusions: CI candidates can benefit from structure preservation surgery with deep insertion when using ES due to insufficient residual hearing. Patients with a preoperative threshold up to 65 dB HL at 500 Hz could perform significantly better with EAS, which advocates shallow insertion.

Surgical experience with the new SlimJ electrode array

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Objective: The surgical technique used for structure and hearing preservation with the SlimJ electrode will be described.

Methodology: A series of 10 cases was implanted with the lateral lying SlimJ electrode array using a round window and soft surgery approach designed to preserve cochlear structures and, where present, residual hearing. Hearing levels were recorded shortly before surgery and continues to be monitored.

Results: All electrode insertions were uneventful. A full insertion was obtained in each case with a mean insertion depth of 420 degrees. Hearing levels continue to be monitored but early results indicate that hearing has been largely preserved in virtually all cases.

Conclusion: With a suitable surgical approach the SlimJ electrode array is straightforward to insert with minimal cochlear trauma and appears capable of supporting hearing preserving CI surgery.

Bilateral electro-acoustic stimulation approach – New findings, Flex28 surgical study

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Objectives: Several studies have shown that with appropriately designed and inserted electrodes, acoustic hearing can be preserved in the majority of subjects during cochlear implant (CI) surgery. The aim of the study was to analyze patients from PDT-EC, PDT-EAS, PDT-ES groups implanted bilaterally and having at Flex 28 Medel electrode with Sonata, Concerto or Synchrony System.

Material and Methods: During recent years we implanted 179 patients with such preoperative conditions. The additional aim of this retrospective study was to apply the HP classification, proposed by the group of HEARRING centers, in assessment of bilateral Partial Deafness Treatment (PDT).

Results and Conclusions: The individual hearing preservation results were stratified into 4 categories: Complete, Partial, Minimal hearing preservation and Loss of Hearing. Additional audiological information was also assessed. Bilateral cases with Partial Deafness Treatment are not as common as other cases, but in PDT-EAS group patients present a lot of benefits, especially after application Flex 28 electrode.

MS 25: Impact of CI on Cognition in Older Adults

Long-term cognitive prognosis of profoundly deaf older adults after hearing rehabilitation using cochlear implant

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Background: Peripheral hearing loss is associated with an increased risk of developing dementia in older adults. However, the impact of hearing rehabilitation on cognitive function remains unknown. The aim of the study was to analyze long-term cognitive status and function following cochlear implantation in profoundly deaf patients (CI).

Design: Prospective observational longitudinal study.

Setting: Ten academic medical centers referent for CI

Participants: Adults aged 65 years and older qualifying as candidates for a CI (n=70)

Measurements: Cognitive tests were administered before CI, and at 1 and >5 years post-CI. Evaluation comprised six tests assessing attention, memory, orientation, executive function, mental flexibility, and fluency. Cognitive status was determined as normal, mild cognitive impairment (MCI) or as dementia. Speech perception in quiet and noise was assessed using disyllabic words and quality of life using the Nijmegen Cochlear Implant Questionnaire.

Results: The mean follow-up was 6.8 years [5.5-8.5]. Speech perception scores and quality of life remained stable between 1- and 7-years post-CI. Before CI, 31 patients (45%) had MCI; only 2 developed dementia during the follow-up, 61% remained stable and 32% returned to normal cognition. Among the 38 patients with normal cognition, none developed dementia during the follow-up although 32% developed MCI.

Conclusion: Among older adults with a profound hearing loss, MCI is highly prevalent. Nevertheless, we observed a low rate of progression to dementia, and cognitive function improved in some patients with MCI at baseline. These results highlight that CI should be strongly proposed for the management of profoundly deaf patients with MCI, and that hearing rehabilitation may be a preventive strategy against cognitive decline in older adults.

Impact of cochlear implantation on cognitive functions of older adults: pilot test results

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Background: A significant relationship between hearing loss and cognitive impairment has been previously reported.

Overall, improvement in speech perception in quiet and quality of life has been observed after cochlear implantation.

However, the impact of hearing loss treatment using cochlear implantation on cognitive functions is yet to be fully elucidated.

Objective: To investigate the impact of cochlear implantation on cognitive and psychological functions of older adults.

Study Design: Prospective patient-control study.

Participants: A total of 39 participants took part in the study: 23 cochlear implant (CI) candidates (M¼69.04_ 12.35 yr) and 16 CI recipients (M¼61.75_15.62 yr). All participants completed an assessment of hearing (puretone thresholds and speech perception in quiet), and a computerised, nonverbal test battery of cognitive function assessment, as well as a depression, anxiety, and stress scale.

Results: Independent-sample t test scores for the changes between 0 and 12 months revealed that CI recipients performed significantly better on measures of simple reaction time, cognitive flexibility, paired-associate learning, working memory, and strategy use ($p<0.05$) compared with implant candidates. Compared with the candidates, recipients also showed significantly lower stress scores ($p<0.05$) after 1 year use of a CI.

Conclusion: Our results indicate that even in participants with a long duration, severe to profound hearing loss, cochlear implantation has some impact on improving a number of cognitive functions. This finding warrants future longitudinal investigations with a large sample size to examine if the observed cognitive enhancement benefits are sustainable.

Accelerated cognitive decline in severely hearing-impaired older adults: cochlear implantation to the rescue?

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Aim of the study: To gain insight into the complexity of cognitive functioning in severely to profoundly hearing-impaired older adults with a Cochlear Implant (CI).

Research questions:

1: How to assess cognition in hearing-impaired individuals?

2: How does cognition evolve in older adults after cochlear implantation?

Methods: The current status of the literature concerning the cognitive outcomes after cochlear implantation in older adults was collected, summarized and critically assessed. It is against this background that a cognitive assessment tool to measure cognition in hearing-impaired individuals was developed: the Repeatable Battery for the Assessment of Neuropsychological Status for Hearing-impaired individuals (RBANS-H). Using the RBANS-H in a prospective longitudinal study design, cognition, speech intelligibility and quality of life were assessed in 20 CI recipients up to one year after implantation.

Results: By providing bimodal (i.e. simultaneous visual and auditory) presentation of the instructions, the RBANS-H was found to be a useful cognitive assessment tool to investigate the cognitive profile of older hearing impaired individuals. Cognitive functioning after one year of CI

usage significantly increased, compared to the preoperative performances. This increase in overall cognition was mainly attributable to significant increases in immediate and delayed memory.

The Development and Validation of a Cognitive Screening Test for the Severely Hearing Impaired: the Hearing Impaired Montreal Cognitive Assessment (HI-MoCA)

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Objectives: To develop a version of the Montreal Cognitive Assessment (MoCA) so it can be administered to severely hearing impaired individuals to assess their scores in two groups of patients (hearing and hearing impaired) who are also cognitively intact over the age of 60.

Study Type: Prospective subject recruitment.

Methods: The MoCA was converted into a time PowerPoint presentation (HI-MoCA) with instructions given visually. Two groups over the age of 60 were recruited. All patients passed screening questionnaires to eliminate those with undiagnosed mild cognitive impairment. The first group had normal hearing. The second group was severely hearing impaired. Group 1 received either the MoCA or HI-MoCA test (T1). Six months later (T2), they were administered the test (MoCA or HI-MoCA) they had not received earlier to determine equivalency. Group 2 received the HI-MoCA at T1 and again at T2 to determine test-retest reliability.

Results: 103 subjects were recruited into Group 1 with a score of 26.66 (HI-MoCA) versus 27.14 (MoCA). This was significant ($p<0.05$) but scoring uses whole numerals and the 0.48 difference was found not clinically significant using post-hoc sensitivity analyses. 49 subjects were recruited into Group 2. They scored 26.18 and 26.49 (HI-MoCA at T1 & T2). No significance was noted ($p>0.05$) with a test-retest coefficient of 0.66.

Conclusions: The HI-MoCA is easy to administer and reliable for screening for cognitive impairment in the severely hearing-impaired. No conversion factor is required in our prospectively tested cohort of cognitively intact subjects.

MS 26: Hearing Outcomes with Electric-Acoustic Stimulation

Long-term speech perception with electric-acoustic stimulation: unilateral and bilateral recipients

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Cochlear Implant systems that combine electric and acoustic stimulation (EAS) in the same ear provide improved speech perception for patients with steeply sloping hearing loss. In a multicenter clinical trial, subjects experienced a significant improvement in speech perception with EAS during the first year of device use as compared to pre-operative results with conventional amplification. At our center, EAS clinical trial subjects were followed annually to assess long-term performance, with some subjects electing to undergo cochlear implantation in the contralateral ear. The objective of the present report is to review the long-term speech perception in unilateral and bilateral EAS recipients.

Methods: Subjects received their cochlear implant as part a clinical trial investigating EAS in cases of bilateral normal-to-moderate low-frequency hearing. After the study endpoint (12 months post-initial EAS activation), subjects were counseled to return annually for audiologic evaluation. Twenty-two subjects had at least 5 years of EAS listening experience. Aided speech perception measures included CNC words in quiet and CUNY sentences in noise. Six subjects elected to undergo cochlear implantation of the contralateral ear. The bilateral subjects were assessed on speech perception measures with each ear independently and in the bilateral condition.

Results: The speech perception performance over time was evaluated using a repeated-measures ANOVA. There was no effect of interval, indicating that speech perception performance was maintained with long-term listening experience. The bilateral EAS recipients experienced a significant improvement in speech perception with the cochlear implant in the contralateral ear as compared to pre-operative performance. Individual data in the bilateral condition will be reviewed.

Conclusion: EAS provides improvement in speech perception that can be maintained with long-term listening experience. Bilateral EAS recipients demonstrate an improvement in speech perception in each ear and in the bilateral condition. Understanding of long-term performance outcomes is needed for the counseling of EAS candidates and as candidacy criteria expands to pediatric candidates.

Programming considerations for electric-acoustic stimulation

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Objective: Electric-Acoustic Stimulation (EAS) is the combination of acoustic and cochlear implant technologies in the same ear. EAS recipients have demonstrated improved speech perception in noise as compared to either modality alone. The present report reviews the programming considerations for EAS recipients as compared to conventional cochlear implant recipients.

Methods: The programming methods of EAS recipients and associated speech perception outcomes were reviewed. Frequency filter assignments, acoustic programming, and electrode array insertion depth were considered. Speech perception was measured acutely and after listening experience with adjusted frequency filter assignments and acoustic setting adjustments.

Results and Conclusions: The programming considerations of EAS recipients differ from that of conventional cochlear implant recipients. EAS recipients may experience additional gains in speech perception with adjusted electric and acoustic settings.

Speech perception in EAS users: impact of reverberation

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Objectives: Speech perception in complex noise conditions (e.g. multiple talker, moving noise sources, reverberation) is challenging for CI users. Previous studies have demonstrated that electric-acoustic stimulation (EAS) either in the same ear or combined with the opposite ear (bimodal stimulation) can improve speech perception compared to electric-only stimulation. In previous studies, speech perception was oftentimes assessed in free-field conditions. The aim of the present study was to assess the impact of reverberation time on speech perception and spatial release from masking (SRM).

Material and Methods:30 CI users (6 bimodal, 10 bilateral, 12 EAS) and a control group of 17 participants with normal hearing (NH) took part in the study. A setup consisting of 128 loudspeakers was used to present the direct sound and the reflections of the speech and noise signals from the appropriate directions with appropriate time delay. Tests were conducted in free-field conditions and for reverberation times of 350 and 500 ms. Speech reception thresholds (SRTs) were measured in S0N0 (speech and noise from 0°) and S0N60 (noise from side) conditions and spatial release from masking (SRM) was calculated.

Results: The NH group had 4.7-6.6 dB lower SRTs than the CI groups. The EAS group was the best performing CI group with 2-3 dB better SRTs than the bimodal CI users. All groups showed increased SRTs with increasing reverberation times. Only the NH group showed SRM in reverberant condition whereas none of the CI groups could benefit from spatial separation of target and interferer in reverberation.

Conclusions: SRTs of CI users considerably deteriorated in listening conditions even with only mild reverberation (e.g. in classrooms with good acoustics) and the ability of SRM completely disappeared. EAS users typically show superior speech perception in modulated noise. As a next step, SRTs in reverberation are measured in modulated noise conditions.

MS 27: Clinical Experiences with Precurved Modiolus Hugging Electrodes

Difficulties in CI surgery with Slim Modiolar electrode: tip foldover – Diagnostics and management

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Introduction: Very delicate perimodiolar electrodes that are associated with several benefits may be more susceptible to tip foldover. Noticing such a complication right after electrode insertion is important, because correct repositioning of the electrode can be achieved in the same surgical sitting.

Materials and methods: The authors report on their 3 tip foldover cases that they experienced out of their 84 cases with Cochlear™ Nucleus® CI532 Slim Modiolar electrode. Two experienced surgeons performed the implantations via the round window following proper specific training. Standard intraoperative tests (electric integrity, neural response telemetry and stapedial reflex threshold tests) and postoperative radiography and/or fluoroscopy were performed on the first postoperative day routinely.

Results: Foldover was not apparent to the surgeon during insertion. Intraoperative telemetry measurements were normal, only the postoperative imaging showed tip foldover. Due to emerging adverse event (constant beeping noise), the implant was replaced by a CI512 implant after 6 months in one case. The electrode array was reloaded into the sheath and reinserted into the scala tympani through an extended round window successfully in two cases. Intraoperative electrophysiological tests and postoperative radiography were normal. The implants work properly.

Conclusion: The electrode should be inserted in parallel with the basal turn of the cochlea. Extended round window approach offers proper angle for insertion even in those cases in which insertion via the round window fails. The

electrode can be reloaded and reinserted without function loss of the device. In order to avoid a revision surgery, the team should ascertain the correct electrode position shortly after insertion. Accessibility to intraoperative imaging diagnostics or development of a widely available intraoperative telemetry test with high sensitivity and specificity to misplaced electrodes are encouraged.

Radiologic investigation of the Nucleus Slim modiolar electrode

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Objectives : To compare the fidelity of computed tomography CT in vivo imaging in characterizing cochlear implant insertion with a Slim Modiolar electrode Nucleus CI 532 and evaluate the incidence of a scalar dislocation and tip rollover.

Study Design: prospective study.

Setting: Tertiary referral center.

Patients: Adult cochlear implant candidates with severe, profound or total hearing loss without inner ear malformations.

Interventions: Cochlear implantation with a Nucleus CI532 cochlear implant using a round window approach.

Patients and method : Twenty-five adult candidates for unilateral cochlear implantation were recruited in one Center. Two surgeons received a training provided by the manufacturer (Cochlear Corp.) with a transparent plastic cochlear model just prior to the first surgery. Feedback on the surgical approach and use of the Slim modiolar electrode was collected via a questionnaire for each case. Computed tomography of the temporal bone was performed postoperatively. The primary aim of this prospective study was to determine the final position of the electrode array in clinical cases as evaluated using a computed tomography. We defined a dislocation as the displacement of the electrode array from the scala tympani to the scala vestibuli across the basilar membrane or the osseous spiral lamina. The images were blinded and evaluated by two expert neuroradiologists.

Results : Twenty five consecutive unilateral cochlear implants Nucleus CI532 in 25 patients (9 children, 16 adults) were analyzed. All arrays had full electrode insertions. One tip rollover (1/25, i.e. 4%) was observed. The subject was subsequently reimplanted successfully with a second CI532. Analysis of surgical videos identified that the mechanism for the tip fold-overs was not related to use errors as outlined in the Physician's Guide for the device. The Slim modiolar electrode was located completely in scala tympani for all subjects

Conclusion : The new Nucleus CI532 cochlear implant with Slim modiolar electrode achieved the goal of consistent scala tympani placement. However, tip rollover occurred in 4 % of our cases and thus, intraoperative imaging is highly recommended.

The Nucleus 532 electrode: intracochlear position and preservation of residual hearing

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In cochlear implantation an optimal position of the electrode array is of great importance, as it may lead to better hearing performance and lower power consumption. Just over a year ago, a new slim modiolus hugging electrode has been introduced, the Cochlear Nucleus 532 (CI532). This electrode design is potentially less traumatic compared to previous types of electrodes because of its' dimensions and a position which is further away from the basilar membrane than a midscalar or lateral wall electrode. Because the electrode is 60% thinner compared to previous Cochlear Nucleus series, folding of the electrode tip might be a risk. The manufacturer has stated that this electrode may be inserted through a round window, extended round window or cochleostomy approach. In this study, we evaluated the electrode position and potential tip fold-over within the cochlea with a per-operative Cone Beam CT-scan.

Participants were 25 adults with a severe to profound hearing loss, unilaterally implanted with the CI532 electrode at the Radboudumc in Nijmegen. All participants were implanted by one surgeon using the cochleostomy technique, drilled anterior – inferior to the round window. Electrode position was per-operatively visualised with a flatpanel rotational CBCT scanner (Siemens Artis Zeego), available in the operation room, facilitating a direct evaluation of the position of the electrode array during surgery. Electrode position variables measured with "Matlab" software, were: electrode scalar position, electrode insertion angle and electrode proximity to the modiolus, defined as wrapping factor. Pre- and postoperative hearing thresholds were evaluated.

The preliminary results of the first 17 participants show; 17 complete surgical insertions, one tip fold over and an average loss of residual hearing of 10,1 dB (range 0 – 28 dB) three-frequency pure tone average (500, 1000 and 2000Hz) and 9,7 dB (0 – 30 dB) of four-frequency pure tone average (500, 1000, 2000 and 4000Hz). A considerable number of electrodes ended up in the scala vestibuli.

An analysis of the electrodes' positions will be presented, and correlated with audiometric outcomes.

Slim, modiolar cochlear implant electrode : Melbourne experience and comparison with the contour perimodiolar electrode

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Objective: To describe the experience and outcomes with the Slim Modiolar cochlear Implant Electrode.

Materials and Methods: Retrospective review of all patients receiving the new CI532 implant. Outcome measures include; pre and postoperative speech perception, operative report details, electrode position as determined by X-ray in all cases and also Cone Beam CT in adults. Comparison was made with prior experience with the Contour perimodiolar CI512 electrode.

Results: 135 CI532 implants were implanted prior to 30/01/2018. 43 in children and 92 in adults. Tip fold over occurred in 6 cases (4.4%). 4 were recognized and corrected intra-operatively, 2 recognized on post op CBCT required revision surgery. Of the 92 adults, CBCT confirmed scala tympani position in all but one case where placement had been into scala vestibuli. There were no translocations from ST to SV. This compares favourably with CI512 translocation rate of 17%. Speech perception outcomes demonstrated good performance with mean pre-op phoneme scores of 21.8 (+/- 15) increasing to 3 month post op of 61.2% (+/- 23). Where 12 month phoneme scores are available, CI532 compared favourably with a matched group of 512 recipients, 79.5 (14) vs 69.4 (17) respectively.

Conclusion: The slim modiolar, CI532 electrode has provided very reliable scala tympani position with a low rate of tip fold over. The speech perception outcomes achieved compare favourably with our experience with previous perimodiolar electrodes.

Comparative study of two different perimodiolar elecrode array cochlear implants. Surgical and audiological otucomes

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Objective: To compare the surgical technique and audiological outcomes of two different perimodiolar electrode array cochlear implants: Nucleus Contour Advance® (CA) and Nucleus 532® (N532).

Design: A total of 79 patients with a history of congenital or acquired hearing loss received a Nucleus cochlear implant, 39 of which received a Contour Advance (CA) electrode and 40 a N532 electrode. Audiological studies were registered before and 3, 6 and 12 months after the surgery. We also documented mean impedances and mean T and C levels.

Results: The type of cochleostomy with the N532 was through a round window (67.5%), while with CA a promontory cochleostomy (92.3%). PTA values before and 12 months after surgery were 90 dB (SD:10.7) and 119 (7.9) respectively for CA group and 98.2 (7.6) and 89.7 (5.6) for N532 group, with a significant statistical difference between groups ($p = 0.040$). On mean disyllabic words recognition, there were not statistical differences ($p = 0.849$) between both groups after 12 months follow-up [70.31% (4.36) for CA group and 69% (5.2) for N532 group]. Mean impedances decreased from 10.38 (0.33) to 6.66 (0.31) for CA group and from 14.01 (0.14) to 8.33 (0.53) for N532 group throughout the 12 months; difference between groups was statistically significant ($p = 0.006$). TC level range during the study period was from 22.29 (2.1) to 30.38 (2.07) for CA group and from 31.20 (1.80) to 38.12 (2.3) for N532 group, significantly lower difference was found between groups during all the study period ($p = 0.012$).

Conclusions: CI model influenced the surgical procedure (cochleostomy). Significant better hearing preservation levels, faster disyllabic words improvement, higher impedances and lower T and C levels are observed with N532 compared to CI CA.

Residual hearing preservation and telemetry measures after cochlear implantation: a comparative study between Nucleus® CI512 and CI532 electrode arrays

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In order to combine the benefits of peri-modiolar stimulation with minimal insertion trauma, a thin, pre-curved electrode (CI532) was recently developed by Cochlear Ltd. (Sidney). This array is held straight prior to insertion by an external polymer reloadable sheath that is removed after full electrode insertion. We studied 67 patients (mean age 42.2 years; mean duration of the hearing loss 19.6 years; mean PTA thresholds at 250-2000 Hz 92.4 dB HL) were implanted with the CI532. Mean duration of surgery was 58.7 minutes. In 61 patients a round window (RW) approach was used. In other 6 cases a cochleostomy was done because of RW ossification. Impedances and ECAP for each electrode are reported. Post-operative PTA threshold in the implanted ear was 102.9 dB HL. Speech recognition level in quiet at 65 dB HL was 44.6 %, after a very short follow up.

To compare the new CI532 with the previous CI512 implant, we studied 21 patients implanted with CI532 and 20 patients with CI512, matching the 2 groups for age, sex and for the cause and the length of the hearing loss.

All subjects received pre-implant and post-implant audiological pure tone audiometry (PTA). The Impedances and ECAP thresholds for each electrode were compared, intraoperatively, one month after surgery and one month after activation. There were no significant differences in the post-operative shift of PTA thresholds and telemetry measurements except for significantly higher electrode impedances for the CI512 than the CI532 array intraoperatively, and there was a significantly higher number of patients with preserved measurable hearing with the CI532.

Our preliminary experience with the new CI532 shows good surgical, electrophysiological and audiological outcomes. In particular, our results are promising regarding the possibility to achieve minimal insertion trauma and good residual hearing preservation with the use of a perimodiolar electrode.

MS 30: The use of AMEI in External and Middle Ear Deformations

Middle ear malformations and the application of AMEI

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Congenital aural atresia (CAA) often causes a remarkable hearing loss, usually conductive or mixed. Conventional atresiaplasty surgery has to be mentioned; it can represent quite a challenge and the functional results can be poor most of the time even when surgery has been technically successful. Moreover, the ear canal surgery represents a high rate of re-stenosis and the complications are very frequent. This means that we are offering to the patients a surgery that is not always satisfactory in terms of functional results, that sometimes requires more than one surgical episode and that may lead to a high rate of complications. Opposite, it has been demonstrated that percutaneous bone conduction hearing aids represent a good solution (BAHA, Ponto), but they can carry several problems, especially on the skin around the abutment. On the other hands the transcutaneous active bone conduction devices like Bonebridge offers excellent results like the previous mentioned without skin problems, but both requires a minimal growth of skull , at least 4 mm to do the surgery. Therefore active middle ear implant (AMEI) constitutes an option in CAA, especially in younger children and patients with mixed hearing loss.

Aim: to determine the audiological benefits of active middle ear implant (Vibrant Soundbridge -VSB-) in patients with CAA.

Materials and methods: 20 patients implanted with VSB were evaluated: 13 patients were unilateral (65 %) and 7 (35%) were bilateral atresia. Different approaches and coupling were used being round window and stapes the most used (90 %)

Results: the mean functional gain obtained for all patients evaluated reached 41 dB at 0.5, 1, 2 and 4 kHz.

Conclusion: VSB represents a good option and solution for patients affected with mixed hearing loss y very young children with CAA.

Active transcutaneous bone conduction implant: middle fossa placement technique in children with bilateral microtia and external auditory canal atresia

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Aim: The aim of this study is to present the middle fossa technique (MFT) as an alternative for patients who cannot undergo traditional surgery for active transcutaneous bone conduction implants (ATBCI) due to their altered anatomy or desire for future aesthetic reconstruction.

Design: A case series descriptive study was designed. The MFT was developed. Pre-operative and post-operative information from 24 patients with external auditory canal atresia (EACA) and implanted with ATBCI was reviewed.

Results: A total of 24 children with bilateral EACA received implants in the middle cranial fossa. Their average age was 12. Of these patients, eight had an associated congenital disorder: Goldenhar Syndrome, Treacher Collins Syndrome or the Pierre Robin Sequence. The average follow-up was at 17 months (ranging from between 2 to 36 months) and there were no major complications. Four patients showed skin erythema at the processor site after turn on, which was solved by lowering the magnet strength. One patient had a scalp hematoma that required puncture drainage. The hearing thresholds went down on average from 66.5 dB to 25.2 dB one month after turn on. Speech recognition improved respectively from 29.4% without and 78.9% with a bone conduction hearing aid to 96.4%.

Conclusions: MFT placement of the ATBCI was proven to be safe and effective and a viable option for treating pediatric patients with EACA who cannot receive implants at the sinodural angle or in the retrosigmoidal position because of their altered anatomy and/or desire for future aesthetic reconstruction.

The use of implantable devices in congenital malformations of the middle and/or external ear

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Introduction: Treating of hearing loss in cases of congenital ear defects is one of the most difficult challenges of modern otology. Patients with malformation of the middle and / or external ear with no possibility of ossculoplasty, extarnal ear canal reconstruction or no anatomical conditions for use of classic hearing aids, are candidates for the use of implantable hearing devices. This work aims to present therapeutic options and effects of treatment of congenital ear defects with the help of various implantable devices.

Material and methods: The analysis includes cases of congenital malformations of the middle and / or external ear, in which hearing implants Baha Attract, Baha Connect, Vibrant Soundbridge and Bonebridge were used. The results of pure tone and speech audiometry in the free field, APHAB questionnaire before and after implantation, were analyzed. In addition, a radiological analysis of the malformation of the middle and external ear structures was performed.

Results: Stable bone conduction thresholds, significant improvement of speech understanding while using the devices after implantation and improvement of communication ease indicate the effectiveness of the applied solutions.

Conclusions: Hearing loss in congenital malformations of external and / or middle ear can be effectively treated with use of many implantable devices. Audiological analysis, radiological evaluation and coexisting factors affect the choice of a particular type of implantable device. The constant development of particular types of devices allows for greater surgical flexibility and their wider use among patients.

The effectiveness of bonebridge in microtia and aural atresia

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Objective: To evaluate the effectiveness of Bonebridge in treating hearing loss in children with bilateral microtia and aural atresia

Material and Methods: Pre- and 5-month-post-operation pure-tone audiometry (PTA), sound-field audiometry with warble tone and speech reception threshold (SRT) of children who received Bonebridge implantation were evaluated. The effectiveness of bone-conduction hearing aids and Bonebridge were compared.

Results: 5 Children (aged 9-17 years old) with bilateral microtia and aural atresia who received Bonebridge implantation were analyzed. In all patients, bone-conduction floating mass transducers were placed at sinodural angle: 1 right ear and 4 left ears. In one patient, only one screw was fixed tightly while the other screw was loose. The Bonebridge was activated for the first time at 3 to 4 weeks after the operation. This applies to every case except for the patient with the only one tightly-fixed screw. The average of pre-operative air-PTA and bone-PTA were 67.33dB (range 60-73.33dB) and 15.33dB (range 6.66-25dB), respectively. There was no statistically significant difference between pre- and post-operative bone-PTA (15.33 VS 18.99dB; p=0.097). Sound-field threshold between unaided and Bonebridge showed statistically significant difference at frequency 0.5,1,2,4,8 Hz (p=0.002, 0.001, 0.003, 0.008, 0.011 respectively). SRT showed statistically significant improvement with Bonebridge (p<0.001). Bone-conduction hearing aids and Bonebridge showed similar hearing level at every frequency. Moreover, there was no statistically significant difference of SRT between bone conduction hearing aids (32dB; SD4.4) and Bonebridge (33dB; SD9). No patients had complication after the operation. Monopolar electro-cauterization was accidentally used during pinna reconstruction in one patient; however, the Bonebridge still worked well.

Conclusions: Bonebridge implantation showed benefits in patients with bilateral microtia and aural atresia. The surgical procedures were simple and have low complications.

The staged functional and aesthetic reconstruction in bilateral microtia-atresia patients with bonebridge

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Objectives: To evaluate the safety and efficacy of auricle reconstruction and active transcutaneous bone-conduction implantation in patients with bilateral microtia-atresia.

Methods: Patients were chosen prospectively, with each being his/her own control. The setting was a tertiary referral center. Twenty-three patients, aged 6–18 years, with bilateral microtia-atresia suffering from bilateral conductive hearing loss were recruited in this study. All had an upper bone conduction threshold limit of 45 dB HL at frequencies of 0.5–4 kHz. Patient satisfaction with the reconstructed auricle was rated as highly satisfactory, basically satisfactory, or unsatisfactory. Mean pure-tone thresholds and speech audiometry test results were compared among patients unaided, with a soft-band Bonebridge, and with an implanted Bonebridge. Subjective satisfaction was analyzed using three questionnaires: the Abbreviated Profile

of Hearing Aid Benefit (APHAB), the Glasgow children's benefit inventory (GCBI), and the International Outcome Inventory for Hearing Aids (IOI-HA).

Results: All patients who underwent auricle reconstruction expressed satisfaction with their appearance. The mean pure-tone thresholds of unaided patients and those with soft-band and implanted Bonebridge were 55.25±3.43 dBHL, 31.37±3.03 dBHL, and 21.25±2.16 dBHL, respectively. The mean speech discrimination scores measured in a sound field with a presentation level of 65 dB SPL under these three conditions were 46.0±0.11%, 80.0±0.09%, and 94.0±0.02%, respectively. Questionnaires demonstrated patients' benefits and satisfaction with this surgery.

Conclusions: The surgical procedure involving auricle reconstruction and Bonebridge implantation was safe and effective for patients with bilateral microtia-atresia, solving both appearance and hearing problems.

MS 31: The Benefits of Bimodal Hearing

Bimodal hearing in asymmetrical hearing loss: prospective study in patients with same CI and HA devices

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Objectives: The present study aimed to evaluate hearing performance in a homogeneous group of adults with asymmetric hearing wearing the same CI device in the poorer ear and adapted to an identical in the ear with residual hearing.

Material and Methods: 10 bimodal patients implanted with Med-El devices, average age 55.3 years and average SNHL duration was 27.3 years, were involved in a A-B-A study (own-study-own HA) where they were adapted to a 15 channel Widex fusion-440 p (study-HA) . Measures included ff-PTA, sentences recognition quiet, SRT50Italian Matrix Test and pitch discrimination at 200 Hz. Speech perception was measured after one months from each HA best fitting condition.

Results: Bimodal stimulation provides better results than any monaural hearing mode, regardless of whether it involves the use of a hearing aid alone or a cochlear implant alone. ff-PTA was on average better for bimodal hearing with study than own HA both at 125-250 (respectively 25 and 31.4 dB and 500-2000 Hz (respectively 22.3 and 28.3). Median values in CI and bimodal condition with own/study HA were: quiet = 51.6, 98.5 and 88.5 % respectively; SRT50 = 12, 9.6 and 5.7 dB SNR respectively. Pitch discrimination median values in CI and own/study HA were 61, 9 and 14 JND respectively. Results obtained with own-HA were not significantly different between pre-post 15-CH assessment.

Discussion: Bimodal hearing has the potential of providing access to bilateral, binaural cues, such as better pitch perception of F0, to overcome some shortcomings in unilateral CI performance. Outcomes and subjective quality perception are influenced by demographical and audiological factors, but also by technical variables such as prescription procedures and number of channels for HA, and coding strategy and channel numbers for CI. These variables should be fully studied in each subject in order to evaluate the effective benefit and support indication to bimodal approach.

Bilateral or bimodal: the influence on primary auditory outcomes in cochlear implanted children

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Due to the current hearing preservation techniques and the success of bilateral cochlear implantation of congenitally deaf children, bimodal children with substantial residual hearing in the non-implanted ear are considered for sequential cochlear implantation. The question is what these bimodal children gain or lose after sequential cochlear implantation. To improve decision making and family counselling regarding bimodal or bilateral stimulation, it is important to measure auditory outcomes in children with substantial residual hearing in the non-implanted ear and compare the results with bilaterally implanted children, both sequentially and simultaneously, and children with normal hearing.

Objective: To compare primary auditory outcomes of sequentially implanted children who had a severe but well aidable hearing loss prior to second implantation with bimodal children with a comparable hearing loss. The primary auditory outcome measures are: perception of interaural level difference (ILD) cues, speech recognition in noise, localization abilities, prosody perception and listening effort. As a reference, the results are compared with the results obtained in simultaneously implanted congenitally deaf children and normal hearing children.

Methods: Perception of ILD-cues is tested with a psychophysical child friendly method in which different sound stimuli are delivered to both devices simultaneously. Speech recognition in noise is tested with a fixed signal to noise ratio in three conditions (S0°N0°, S0°N-90° and S0°N90°). Sound localization abilities are tested in a child friendly setup, by measuring head oriented responses towards perceived sound locations. For prosody perception the just noticeable difference in fundamental frequency of the nonsense-word "baba" is assessed. Listening effort is measured with a word recognition task combined with a semantic categorization task.

Results: Data acquisition will start soon. Preliminary data will be presented.

The benefit of a contralateral hearing aid for speech understanding in noise

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Objectives: The recently launched NaídaTM Link hearing aid (HA) can be wirelessly coupled to a Naída cochlear implant (CI). In this study, we tested the bimodal benefit of this system on speech understanding scores in noise. We applied three different noise reduction algorithms in both the CI and HA to optimize speech understanding. These algorithms included a monaural beamformer (UltraZoom), a binaural beamformer (StereoZoom), and a single-channel noise reduction algorithm algorithm (ClearVoiceTM) that reduced static noise in the speech signal.

Material and methods: Fifteen unilaterally implanted CI users were contralaterally fitted with a Naída Link. Study inclusion criteria included a hearing threshold of ≤80 dB at 125 – 500 Hz, and a CVC phoneme score of ≥80% with their CI in quiet. The Dutch Matrix test was used to determine speech reception thresholds (SRTs). A homogeneous, diffuse noise field was used. We tested SRTs in static noise as well as in a multitalker babble noise (ICRA). Beamforming and single-channel noise-reduction strategies were tested for their effectiveness in improving the SRT.

Results and Conclusions: Adding a contralateral HA improved the SRT significantly by an average of 0.9 dB in static noise, and 1.7 dB in babble using omnidirectional microphone settings. Beamforming improved the average SRT in bimodal listeners by approximately 3.5 dB in static noise and by approximately 4.5 dB in multitalker babble noise, compared to the CI-alone condition. The monaural and binaural beamformers were equally effective. The addition of single-channel noise-reduction had no added benefit, either alone, or in combination with the beamforming strategies.

We conclude that bimodal listening increases speech perception in both static and multitalker babble noise. We have shown that beamformers are an effective means to further improve speech understanding with the Naída Link system.

The benefits of bimodal aiding on extended dimensions of speech perception: intelligibility, listening effort, and sound quality

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The benefits of combining a cochlear implant (CI) and a hearing aid (HA) in opposite ears on speech perception were examined in 15 adult unilateral CI recipients who regularly use a contralateral HA. A within-subjects design was carried out to assess speech intelligibility testing, listening effort ratings, and a sound quality questionnaire for the conditions CI alone, CIHA together, and HA alone when applicable. The primary outcome of bimodal benefit, defined as the difference between CIHA and CI, was statistically significant for speech intelligibility in quiet as well as for intelligibility in noise across tested spatial conditions. A reduction in effort on top of intelligibility at the highest tested signal-to-noise ratio was found. Moreover, the bimodal listening situation was rated to sound more voluminous, less tinny, and less unpleasant than CI alone. Listening effort and sound quality emerged as feasible and relevant measures to demonstrate bimodal benefit across a clinically representative range of bimodal users. These extended dimensions of speech perception can shed more light on the array of benefits provided by complementing a CI with a contralateral HA.

Bimodal speech perception and prosody recognition in CI recipients with asymmetric hearing loss

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Objectives: To evaluate the outcomes of bimodal stimulation by means of cochlear implant (CI) and contralateral hearing aid (HA) in terms of speech perception and suprasegmental cues

Material and Methods: A selected cohort of 12 adults with asymmetric hearing loss (profound in one ear and severe in the other) received an Oticon Neuro ZTI® cochlear implant and a Dynamo® hearing aid, respectively (bimodal stimulation). Patients' age ranged from 16 to 76 years (mean 47.5, SD 24.6).

They were tested before implantation (time T0), at month 3, 6 and 12 after CI activation (time 3M, 6M, 12M respectively), by means of: pure-tone audiogram (PTA) in sound booth and in free-field (FF); speech perception (dysillabic words recognition) in free-field (FF) in quiet and with cocktail party noise masking; the 48 items SSQ questionnaire (Tyler, 2009); the ASSE test.

The performances for all tests were checked in the 3 following conditions: bimodal (CI + HA); CI only; HA only.

Results: As expected on the basis of the pre-op unaided contralateral residual speech perception ability, the speech recognition scores were slightly better in the CI+HA condition than with the CI alone but significantly better than with HA alone in quiet; quite surprisingly though, the differences in noise did not increase significantly in the bimodal condition.

The SSQ for the bimodal stimulation showed a constant improvement over 12 months, especially for the "quality of sound" sub-scale.

The ASSE test returned the most interesting results: the combined (CI+HA) stimulation provided a statistically significant advantage to CI recipients on all the 7 tasks, with a constant improvement over time. The greatest advantages were observed with the JND (just noticeable difference) and the PD (phoneme discrimination) subtests.

MS 32: Future Directions for Rehabilitation: Where are we going?

Association between communication mode before cochlear implantation and longitudinal spoken language development after implantation: the childhood development after cochlear implantation study

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Objectives: Most hearing parents of children born with severe to profound SNHL wish their children to acquire spoken language. A key question parents face after the HL diagnosis is to identify a habilitation program that will facilitate subsequent language development while contemplating treatment options such as CI. We studied this question using longitudinal data from a multi-center study.

Methods: CI candidates (mean age 26m) were classified into 5 subgroups based on parent-reported communication modes in habilitation settings before CI: 1:American Sign Language (ASL) only (N=42); 2:auditory-verbal, auditory-oral, or cued speech only (ORAL, N=63); 3:concurrent ORAL and ASL (N=47); 4:ORAL and non-ASL signs or total communication (N=19); and 5:no reported habilitation or use of gestures only (N=16). Spoken language developments were tracked via the Reynell Developmental Language Scales from baseline to the 3rd post-CI annual follow-up, and the Comprehensive Assessment of Spoken Language annually thereafter. Core composite SS based on age appropriate core tests through the 8th year follow-up were analyzed using mixed-effects regression accounting for age at CI, family income, and cognitive screening, speech perception, and maternal sensitivity scores. Pragmatic language SS between 4- and 8 years post CI were analyzed similarly.

Results : There was significantly different longitudinal trajectories in overall spoken language development between groups (p=0.02). Group 2 gained 1.2 points/year faster (p=0.0037) and group 4 gained 1.5 points/year faster (p=0.0105) in core composite SS over 8 years, while groups 3 and 5 were not statistically different, when compared to the group 1 (ASL only). Although similar between-group patterns were seen in pragmatic language SS 4-8 years post CI, the differences were not statistically significant.

Conclusion: Parental report of enrollment into an ASL only habilitation setting before CI was associated with a slower rate of overall spoken language development post CI in comparison to other communication settings.

MS 33: Utilizing Regenerative Medicine to Optimize the Neural-Cochlear Implant Interface

Adipose-derived stem cells used as an autologous source of neurotrophins in a model of cochlear implantation

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Introduction: In the healthy inner ear hair cells are producing neurotrophic factors that are required for the establishment and maintenance of the innervation. In sensory hearing loss, there is a lack of hair cells and neurotrophic support breaks down. This leads to a degeneration of the auditory nerve that starts in the peripheral dendrites. After cochlear implantation, however, the peripheral dendrite is the optimal stimulation site.

Adipose-derived stem cells (ASCs) are multipotent cells that can be harvested from adult individuals. Similar to

hair cells, ASCs secrete brain-derived neurotrophic factor (BDNF) that is important for auditory neurons.

Methods: Autologous ASCs were isolated from guinea pigs. Then, animals were deafened with local gentamicin application and ASCs were transplanted into one ear. One subgroup was treated with a cochlea implants (CIs) with or without ASC-transplantation. ABR testing and histology was performed.

Results: At 8 weeks there was a significant loss of auditory neurons in all animals that was most pronounced in the basal turn. In the ASC-treated ears the loss of neurons was significantly reduced and the number of peripheral dendrites increased. CI function was better in ASC-treated ears.

Conclusion: Autologous ASC-transplantation into the cochlea improves the survival of neurons in the impaired auditory system and may be useful for an enhance electrode-neuron interface.

MS 34: Lateral Wall Electrodes and Hearing and Structural Preservation

Electrical partial stimulation for patients with normal low-frequency hearing

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Introduction and Objectives: Among patients with partial deafness, there is a group of patients with normal low-frequency hearing. They seem to hear well, but they have difficulty in doing professional work because of the poor speech intelligibility. They have tried to wear a hearing aid but have failed. The remaining method for these patients is cochlear implant and we wanted to study the following.

1. Is Electrical partial stimulation beneficial to hearing rehabilitation in language and music?
2. Hearing preservation results in this group.
3. Is there a subjective satisfaction with the patient after the operation?
4. Proper fitting method for Electrical partial stimulation

Materials and Methods: From August 2012 to July 2017, data were retrospectively analyzed in 10 patients who underwent CI surgery in Soree Ear Clinic. Their hearing was normal at low frequencies and suddenly dropped to high frequencies. The age of the patients was 20-48 years. The mean age was 34.2 years (7 female and 3 male).

We analyzed these data. Speech performance (syllable, sentence, HINT), music evaluation according to time before and after surgery. Hearing preservation rate (Correction by reduction of opposite hearing) Nijmegen cochlear implant questionnaire. (before and after surgery) and fitting results.

Results: Electrical partial stimulation is effective for hearing rehabilitation for these partial deafness patients. Speech performance was improved and music score was maintained. Hearing preservation rate was 80% and residual hearing was well maintained over time. There were two patients with hearing loss, but the two patients were using EAS(hybrid) mode. Nijmegen cochlear implant questionnaire showed improved life quality especially self-esteem. The proper fitting method of Electrical partial stimulation was GAP.

Conclusion: In patients with partial deafness, especially in patients with low frequency hearing, electrical partial stimulation can improve speech performance while preserving low frequency hearing and may be the best way to overcome the limitations of current CI.

Long-term outcome of hearing preservation in cochlear implantation via round window approach

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Objectives: This study was designed to analyze the outcomes of low-frequency hearing preservation (HP) 1 year after cochlear implantation (CI) and to identify the prognostic variables associated with residual low-frequency HP.

Material and Methods : Among the patients who underwent CI at the Ajou University Hospital, 36 patients with preoperative pure tone average ≤ 85dB HL on 125, 250, and 500Hz were included. There were 14 males and 22 females with a mean age of 37.0 years (range: 5.1-84.8). Preoperative pure tone average was 65.3 ± 15.4 dB HL. The straight type electrode was inserted via round window approach in all patients. Sixteen patients received Cochlear devices and 20 patients received MEDEL devices. The change of pure tone average was categorized after CI (1, 6, 12 month): 'completely preserved (≤10dB)', 'partially preserved (between 10dB and 30dB)', and 'failure (> 30dB)'. The preservation of residual hearing was defined in cases of 'completely preserved' or 'partially preserved'.

Results: Of the thirty six patients, the HP was observed in 25 patients (69%) 1 month after CI ('Completely preserved', N=11; 'partially preserved', N=14), 24 patients (67%) 6 months after CI ('Completely preserved', N=11; 'partially preserved', N=13), and 23 patients (64%) 1 year after CI ('Completely preserved', N=13; 'partially preserved', N=10). In multivariate regression, age was the only significant prognostic factor for better HP ($p<.05$) at short term (1 month and 6 months) and long term follow-ups.

Conclusion: HP can be achieved until 1 year after CI and the age is associated with better HP outcomes. Further follow-up for more than 1 year could be needed to investigate the gradual deterioration of HP with time by the natural progression of hearing loss.

Intracochlear shearing force during electrode insertion

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Objective: Electrode insertion into the cochlea lead to significant pressure changes inside the cochlea with assumed effects on the functionality of the cochlea in terms of residual hearing. Fluid dynamics underline the importance of pressure changes close to inserted things.

The aim of the study was to observe the occurence of pressure changes during electrode insertion at the cochlea implant electrode.

Methods: The experiments were performed in different artificial cochlear models. A micro fibre pressure sensor was attached to a cochlear implant electrode at two different positions of the electrode and inserted at different speeds.

Results: We observed significant pressure differences in terms of sensor position and depth of insertion.

Conclusion: In our model experiments intracochlear pressure changes during cochlear implant electrode insertion are influenced by sensor position.

The straight electrode array Flex28 (MED-EL GmbH, Innsbruck, Austria) using a round window insertion guarantees a scala tympani position

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Objectives : To compare the fidelity of computed tomography CT in vivo imaging in characterizing cochlear implant insertion with a straight electrode array FLEX28 of one single Manufacturer (MED-EL GmbH, Innsbruck, Austria) and evaluate the incidence of a scalar dislocation.

Study Design: consecutive case study.

Setting: Tertiary referral center.

Patients: Adult cochlear implant candidates with severe, profound or total hearing loss without inner ear malformations.

Interventions: Cochlear implantation with FLEX28 (MED-EL GmbH, Innsbruck, Austria) using a round window approach.

Main Outcome Measure : postoperative cone beam computed tomography (CBCT) reconstructions of array location with a NewTom 5G (NewTom, Verona, Italy) for the first 70 implants and a high resolution computed tomography (General Electrics), for the last50 implants. For the CBCT, total filtrations were 2 mm and pitch 125 µm, with field of view corresponding to a 12 x 7.5 cm diameter cylinder. Images were reconstructed in 125 µm isometric voxels and obtained in axial, coronal and sagittal oblique planes, using the software provided by NewTom.

We defined a dislocation as the displacement of the electrode array from the scala tympani to the scala vestibuli across the basilar membrane or the osseous spiral lamina. The images were blinded and evaluated by two expert neuroradiologists. A subjective scale was used to determine the usefulness of both imaging technique (CBCT & HRCT).

Results : One hundred twenty cochlear implants (FLEX28) in 113 patients (28-88 years) were analyzed (7 bilateral implantations). All arrays had full electrode insertions. No dislocation and no tip rollover was observed. The last generation of high resolution computed tomography enables an accurate evaluation of the electrode array with limited artifacts.

Conclusion : Choosing a Flex28 electrode array is a guarantee for a scala tympani position

Individual solutions in cochlear implantation: one step closer

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Introduction: In order to quickly estimate an individual's cochlear duct length (CDL), a research software application was developed. Clinicians can use this information to select the cochlear electrode array size that is individually suited to each cochlear implant (CI) recipient.

The objective was to evaluate the usefulness and reliability of the research software application for the estimation of an individual's CDL as a basis for electrode selection.

Methods: Before surgery, the maximum basal turn diameter (value "A") was measured on a coronal section of high-resolution computed tomography (HRCT) of the temporal bone. Based on "A", the research software application calculated the CDL, and the appropriate electrode was chosen for implantation. After implantation, the results of 21 consecutive patients (23 ears) obtained using the research software applications were compared to their postoperative X-ray measurements and to the surgeon's intraoperative notes.

Results: The "A" distance measured on CT scans varied from 7.8mm to 9.7mm with a mean value of 9.14mm; The mean CDL was 34.05mm ± 1.72. Full insertion was achieved in all but 2 cases but there were no contacts of the array outside the cochlea. There was no misplaced

electrode array or electrode fold over detected on imaging. We inserted the electrode mostly through the round window (18/23). For 17 long electrode arrays, the software application suggested an insertion depth of 30.7mm which ultimately was 29.4 mm (average) according to X-ray measurements. For the 5 shorter electrode arrays, the predicted insertion depth was 27.4 mm with a actual depth of 26.6 mm as measured via X-ray. In one case we used an even shorter electrode as suggested by the software.

Conclusion: The results show a good correlation between the preoperatively predicted insertion depths using the software application and postoperatively measured using X-ray.

MS 35: Presentation and Discussion of Consensus Statements for Treatment of Patients with Conductive and Mixed Hearing Loss with Implantable Devices

Presentation and discussion of Consensus Statements for Treatment of Patients with Conductive and Mixed Hearing Loss with Implantable Devices

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Since the mid-eighties, several types of implantable hearing devices have been introduced for patients with conductive and mixed hearing loss (implantable bone-conduction devices and active middle ear implants). If reconstructive surgery is not feasible and fitting of conventional hearing devices is contraindicated, then such devices might be the next option. However, the different types of implantable devices are not equivalents, neither in medical/surgical terms nor in audiological terms, thus, choices have to be made, preferably on the basis of reliable evidence. Vice versa, results from treatments have to be collected and reported in a form that can be used to provide and extend this evidence regarding all factors crucial for success: the proper choice of device/class of device, medical issues, audiological issues and the evaluation of the outcomes.

According to evidence levels, consensus statements are poorly ranked. However, the hierarchic model of evidence levels is under debate because high-level evidence doesn't necessarily lead to the best advice for an individual patient. As nowadays the focus is on personalization of health care, based on the patient's needs, his/her characteristics and personal context, evidence-base practice is changing into context-based practice. During the last years, also a shift is seen from practitioner centered to patient-centered care. Patients should be enabled and encouraged to take an active role in their health care in relationship with the clinicians, and the clinicians should be prepared to help the patient with making a decision. Consensus statements might facilitate this process.

Several stakeholders besides the patient play a role like the clinicians, the companies and the health authorities; therefore, statements are categorized per stakeholder.

During the round table, a second draft of the consensus statements will be presented and discussed with the audience; broad support for such statements is essential.

MS 36: Restoring Vestibular Function: Preliminary Results and Challenges

The vestibular implant input interacts with residual natural function

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Objective: To investigate how "artificial" VI-input is integrated with residual "natural" input by the central vestibular system.

Materials and methods: Five vestibular electrodes in 4 patients with bilateral vestibulopathy implanted with a vestibular implant were available. This involved electrodes with a predominantly horizontal response and electrodes with a predominantly vertical response. Responses to predominantly horizontal residual "natural" input and predominantly horizontal and vertical "artificial" VI-input were separately measured first. Then, inputs were combined in conditions where both would hypothetically collaborate or counteract. Each condition involved 60 cycles of 1Hz sinusoidal stimulation. Gain, asymmetry, phase and angle of eye responses were calculated.

Results: Combining residual "natural" input and "artificial" VI-input resulted in an interaction in which characteristics of the resulting eye movement responses could significantly differ from those observed when responses were measured for each input separately ($p<0.0013$). In the total eye response, inputs with a stronger vector magnitude seemed to have stronger weights than inputs with a lower vector magnitude, in a non-linear combination. "Artificial" VI-input was able to significantly influence and counteract the response to residual "natural" input.

Conclusion: In the acute phase of VI-activation, residual "natural" input and "artificial" VI-input interact to generate eye movement responses in a non-linear fashion. This implies that different stimulation paradigms and more complex signal processing strategies will be required unless the brain is able to optimally combine both sources of information after adaptation during chronic use. Next to this, these findings could pave the way for using the VI as "vestibular pacemaker".

MS 37: Intra-cochlear ECochG in or during CI surgery

Analysis of residual hearing preservation between perimodiolar and antimodiolar electrode arrays with a real-time intracochlear electrocochleograghy system

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Introduction: There is no consensus about which type/ characteristics of a cochlear implant (CI) achieves the best hearing preservation. However CI522 has been described in recent studies as the least traumatic electrode array. Cochlear implant 532 is the thinnest electrode and it could be used in all type of surgical approaches. On the other hand Intracochlear Electrocochleography (ECoG) recording provided larger signal amplitude to obtain data in more complex cases that allows to evaluate the residual hearing during the insertion..

Objective: To determine if a perimodiolar electrode array could be as good as a antimodiolar electrode array for hearing preservation by using an Intracochlear ECOG system.

Material and Methods: 5 patients were implanted with CI532 and 5 patients with CI522. Auditory thresholds obtained by pure tone audiometry (PTA) were measured in all patients. Electrocochleography (ECoG), in an intracochlear way recorder, was performed during the electrode array insertion on frequency 500Hz. We used round window and cochleostomy surgical approaches.

Results: No statistical differences were found comparing results from auditory thresholds in both groups neither for ECoG results. ECoG measurements during and after insertion dynamics of both electrodes showed preservation of the cochlear microphonics in 61.5% of the cases. In 65% of CI 532 cases with preoperative residual hearing, preservation was achieved, (considering good preservation when the hearing loss is less than 15 dB). In all the cases where cochlear microphonics were present after surgery, hearing preservation was also observed in the PTA 3 months later.

Conclusions: Residual hearing preservation is possible with the atraumatic perimodiolar flexible electrode array CI532

Advanced peroperative ECochG and fluoroscopy examination to aid hearing preservation with Flex electrodes

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There is a rising interest in ECochG measurements during cochlear implant (CI) surgery. These measurements might give the surgeon feedback about CI electrode array insertion. ECochG alone does not allow to observe movements of the electrode, while these may be causing trauma to the inner ear structures. This has been examined in our study using peroperative fluoroscopy to monitor the intra-cochlear electrode array movements while simultaneously recording ECochG.

Objectives: The aim of this study is to investigate whether simultaneous ECoG and fluoroscopy imaging can give us information how to minimize the risk factors during electrode array insertion, regarding intra-cochlear trauma.¨

This is prospective and on-going study.

Methods: During insertion of Medel Flex electrode arrays, peroperative fluoroscopy video was conducted to monitor the insertion dynamics visually while performing ECochG. The surgery itself was carried out using a round window approach with structure preservation.

Results: Simultaneous ECochG and fluoroscopy video were obtained. Together they gave interesting insights about possible intra-cochlear trauma while the electrode was moving inside the cochlea.

Conclusion: ECochG is a valuable tool to investigate possible intra-cochlear trauma during the electrode array insertion. Fluoroscopic imaging helps to identify critical moments during insertion, and to interpret the ECochG results obtained during CI surgery.

Correlation between extra- and intracochlear electrocochleography during cochlear implantation

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Objectives: In human cochlear implant (CI) recipients, ECoG has been performed from extra- as well as intracochlear sites. However, further insight is needed to elucidate the implications of changes of ECoG responses during cochlear implantation. The aim of this study was: 1)

to correlate extra- with intracochlear ECoG findings during cochlear implantation, and 2) to correlate changes of ECoG responses with radiological findings.

Material and Methods: ECoG responses to 500, 750, and 1000 Hz tone bursts were recorded. For extracochlear ECoG, a recording electrode was placed on the promontory. For intracochlear ECoG recordings, the most apical contact of the CI electrode array was used as recording electrode. ECoG findings during insertion were correlated with postoperative cone beam CT findings.

Results: Unchanged extracochlear ECoG recordings after full insertion and a steady increase of intracochlear ECoG recordings during insertion was associated with a correct placement of the electrode array in the scala tympani. Radiologically detectable trauma was associated with a decrease of extracochlear responses and an amplitude drop after an initial increase in intracochlear ECoG recordings.

Conclusion: Intracochlear ECoG using the CI electrode itself as recording electrode is a promising method to monitor electrophysiological changes and thereby cochlear trauma during cochlear implantation. Unchanged cochlear function during insertion of the electrode array seems to go along with a steady increase of intracochlear ECoG responses as the recording electrode approaches the generators of the ECoG signal. Cochlear trauma according to radiological findings seems to be associated with a decrease in extra- and intracochlear ECoG recordings during insertion.

Using the Implant Electrode Array For Direct Real-Time Intraoperative Hearing Monitoring For Hearing Preservation During Cochlear Implantation

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Introduction: Hearing preservation has become one of the key elements in cochlear implantation, preservation of the residual hearing in cochlear implantation has dual purpose, firstly to allow the patient to harness the functional benefits of combining the residual acoustic hearing with the electric implant stimulation termed as electric-acoustic or hybrid stimulation, secondly to preserve functional tissue in the inner ear for future regenerative or gene-therapeutic treatment strategies. Several factors affect hearing preservation outcomes after cochlear implant surgery, one crucial element is the actual physical insertion of the implant electrode array into the cochlea, the goal being to make this as atraumatic as possible. Several electrocochleography techniques have been trialled to monitor the cochlear function during the insertion in real-time, currently these techniques are able to provide feedback at certain time points but not in real-time. We investigated a novel technique using the implant electrode array itself to monitor intracochlear potentials during the insertion in order to maximize hearing preservation during cochlear implant surgery

Patient and Methods: Prospective study with 18 patients who had measurable hearing prior implantation. All patients has standard implant asssessments and underwent cochlear implantation using hearing preservation techniques with complete cochlear coverage electrode arrays. Intracochlear microphonics (ICM) were measured at various insertions depths during implant surgery and then at every implant programming/mapping session at 1,3,6 and 12 months post-implantation.The ICM were then compared with the postoperative audiograms.

Results: Intraoperative and postoperative ICM showed a variable correlation with postoperative hearing thresholds, intraoperative ICM were able to measure potentials in socalled audiologic ‚dead regions'. Hearing thresholds remained stable in all patients which was reflected in stable ICM.

Conclusion: Real-time intraoperative ICM monitoring via the implant array is feasible, demonstrating robust correlation with postoperative audiologic hearing thresholds postoperatively. Correlations between intraoperative ICMs and postoperative hearing thresholds are variable, indicating that there are several factors influencing the measurements. Improving ICM measuring speeds in the current software algorithms will allow true real-time instantaneous intraoperative hearing monitoring in the near future.

MS 39: Cochlear Implantation and Tinnitus

Tinnitus suppression in cochlear implant patients using the ReSound Relief™ app

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Objectives: The use of acoustic stimuli to reduce the prominence of tinnitus has been used for decades. Counseling and tinnitus sound therapy options are not currently widespread for cochlear implant (CI) users. The goal of this study was to determine whether tinnitus therapy sounds created for individuals with acoustic hearing may also benefit CI users.

Method: Sounds from the ReSound Relief App were streamed from an iPod to the CI. 16 sounds were selected from the App to be used for the study. 16 participants were asked to rate the overall acceptability of each of the sounds and to write the description of the sound they perceived. 13 participants completed a 5 minute trial where they rated their pre-trial and post-trial tinnitus and the acceptability of the sound. 10 subjects completed a home-trial and were asked to complete online tinnitus questionnaires and rated the effectiveness of sound therapy.

Results: Individual differences were large. Results from the 5 minute trial showed that sounds perceived as rain, music,

and waves were rated the most acceptable. For all of the subjects, the post-trial tinnitus loudness rating was lower than the pre-trial rating, with some subjects experiencing greater difference in their tinnitus loudness than others. At the end of the 2-week home trial, 3 of 10 subjects rated the effectiveness of sound therapy 70% or higher.

Conclusions: The results suggest that the use of tinnitus therapy sounds delivered through a CI can provide relief for some CI users with tinnitus.

MS 40: Applications and Experiences with AMEI

Surgical impact of coupling an active middle ear implant to the short incus process

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Introduction: Since 1996 the active middle-ear implant Vibrant Soundbridge® (VSB) is used to treat mild-to-severe sensorineural hearing losses. The former standard surgical approach for incus vibroplasty included a mastoidectomy and a posterior tympanotomy, crimping the Floating-Mass Transducer (FMT) to the long incus process. The introduction of the short process (SP) coupler allows the attachement of the FMT to the incus body making the procedure of a posterior tympanotomy unnecessary.

The aim of this study was to evaluate the surgical case length and to compare the audiological results of SP coupling with the former standard surgical approach to the long incus process.

Materials and Methods: Patients undergoing an incus vibroplasty between 10/2009 and 02/2016 were included in this cohort study. The patients received an incus vibroplasty with crimping the FMT to the long incus process (former standard application) (n=25) and with the SP coupler (n=17) respectively. The surgical case length as well as the functional audiological outcome was assessed 12 months postoperatively using pure-tone audiometry and speech audiometry.

Results: The surgical case length was significantly shorter in the SP coupler group compared to the standard application (85 ± 29 min vs. 114 ± 50 min) incus vibroplasty. Additionally, patients receiving the SP coupler had an increased speech perception if compared to the standard application (Freiburger monosyllables at 65 dB SPL: 76.1 ± 16.1 % versus 66.2 ± 23.5 %).

Conclusion: The SP coupler leads to a shortened time of surgery and by the less invasive surgery to a reduced risk for facial nerve and chorda tympani. Speech perception is significantly improved by SP coupling compared to classic long incus coupling.

An adaptive feedback canceling algorithm for the cochlear Carina™ hearing system: first clinical results

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Background: An adaptive feedback canceling algorithm was developed for use with the Cochlear Carina™ hearing system and tested in a multicenter trial to determine its effectiveness in reducing feedback, distortion and audible artifacts, and thus to improve sound quality as perceived by recipients.

Patients & Methods: A prospective study was conducted at 3 centers. It comprised two phases with 14 patients total over 31 months. In the first phase, the expansion processing was optimized to reduce potential noise. In the second phase, patients were assigned randomly to two groups: one for which the new adaptive feedback canceler (AFC) replaced the existing fixed feedback canceler (FFC) in the implant processor, and one using the implant with the FFC unchanged.

Results: Subjects were asked to rate their preferences for either feedback canceler. Among study subjects, 93% expressed a preference, and 72% a strong preference, for the AFC over the FFC.

Aided thresholds were similar for both groups across the range of audiometric frequencies.

Word recognition scores were similar for AFC and FFC across presentation levels from 60 to 80 dB SPL. At 55 dB SPL, AFC showed a clinically significant improvement of 20%.

In addition, the introduction of AFC has allowed a sequence of time-consuming positional measurements to be eliminated from the fitting procedure, making the process simpler and easier for clinician and patient.

Conclusion: The AFC appears to be more stable under complex and changing conditions affecting feedback, and is perceived by a large majority of users to be more comfortable and natural-sounding. The AFC is found to have

satisfied its design goals, and will be incorporated in future versions of the Cochlear Carina™ Fitting Software.

Treatment of severe mixed hearing loss with power hearing aids or acoustic implants?

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Objective: Here we investigated if mixed hearing loss patients can be adequately treated with stapes surgery plus conventional hearing aids (HA) and how outcomes compare to acoustic implants.

Methods: To analyze real-world outcomes of stapes surgery, AC and BC hearing thresholds (HTL) from 343 ears were analyzed.

To determine if a state-of-the-art (SOTA) power HA could satisfy the audiological needs of those patients, we calculated required gain (½BC+ABG) and dynamic range (AC+35 dB), and compared with technical specifications of popular SOTA HA, at 500 Hz,1,2,4 kHz.

To validate our prediction of hearing aid fitness, we tested 21 patients (41 ears) with mixed hearing loss after a trial use of a SOTA HA, for speech in quiet and noise. For comparison, a group of 41 Direct Acoustic Cochlear Implant (DACI) recipients with similar audiograms was selected, and the same outcome measures analyzed.

Results: Whether the SOTA HA can satisfy audiological needs (gain or MPO) at all 4 frequencies (group G0) or all but one (G1), speech performance was equal, both in quiet and in noise. When the SOTA HA was insufficient at 2 or more frequencies (group G2), speech performance in quiet was lower, and speech performance in noise was significantly lower than for G0.

Speech performance in noise with the walk-in HA was significantly lower than with the SOTA HA in G0 and G1.

When comparing the outcomes of DACI recipients to the best aided conventional condition (better of walk-in and SOTA HA), speech in quiet with HA was significantly worse than with DACI in group G2, and speech in noise was significantly worse than with DACI in groups G1 and G2.

Conclusion: Conventional power hearing aids cannot meet gain and dynamic range requirements of some severe mixed hearing loss patients, and will not provide sufficient benefit. If the HA is insufficient at only one frequency, speech in noise performance is already affected and a DACI or other acoustic implant is a better solution.

First results of a new coupling device for precise round window coupling of the Vibrant Soundbridge

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Introduction: For more than 20 years the Vibrant Soundbridge (VSB) is successfully used to treat patients. The Floating Mass Trancducer (FMT) can be coupled to different parts of the ossicular chain. Round window coupling, shows favorable results. To place the FMT in front of the round window membrane (RWM) biological as well as artificial materials have been used to improve the vibratory transmission into the cochlea. To overcome the undefined contact forces and standardize the procedure, a special coupler has been designed. The new design allows precise and standardized RWM-coupling and exerts a constant and controllable preload of the FMT to the RWM. Laser Doppler vibration experiments were performed in human temporal bones before first patients were treated.

Methods: By now, n=4 patients have been implanted with a Custom Made Device (CMD) of the new RW coupler at the Hannover Medical School. To assess the audiological outcomes pre- and post- operative hearing thresholds, Freiburg Monosyllables (FBM) 65 dB and the Oldenburg sentence test (OLSA) in noise were performed up to 3 months after first activation.

Results: It could be shown, that the bone conduction thresholds had not been affected by the surgical invention (n=4). Aided thresholds stayed stable between first activation and 3 months (n=2). The speech perception outcomes in quiet were 72% (n=3) at first activation and 90% (n=2) at 3 months in the FBM. Speech in noise outcomes measured with the OLSA were -2.3 dB SNR (n=2) at 3 months.

Conclusion: The new coupler is a reliable and safe method for round window coupling. Precise and standardized placement of the FMT was possible during the surgical intervention. The inner ear function has not been affected and preliminary results show good speech perception outcomes in quiet and noise 3 months postoperatively.

Coupling of active middle ear implants to the short incus process in meatal stenosis

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Classical coupling of the active middle ear implant Vibrant Soundbridge (VSB) to the long process of the incus may be difficult because of a narrow facial recess or ossicular malformation.

14 patients with congenital or aquired stenosis of the external auditory canal were provided with a VSB (VORP 502 or 503) by coupling the floating mass transducer (FMT) to the

short process (SP) of the incus. Subjective and audiological hearing results were analyzed according to pure conductive or combined hearing loss with and without VSB.

The mean functional gain in all patients was 42.1±8.8 dB with a resulting 4-pure-tone-average of 28.6±8.6 dB. The comparison of both groups did not show a significant difference in functional gain. However, there was a tendency for a better postoperative hearing threshold in patients with congenital aural atresia compared to those with acquired meatal stenosis (p=0.053). The overall improvement of monosyllabic words was 61.8 dB without any difference between subjects with congenital and acquired meatal occlusion (p=0.18). Speech understanding in noise improved for 6.8 dB. There was no audiological difference between direct FMT coupling (VORP 502) to the short process compared to the use of the SP coupler system (VORP 503).

FMT coupling to the short incus process is a promising alternative in cases with difficult access to the long process. In normal ossicular anatomy, the SP coupler facilitates the surgical adaptation of the FMT. In cases of ossicular malformation, additional fixation of the coupler using bone cement may be necessary. In patients with a pure conductive hearing loss, coupling of the FMT to the short process audiologically is comparable to the fixation to the long process. Further studies have to show, whether this coupling procedure in individuals with mixed hearing loss will be as beneficial as the attachment to the long process.

MS 41: Experiences with Early Activation of the CI

CI activation within 24 hours postoperatively

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Not every case is considered suitable for early activation within 24 hours. We believe early CI activation can only be done if the following conditions are met: Minimal pain in the post-auricular area, minimal swelling around the receiver site, and minimal disturbance within the cochleae. Commencement of electrical stimulation within 24 hours after the surgery has long been performed in our department on a routine basis. The idea issued from the need to "wake up and sound" for international patients. This study presented the safety and feasibility of the procedure.

Method: 809 subjects with profound hearing impairment were studied. A minimal invasive approach was used for cochlear implantation, with an intention to control wound condition and tissue swelling. Intra/post operative impedanc changes were recorded. Hearing threshold was measured pre- and post-operatively.

Results: Initial switch-on within 24 hours was done in all patients. Good hearing gain was obtained. No major complication occurred. There was no significant difference in hearing post-operatively that was attributable to the early switch-on. The impedance and ECAP were stable. There were no any adverse reactions or complications caused by early activation.

Conclusion:The minimal invasive approach made initial switch-on one day after surgery possible. The strategy of immediate initial switch-on also provided our subjects with nonstop rehabilitation programs peri-operatively, and shortened the duration of uncertainty/worry for patients/families about the functioning of implant. Those benefits were especially important for international patients and those from distant cities of our country. Because of early activation,

there are over 500 patients who have come overseas for CI implantation in our clinic.

Early fitting of the cochlear implant speech processor: how early is too early?

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Objectives: Traditional first-time activation of the cochlear implant (CI) remained the same throughout the years without empirical evidence for the time required after surgery. First activation usually takes place 2-6 weeks after the CI surgery (ASHA, 2015; FDA, 2017).

In our early fitting (EF) studies, we evaluated: the effect of EF on the healing process of the wound, the effect of EF on the evolution of electrical stimulation, the difference between EF vs traditional fitting and how early can we get.

Material and methods: Participants:100 patients fitted on the next day of surgery and 100 patients fitted 3-4 weeks post CI. 9 patient with 11 implants also received same-day fitting following surgery under local anesthesia to evaluate the feasibility of same-day fitting. All implanted with standard MED-EL Concerto.

For comparison, electrode impedance telemetry (EIT), MCL and THR were obtained for both groups of patients: On day of surgery, four weeks post-op, 6 months post-op and 1 year post-op. For same-day fitting, a comparison was made between EIT, MCL and THR during same-day fitting, the next day fitting, one week after and 6-weeks after.

Results:

-A significant difference between early fitting and late fitting for Thresholds was found for E1, E2, E3 and E4 (all $p<0.001$) at 1-year testing

-No statistically significant differences between early fitting and late fitting were found for impedances at all tested intervals.

-No statistically significant differences between early fitting and late fitting were found for MCLs at 1-year testing.

-Statistically significant difference between same-day and second day and between second day and 1 week post-op for THR levels in the apical and basal regions.

Conclusion:

-Next day fitting feasible and has no adverse effects.

-Same day fitting must be followed by next day fitting.

-Early stimulation might hinder fibrosis formation within the cochlea

Early cochlear implant activation using Nucleus fitting software for tablets

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Objectives: The aim of this study is to show that an early cochlear activation (using the Nucleus Fitting Software on a tablet), one day after surgery, does not provide more complications than classic activation and allows to reach NRT (Neural Response Thresholds) levels, collected with the CR220 remote assistant during surgery, in less than a month by letting the patient use the Master Volume Control on his CR230 remote assistant.

Material and Methods: Since September 2016, each adult patient implanted (21 patients) with a CI512 or CI532 cochlear implant received a cochlear implant fitting the very next day after their surgery. This activation was done using the Nucleus Fitting Software for tablets in the patient's hospital room just before they left and went back home. We used NRT datas collected during surgery with the CR220 remote assistant Patients were told to increase Master Volume using their CR230 remote assistant every morning until they reach a comfortable hearing level. Usual post operative control visit, seven days after surgery, allowed to check if any side effects or complications occurred. From then, our fitting protocol was used (first visit 2 weeks after surgery). NRT levels (peroperative) and C-levels (day 1, day 14, day 21 and day 28) were collected on 5 electrodes.

Results and Conclusions: None of our patient presented medical complications due to early magnet presence on the skin. We show that C-levels are at least reaching NRT levels one month after surgery. All our patients were delighted to be able to hear as they were leaving hospital. They also all appreciated to use their CR230 remote assistant that allows soft, daily and progressive increase of their master volume. We propose that early activation could become a standard procedure after a wider evaluation using a multi centric study.

Sound experiences in early activation cochlear implant recipients

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Objectives: Early activation had been discussed several years. Most researches focused on the safety and feasibility of early activation but rare focused on the subjective feedback of sound. The objective of the research was to investigate the changes of sound experiences from 24hrs activation postoperatively to long term mapping.

Materials and Method: 35 CI recipients were included, with random gender, age and implanted sides. Pre-operation auditory abilities and background information were recorded, and specific questions were asked at the end of each programming session.

Results and Conclusions: 6 recipients could understand simple phrases after 4-5 practices within 3 mins after activation. Most recipients described CI's sound just like robot's voice and very noisy. All recipients could adapt the sound and start experiencing the new sound world within 7 days post-activation. Also they could describe sound quality precisely on first programming session. The progress was very helpful to program the sound processor. Recipients' favorite sound quality could be attained in a short time.

The longitudinal change of impedance in very early-activation cochlear implant recipients

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Objectives: CI is generally switch on 3 to 6 weeks after the implantation surgery. More and more surgeons and clinical audiologist have chosen to activate the device earlier based on the safety and efficacy researches approved by many literatures. However, there is still limited data regard to very early activation (post-operative 1 to 3 days). In this study, we routinely switch on the CI within 24 hours post-implantation and we observe the longitudinal change of impedance from intra-operative, switch-on to the follow-up session which represents the status of the electrode and the change of its adjacent environment.

Material and Methods: Patients who had been implanted CI by our team between 2009 and 2018 were enrolled in this study. They were divided into three groups according to the brand of device>Advanced Bionics, Cochlear and MED-EL. All devices were activated within 24 hours post-operatively. The impedance level was measured and compared from intra-operatively, switch-on to the follow-up session.

Results & Conclusion: Total 700 cases were enrolled. Electrode impedances in three groups all show similar trend regardless of their brand>the impedance is lowest in activation session and then gradually increased until 2-4 weeks post-operatively. No adverse events or complications of all subjects were reported post-operatively. This finding is compatible to other early activation literatures. The similar trend of impedance change may imply that very-early activation of CI is feasible and have advantages because patients will have similar recover period but earlier timing of rehabilitation/habilitation.

Electrical stapedius reflex threshold and most comfortable level correlations in early activation cochlear implant adults

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Objectives: The ESRT and MCL correlations had been established. ESRT and MCL was highly correlated. ESRT can be used to predict MCL. But all results were not based on early activation data. The objective of the research was to investigate whether the correlation between ESRT and MCL in early activation CI users is same as before.

Materials and Method: ESRT were collected in operation and post- operatively 24 hours activation session. In activation session, CI users have to use loudness scale to find the MCL values. Comparing which ESRT was highly correlated with first MCL.

Results and Conclusions: 60 users' data was collected. In Medel and AB, the ESRT was highly correlated with firs MCL. But some patients' ESRT were higher than MCL, some patients were not. In Cochlear, all patients' ESRT were higher than MCL. The correlation of ESRT and MCL within middle electrodes (ex: ch 16~ch5) were higher than apical and basal electrodes. In conclusion, the ESRT still can predict MCL in early activation CI users.

Early activation of cochlear implantation in the patients with inner ear malformation

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Background: Cochlear implantation could be successfully performed in the patients with inner ear malformations resulting in significant auditory benefits. On the other hand, the safety and feasibility of early activation of cochlear implantation have been reported in recent years. Nevertheless, there was no reports to address early activation in the patients with inner ear malformation to date. The aim of this report was to evaluate safety and feasibility of early activation in the cochlear implantation patients with inner ear malformation.

Methods: We performed a retrospective review at a single institution. Patients with inner ear malformation who received cochlear implantation were included. Commencement of electrical stimulation within 24 hours after the surgery has been performed in our cochlear implant center.

Result: Among 17 patients (bilateral implantation, n=3) included in this study, inner ear malformation included incomplete partition type II (n=9), incomplete partition type III (n=2), cochlear hypoplasia (n=6), and common cavity (n=3). Initial switch-on within 24 hours was done in all patients. No major complication occurred.

Conclusion: This study revealed that early activation of cochlear implantation was clinically safe and feasible in patients with inner ear malformation. It could fulfill the unmet need for international patients with inner ear malformation who had to depart within days after the surgery due to visa and budget issues.

MS 42: State of the Art of Robotic-assisted CI Surgery

Increase of intracochlear trauma by inserting the electrode array in an inaccurate axis during cochlear implantation

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Objectives: We assessed the intracochlear trauma provoked by inserting an array in an inaccurate axis during cochlear implantation.

Material and methods: Twelve temporal bones were used for insertions. A pre-implantation cone beam CT was performed and there was determined an optimal insertion axis (n=5) or an inaccurate axis (optimal+15°) (n=7). The 3D position of the insertion axis (optimal or inaccurate) was loaded in a software allowing to align an insertion tool by a robot arm (RobOtol, Collin, France) according to an electromagnetic tracking system (FasTrak, Colchester, US). The electrode array EVO 25 (Oticon Medical, Vallauris, France) was loaded on the insertion tool. Once the tool aligned with the insertion axis, the array was inserted in a constant speed (0.25 mm/s). Afterwards, histological analysis was performed in order to assess the intracochlear trauma at the level of each electrode.

Results: An optimal axis allowed to decrease the intracochlear trauma according to the inaccurate axis. Although, the ST axis is the ideal way to insert the array into the cochlea, it has never been accessible from the posterior tympanotomy because of the variability of the facial nerve position.

Despite the use of an optimal axis to insert the array, the angle between the scala tympani (ST) axis and the insertion axis was correlated to the intracochlear trauma (r=-0.65, p=0.02, Spearman Rank correlation).

Conclusion: The relationship between the basal turn of the cochlea and the facial nerve is variable and it can change the angle of approach to the scala tympani. The lower the angle between the insertion axis and the ST axis, the lower the intracochlear trauma during the array insertion.

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Diminution of the intracochlear trauma using a robot-based electrode array insertion technique

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Objective: We compared the intracochlear trauma generated by an optimized insertion technique (optimal axis + constant speed insertion) and a manual insertion technique.

Material and methods: A pre-implantation cone-beam CT was performed in twenty temporal bones. In the case of an optimized insertion, an optimal axis was determined to have a direct access to the round window from the posterior tympanotomy. One prototype array (Oticon Medical, Vallauris, France) was inserted at different lengths (21 or 25 mm). A manual insertion was performed with a microforceps. An optimized insertion involved both a robot arm (RobOtol, Collin, France) controlled by a tracking system (FasTrak, Colchester, US), and a constant speed insertion performed by an insertion tool (0.25 mm/s). Finally, cochleae were removed and a histological analysis performed to assess the intracochlear truma at the level of each electrode.

Results: The depth of insertion was similar using both optimized and manual insertion techniques. An optimized insertion was associated with less intracochlear trauma than a manual insertion (p = 0.02, two-way ANOVA) regardless the length of the inserted array.

Conclusion: The array insertion in an optimal axis and in constant speed performed by a robot system allowed to reduce the intracochlear trauma during the array insertion, compared with a manual insertion technique.

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Technical accuracy of the stereotactic minimally invasive „RoboJig" system for CI surgery

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Introduction: The essential aspect of the CI surgery is the placement of the CI electrode into the cochlea. However, the main part of the conventional surgical procedure is dealing with the approach to the cochlea. Reducing the approach to a slim tunnel, drilled by high accurate surgical instruments based on temporal bone imaging would reduce the vast extent of the conventional surgical approach. We develop currently a mini-stereotactic frame to hit the cochlea by drilling a tunnel in the mastoid through the facial recess, called RoboJig. The success of the system is mainly dependent its accuracy. We investigated how accurate the target point needs to be reached and how accurate the RoboJig system may be under lab conditions.

Methods: Relevant anatomical structures for the CI surgery approach were segmented in eight 3D histological data sets of human temporal bone specimens. Different straight trajectories from the surface of the mastoid passing through the facial recess and entering the cochlea were planned in this virtual environment. A circular region was defined indicating proper places for Cochleostomy

To determine the technical accuracy of the system, 20 RoboJig guiding platforms with different trajectories were fabricated and the position and orientation of an inserted drill guide were measured in lab, using a portable coordinate measuring machine.

Results: On average the suitable target region was 1.56mm ± 0.11 mm in diameter leading to a mean safety margin of 0.28 mm if the cochleostomy has a diameter of 1.0 mm. On the other side, positioning accuracy was 0.11 mm ± 0.04 mm.

Conclusions: Based on planning the surgical root for the straight approach to the cochlea in virtual histological dataset, the RoboJig system seems to be accurate enough for minimally invasive cochlear implantation surgery. However, additional error sources are expected if the drilling is performed in the inhomogeneous bone of the mastoid.

The feasibility of 1 mm keyhole robotic cochlear implantation through the HEARO procedure and its effect on the patient population

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Objectives: The key inclusion criteria for robotic cochlear implantation is the ability to plan a trajectory through the facial recess with sufficient safety margin to the critical structures mainly the Facial nerve. Therefore three main factors of the facial recess size, the drill bit diameter and accuracy/precision of the robotic system defines the patient population that can be covered by the system. In this work the feasibility of reducing the drill bit diameter from 1.8 mm to 1 mm on was investigated.

Methods: Nine formalin fixed temporal bones were used. Preoperative imaging was performed after positioning of 4 fiducials screws (CAScintion AG, Switzerland) using XCAT XL (Xoran Ltd., USA) with 0.1mm reconstruction. Surgical planning was performed using OTOPLANTM software. The target was set at the level of the round window membrane. The trajectory was chosen to reduce the risk of hitting the facial nerve, the chorda tympani and the auditory ossicles, and to align with the centerline of the scala tympani of the basal turn of the cochlea. The Direct Cochlear Access was drilled out using the HEAROTM robotic system with a 1.0mm step drill (CAScination AG, Switzerland). Custom made MED-EL FLEX28 electrode with lead diameter of 0.8mm was inserted through the drilled tunnel. The insertion process was supervised using an endoscope through the posterior tympanomeatal flap. Postoperative imaging was performed to assess the positioning of the electrode array.

Results and conclusions: Implantation through 1 mm diameter Direct Cochlear Access was feasible in all cases. Arrays were inserted in the scala tympani of the basal turn of the cochlea in all cases.

The reduction of the tunnel diameter to 1 mm would expand the indications of robotic assisted cochlear implant surgery, even in small and medium sized facial recesses.

MS 43: Different Approaches to Rehabilitate Older Adults with a CI

A prospective, multi-site us clinical study assessing stimulation rate in older adults with MED-EL cochlear implants

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Objectives: Older adults show benefit in speech understanding and quality of life from cochlear implants (CIs). When an older adult user performs poorly, a common practice is to reduce stimulation rate despite the lack of empirical evidence. The study objective was to investigate lower stimulation rate in older adult CI users. It was hypothesized that decreased stimulation rate will result in significantly improved speech perception performance for older adult MED-EL CI recipients who perform poorly with the higher, default stimulation rate.

Materials and Methods: Thirty-two subjects completed testing at five US sites. All subjects were postlingually-deafened MED-EL CI recipients aged 60 years and older at the time of implantation. Based on 6-month word (CNC) scores, subjects were divided into higher-performing (score ≥50%; n=12) and lower-performing (score <50%; n=20) groups. The lower-performing group was randomized into two groups: default stimulation rate (n=10), or reduced stimulation rate (n=10). Primary analyses were speech perception performance for CNC words at 12-months post-activation, and secondary analyses for AzBio sentences in quiet and +5 SNR noise.

Results and Conclusions: There were no significant differences in speech perception performance between the low-rate and default-rate poorer-performing groups across all speech perception tests. The higher-performing group performed significantly better compared to each of the poorer-performing groups. These results provide high-level evidence that there is no advantage to the common clinical practice of decreasing stimulation rate for poorer-performing older adults. These findings inform important decisions regarding programming the stimulation rate for the older adult cochlear implant patient.

Empowering senior cochlear implant users at home via a tablet-computer application

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Objective: The introduction of connectivity technologies in hearing implants allows new ways to support cochlear implant (CI) users remotely. Some functionalities and services that are traditionally only available in an in-clinic care model, can now also be accessed at home. This study explores the feasibility of a prototype of a tablet computer application in a group of senior experienced CI users at home, evaluating usability and user motivation.

Materials and Methods: Based on user feedback, a tablet computer application (MyHearingApp, MHA) was designed implementing 6 different functionalities: (1) My Hearing tests, (2) My Environment, (3) My Hearing Journey, (4) Tip of the Day, (5) Recipient Portal, and (6) Program use and Events. The clinical evaluation design was a prospective study of the MHA in 16 senior experienced CI users. During 4 weeks, participants could freely explore the functionalities. At the end usability and their motivation for uptake and adherence were measured using questionnaires.

Results: Based on the System Usability Score, a good level of usability was indicated (75.6). The ability to perform hearing tests at home is ranked as the most relevant functionality within the MyHearingApp. According to the Intrinsic Motivation Inventory questionnaire, participants reported high levels of interest and enjoyment, found themselves competent, and did not experience pressure while working with the app.

Conclusions: The user feedback from this small scale study with a research prototype suggests that at least part of the adult CI users are open to take more responsibility for and to become a more active actor in their own hearing care, if only this is facilitated with the right tools. This may speed up the evolution from a clinic-led to a more patient-centered care model, where CI users feel more empowered.

Effect of cochlear implantation on loneliness and social interaction of older adults

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Background: Social isolation and loneliness are considered as contributing factors to the age-associated hearing loss in older adults. This cross sectional study investigated the association between the severity of speech and high frequency ARHL and depression, anxiety and stress in older adults.

Study design: Cross-sectional study of a community-derived sample of adult volunteers.

Methods: A total of 27 cochlear implant recipients (CIR; M = 61.59 + 13.95 years) and 16 implant candidates (CIC; M = 65.06 +8.59 years) were recruited. Both participant groups completed a hearing assessment, De Jong Gierveld Loneliness Scale and Berkman-Syme Social Network Index. CIR completed the assessments at the baseline, post-implant 6 and 12 months and CIC completed the assessments at baseline, 6 and 12 months intervals.

Results: Nonparametric Mann-Whitney U test was carried out to compare the baseline-6 months and baseline-12 months difference in scores for emotional and social loneliness and social support and interaction scores. Results revealed a baseline-12 months significant difference in scores for emotional and total loneliness scores ($P < .05$).

Conclusion: These results suggest that cochlear implantation has a positive impact on loneliness scores of the implant recipients.

Music in the mind: why consider music based training for cognition in elderly adults following cochlear implantation

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Singing has been associated with better physical health such as improved heart rate, immune functions, emotional well-being and social functioning in older adults (Skingley, 2010). Singing for brain health and exposure to musical training are also associated with better working memory performance in elderly adults (Parbery-Clark et al., 2011). Movement and music is pertinent for embodied music cognition, whereby the cognitive processing of music is based on corporeally mediated interaction with music (Picard, 2014).

As music-based interventions have demonstrated a capacity to improve cognitive functioning, the objective of Music in the Mind was to deliver an interactive programme for home use to engage elderly adults, including those with dementia.

Method: Elderly adults using cochlear implants attended a bi-weekly music group for four months. Some adults had early onset dementia. Participants undertook interactive musical exercises from differing musical era, vocal exercises, rhythmic concurrent movements, singing familiar and unfamiliar songs, playing instruments and improvising. The musical memory materials incorporated environmental, historical sound associations within a multi- sensory approach. Materials were provided for home based support. A pre and post session survey was completed by the participants and the carers.

Results: Positive outcomes were recorded in the areas of emotional, social and cognitive benefits. Qualitative and quantitative outcomes demonstrate the potential for elderly adults with cochlear implants to utilise musical memory to sustain and improve cognitive functioning .

Conclusion: Singing for the brain can improve cognitive functioning. Rehabilitation involving singing, movement and playing may enhance mood, orientation and potentially encourage improvements in attention, executive functionating and general cognition; leading to a positive effect on the quality of life for elderly adults, including those with dementia.

Designing rehabilitation for elderly adults for benefits in hearing health, cognition & well-being

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Research indicates cochlear implantation in elderly people can restore aural communication, improve quality of life, reduce symptoms associated with depression and improve global cognitive function. (Monsnier, 2015). The most rapidly growing population receiving cochlear implants are those over age 65. Supporting elderly adults following cochlear implantation requires rehabilitation which focusses not only on restoring hearing, but also general cognitive functions. This work seeks to understand in closer detail the benefits of an online, self-directed aural rehabilitation programme which integrates functional vocabulary and everyday topics. Hierarchical exercises move through closed set to open set, reflecting the synthetic aspects of live voice clinical rehabilitation sessions.

Method: 40 participants aged 65 – 98 years, completed a qualitative survey using a self-reported Likert rating scale outcome measure. A subsequent follow up questionnaire was sent to collect further specific informative information.

Results: Participants reported the online resource supported their communication and self-reported improvement in communication confidence levels. Outcomes documented improved concentration and attention leading to a perception of improved listening ability. The resource also prompted further help-seeking behaviours for some individuals. Results indicated a greater flexibility and ownership of their own self-management.

Discussion: Remote rehabilitation online resources now form part of standard clinical practice for CI programmes. This type of visual and auditory program may increase optimal training opportunities for elderly adults; improving not only their aural abilities but importantly cognitive functioning. This was an important first step for informing future theory-driven developments within this online rehabilitation intervention, which may help to prevent a higher level of cognitive decline in elderly adults with hearing loss.

MS 44: Brain Plasticity and Imaging in CI

Prediction of long-term speech outcome in prelingual deaf subjects after CI using resting-state PET

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There are numerous patient factors affecting the outcome of cochlear implantation (CI). However, preoperative functional status of the cerebral cortex has only been investigated in small numbers of patients. Hence, the current study was performed to reveal functional neuroimaging signatures of speech outcome after CI in prelingually deaf patients using resting-state FDG-PET big-data based machine learning approach and to suggest a outcome prediction model based on cortical predictors of CI outcome. A total of 111 prelingually deaf children underwent pre-CI resting-state FDG-PET. This FDG-PET was used to predict post-CI 3 year speech outcome with regard to open set word and sentence test under auditory-only (A- only) and audiovisual (AV) conditions. FDG-PET data was preprocessed with MarsBaR toolbox for region of interest (ROI) analysis, and 90 cerebral cortical ROIs were used for the analysis. For statistical analysis, LASSO (Least Absolute Shrinkage and Selection Operator) regression analysis using average glucose metabolism of 90 ROIs with regard to post-CI 3 year open set word and sentence scores. In prelingually deaf CI users, activations of the suprerior temporal gyrus, supramarginal gyrus, and inferior frontal gyrus were predictors of higher post-CI 3 year speech outcome under the A-only condition. Meanwhile, under A-V condition, an additional activation of the anterior cingulate gyrus was necessary to show better speech outcome. In prelingually deaf CI users, activations of the ventral attention network and prefrontal top-down modulator are important to better process language under the A-only condition. Under A-V condition, an additional activation of the salience network is necessary to better understand multimodal information. Taken together, FDG-PET-based machine learning using LASSO could predict CI outcome in prelingually deaf subjects, functional neuroimaging-based outcome prediction may be of help for precision medicine in CI subjects.

Cortical plasticity following cochlear implantation as revealed by functional near infrared spectroscopy

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Congenitally-deaf children typically receive their cochlear implant (CI) several years before they can complete behavioural speech tests; during this time, clinicians lack information on which to allocate rehabilitation resources or programme devices. Since speech outcomes vary considerably between children, our work aims to predict and monitor CI outcome based on cortical plasticity revealed using functional near-infrared spectroscopy (fNIRS). In deaf adults, we show that cortical reorganisation before implantation predicts clinical outcome. In normally-hearing adults, we show that fNIRS responses correlate with speech intelligibility and listening effort; our paediatric testing is ongoing. We feel fNIRS can help predict and optimise CI benefit.

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Single-sided and binaural deafness affects spatial representation differently

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Objectives: Early single-sided deafness leads to a reorganization of aural preference (Kral et al., 2013, Brain; Kral et al., 2013, Front Syst Neurosci) and representation of interaural time differences (ITDs) (Tillein et al., 2010; 2016, Cereb Cortex). Here we additionally analyzed sensitivity to interaural level differences (ILD) in the auditory cortex in adult normal hearing cats (HCs), congenitally deaf cats (CDCs) born deaf on both ears, and cats born with unilateral deafness but normal hearing on the other ear (uCDCs).

Results and Conclusions: In CDCs the monaural response thresholds, dynamic ranges and spontaneous activity were significantly reduced compared to HCs. There were fewer excitatory-excitatory (EE) responses and more 0E responses, but fewer binaural facilitation in CDCs. The highest spontaneous firing rate was found in uCDCs, followed by HCs and CDCs. uCDCs showed weaker responses to the deaf ear compared to the hearing ear. The monaural and binaural responsiveness depended on the relation of the recorded cortex and the hearing ear in uCDCs. The cortex ipsilateral to the hearing ear reorganized extensively, with more EE and less E0 responses. The cortex contralateral to the hearing ear demonstrated more E0 responses and more suppressive interactions. Facilitatory binaural interactions were similarly reduced in CDCs and uCDCs. Similar to ITDs, also ILD sensitive units were extensively affected in uCDCs. In total, unilateral deafness prevented nonspecific deficits in responsiveness, but reorganized the hemispheres differently, with more extensive reorganizations at the cortex ipsilateral to the hearing ear. Finally, binaural interactions were extensively reduced in unilateral deafness. These results demonstrate significant loss of sensitivity to binaural (timing and level) cues following single-sided deafness and a hemisphere-specific reorganization as a consequence of single-sided deafness.

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MS 45: Measuring the Cochlear Duct Length

Cone beam CT for perioperative imaging in hearing preservation cochlear implantation – A human cadaveric study

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Objectives: Our primary aim was validating cone beam computed tomography (CBCT) for use in cochlear metrics, by comparing it against microcomputed CT (uCT). Our secondary aim explored the feasibility of using CBCT to measure electrode insertion depth, and the relationship between outer wall cochlear duct length and insertion depth for 3 electrodes of different lengths.

Study design: Human cadaveric temporal bone study

Setting: Tertiary academic centre

Interventions: 10 temporal bones were subjected to the standard facial recess approach and imaged by CBCT followed by uCT. Measurements were performed on a three-dimensional reconstructed model of the cochlea. Next, sequential insertion of 3 electrodes (Med-El Flex24, 28 and 31) was performed in 5 bones and these were imaged by CBCT.

Main outcome measures: Concordance between both modalities for measurement of the diameter of the basal turn (A-value) and outer wall cochlear duct length at various intervals from the round window to 2 complete turns. The secondary outcome measure was the relationship between electrode insertion depth and outer wall duct length.

Results: There was good concordance between both modalities for A-value and outer wall cochlear duct length,

360° and 720° respectively (r=0.85, p<0.01 and r=0.79, p<0.01). The Flex24 electrode displayed consistent insertion depth across different bones.

Conclusions: CBCT reliably performs cochlear metrics and measures electrode insertion depth. The low radiation dose, fast acquisition time, diminished metallic artifacts and portability of CBCT make it worthwhile for further studies to explore its utility in neurotologic surgery.

Variations in cochlear duct shape revealed on clinical CT images with an automatic tracing method

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Cochlear size and morphology vary greatly and may influence the course of a cochlear implant electrode array during insertion and its final intra-cochlear position. Detailed insight into these variations is valuable for characterizing each cochlea and offers the opportunity to study possible correlations with surgical or speech perception outcomes. This study presents an automatic tracing method to assess individual cochlear duct shapes from clinical CT images. On pre-operative CT scans of 479 inner ears the cochlear walls were discriminated by interpolating voxel intensities along radial and perpendicular lines within multiplanar reconstructions at 1 degree intervals from the round window. In all 479 cochleas, the outer wall could be traced automatically up to 720 degrees. The inner wall and floor of the scala tympani in 192 cochleas. The shape of the cochlear walls were modelled using a logarithmic spiral function including an offset value. The vertical trajectories of the scala tympani exhibited a non-monotonous spiral slope with specific regions at risk for CI-related insertion trauma, and three slope categories could be distinguished. This presented automatic tracing method allows the detailed description of cochlear morphology and can be used for both individual and large cohort evaluation of cochlear implant patients.

Temporal bone model for the study of insertion-related damage. Comparison of Cone Beam CT in implanted patients *vs* cadaveric specimens

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Cochlear implant insertion should be as less traumatic as possible in order to reduce trauma to the cochlear sensory structures. We recently demonstrated that the force applied during the array insertion and the axis of insertion are correlated to the insertion-related damage in temporal bones. Aim of this study is to validate the use of the cadaveric temporal bone as model for studying the insertion related trauma.

Twelve freshly frozen cadaveric temporal bones were implanted with a long straight electrodes array (Flex 28®, MedEl) through an extended round window insertion with real-time measurement of the insertion forces. Eight adult patients (9 ears) were implanted with the same electrodes array and the same surgical technique. The postinsertion cone beam CT scan (CBCT) images and the histologic findings in temporal bones specimens were compared with postoperative CBCT of the implanted patients to determine if the insertion related trauma could be reliably assessed with CBCT and if the intracochlear damage was similar in the two groups. An oto-radiologist and two otologists examined the images and assessed the electrodes position. The temporal bone specimens underwent histological analysis for confirm the exact position.

Results: In temporal bones an atraumatic insertion occurred in six cochleae, a translocation in five cochleae and a basilar membrane rupture in one cochlea. The translocation always occurred in the 150- to 180-degree region. A good concordance was found between the histological results and the CBCT evaluation for the electrodes position identification in the basal turn, while lower agreement (Cohen's k 0.31) was found in the identification of the apical electrode position. In the patient group, for basal electrodes all observers agreed for scala tympani position except for 1 evaluation, while a discrepancy in 3 patients for the second turn and apical electrodes assessment were found. After the consensus the observers agreed that among patients only two translocations occurred both in the second turn.

In conclusion the CBCT was confirmed to be a reliable imaging technique for the identification of scalar translocation even for lateral wall flexible arrays in adult implanted patients. The radiological translocation rate in patients was significantly lower than our findings in temporal bone. Nevertheless, we believe that the present temporal bone model allowed the identification of the area at risk

for trauma and translocation that correspond approximately to the first point of contact of the array with the lateral wall of the cochlea, and allowed to quantify the forces responsible for a trauma.

Retrospective Validation of Cochlear Duct Length and Electrode Insertion Depth Measures on Clinical CT Scans Using New Planning Software

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Background Up until today, no clinically oriented three-dimensional reconstruction models of the cochlea are available. For this reason, statistical equations were previously applied to two-dimensional computed tomography (CT) images to estimate the cochlear duct length for appropriate electrode selection prior to cochlear implantation. Moreover, postoperative estimation of insertion angle of each electrode, needed for optimal frequency-place matched fitting, is often not available.

Aim of the study The threefold aim of the retrospective study was to investigate the clinical applicability of a new three-dimensional planning software (1) to obtain an optimal cochlear view prior to implantation to estimate the two turn length (2TL) in order to predict and select the optimal electrode length, (2) to visualize the actual postoperative electrode angular depth, and (3) to investigate the deviation between the preoperatively predicted electrode angular depth and the postoperatively measured actual electrode angular depth.

Methods Retrospective CT data are imported into an experimental planning software OTOPLAN. Using preoperative CT images, optimal three-dimensional cochlear views are pursued and 2TL are estimated. Using postoperative CT images, the electrode contacts are identified and based on this identification, the actual insertion angle is calculated. Differences between the predicted insertion angle and the actual insertion angle are registered.

Results Good correlations were obtained. Detaile data will be provided and discussed.

Conclusion The new planning software fulfills the needs for a quick patient-specific three-dimensional reconstruction and easily visualize each patient's unique anatomy. Postoperative reconstructions can be used to accurately determine the electrode insertion angles.

Cochlear Modelling and Anatomy

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The human inner ear has an intricate spiral shape often compared to shells of mollusks, particularly to the nautilus shell. It has inspired many functional hearing theories. The reasons for this complex geometry remain unresolved. We digitized 138 human cochleae at microscopic resolution and observed an astonishing interindividual variability in the shape. A 3D analytical cochlear model was developed that fits the analyzed data with high precision. The cochlear geometry neither matched a proposed function, namely sound focusing similar to a whispering gallery, nor did it have the form of a nautilus. Instead, the innate cochlear blueprint and its actual ontogenetic variants were determined by spatial constraints and resulted from an efficient packing of the cochlear duct within the petrous bone. The analytical model predicts well the individual 3D cochlear geometry from few clinical measures and represents a clinical tool for an individualized approach to neurosensory restoration with cochlear implants.

MS 46: Postlingual CI Auditory Outcome

Retrospective and cross-sectional analysis on the residual hearing of recipients of the nucleus contour using a cochleostomy approach and the Nucleus CI422/522 using the round window approach

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Introduction and aim: With the expansion of the criteria for cochlear implantation (CI), preservation of residual hearing (HP, hearing preservation) becomes more important. At our clinics patients with significant residual hearing are implanted with a Nucleus CI422/522 cochlear implant using a round window approach (RW/CI422/522 group). The aim of this study is to evaluate the degree of HP with this intervention. As a reference, a group of patients is evaluated with less, but still measurable residual hearing and implanted with a Nucleus Contour Advance electrode (C/CA group) using a cochleostomy approach.

Material and methods: A retrospective and cross-sectional analysis was conducted on the residual hearing of the C/CA group (N=128) and of the RW/CI422/522 group (N=49) at the Radboudumc Nijmegen or the Ghent University Hospital. The pure-tone average (PTA) of 250, 500,

and 1000 Hz was measured preoperatively, at first fitting and one year or more postoperatively. Loss of residual hearing was tested with a multilevel linear regression analysis. Systemically applied corticosteroids was only included as a covariate for the C/CA group, since all patients of the RW/CI422/522 group received corticosteroids.

Results: A significant increase in PTA in both groups was seen at first fitting postoperatively compared to preoperatively (C/CA group: difference of 17.9 dB, RW/CI422/522 group: difference of 19.7 dB), p=0.000. The residual hearing thresholds increased even further for both groups between first fitting and measured at one year postoperatively (C/CA group: difference of 2.7 dB, RW/CI422/522 group: difference of 7.5 dB), which was statistically significant for the RW/CI422/522 group (p=0.002). No significant effect of corticosteroids was seen on the PTA (p=0.448).

Conclusion: Hearing preservation outcomes decline over time in patients who receive a Nucleus Contour Advance electrode using a cochleostomy procedure and in patients who receive a Nucleus CI422/522 electrode using a round window approach.

The impact of non-auditory cues on word recognition by adult CI users in spectrally complex listening situations

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Objective: Cochlear implants (CIs) convey primarily the temporal envelope and eliminate fine structure that aids perception of spectrally complex auditory sounds, such as musical pitch, speech prosody and speech reception in noise. CI users have poorer perception of these sounds, but some may benefit from use of non-auditory cues. This study compared the effectiveness of 2 non-auditory cues and examined the impact of user characteristics and device type on word recognition during spectrally complex listening.

Materials and Methods: We tested 63 adults using long electrode CIs (LE) or electric plus acoustic stimulation (EAS). Spectrally complex test items were sung versions of sentences from the Connected Sentences Test against background accompaniment at +2 SNR. Items were initially presented in Auditory Only (AO) and then repeated in 3 conditions: Auditory Only (AO), Auditory + Context (AC), or Auditory + Visual (AV) (lipreading). Testing measured change in word recognition from the first to second attempt. Analyses consisted of a mixed effects model. Covariates in the model were CI type (LE, EAS), months of CI use, age, lipreading score, residual hearing, attempt, and test condition.

Results: There was a significant interaction between test condition and test attempt, $F(2, 39) = 56.7$, $p < .0001$. The main effect for attempt, $F(1, 39) = 331.0$, $p < .0001$, indicates a significant practice effect; more words were recognized on second attempt. However, the increase from attempt 1 to 2 was significantly larger for the AV condition than AO or AC conditions, $F(2, 39) = 90.4$, $p < .0001$. The only statistically significant covariate (.05) was months of CI use; increased use corresponded with greater word recognition.

Conclusion: Some non-auditory cues may be more beneficial than others. CI users should be counselled in use of the most effective cues in spectrally complex listening situations.

Multivariate analysis on auditory outcomes of adults cochlear implanted patients with a straight electrode: role of intracochlear electrodes position, patient's age and preoperative hearing

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Objective: To analyze the influence of the intracochlear position of a straight electrodes array and patient's specific factors (age, pre-op audiological features) on speech perception score and quality of life at 6 months and 1 year in a group of adult implanted patients.

Study Design: Twenty-six patients, mean age 56 years [range 28-81], implanted with a straight electrode (CI 422, Cochlear) were included (28 ears). Auditory speech scores in quiet (dissyllabic words) were tested at 6 and 12 months after activation. Tests in noise were performed at 12 months with an adaptive test (Matrix) aiming the SRT 50%. The Abbreviated Profile of Hearing Aid Benefit inventory (APHAB) was also evaluated at 6 and 12 months after the activation. A postoperative cone beam CT scan evaluated the following insertion parameters: Electrode-modiolus distance for the electrodes at 180° and 360°, the angle of insertion and the electrode array scalar translocation.

Results: Stable results were observed in speech perception score (words) between 6 and 12 months postoperatively, whereas the phoneme identification improved (+9.9 ± 5.4%, $p<0.05$, paired t–test). The APHAB score decreased (i.e. decrease of the impact of hearing impairment on the quality of life) after the surgery (all the subscales except for the aversiveness, $p<0.05$, paired t –test). 27/28 electrodes array were fully inserted (mean angle 404° ± 38). A scala vestibuli positioning of the electrodes array was observed in 6 ears (20%); one patient had an intracochlear

schwannoma in the second turn on the scala tympani, a second patient has a total ossification of the scala tympani, 4 arrays translocated from the tympanic to the vestibular ramp without any known reason. Multivariate analysis models showed both at 6 and 12 months postimplantation that age and duration of profound deafness (without interaction) explained around 30% of the evolution of hearing performance (phonemes and words at 12 months, adjusted R^2=30.03, p=0.011 and adjusted R^2=36.9, p-value=0.004 respectively). No correlation between speech perception scores and the electrodes position parameters were found.

In conclusion the straight electrodes array CI422 had in this study a relatively small translocation rate. The smaller age of the patient and shorter duration of profound hearing loss were correlated to better hearing performance without influence of intracochlear electrodes position or traslocation.

Long-term outcomes of electro-acoustic stimulation cochlear implants: a single United Kingdom centre experience

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Objective: To evaluate long-term outcomes of electro-acoustic stimulation (EAS) cochlear implants

Design: A retrospective case note review

Setting: A tertiary hearing implant centre

Participants: All adult patients undergoing EAS cochlear implantation between 2003 and 2016 were identified from the departmental cochlear implant database.

Main outcome measures: Outcome measures included pre- and post-operative pure tone thresholds (250Hz, 500Hz, 750Hz and 1kHz), speech perception scores (Bamford-Kowal- Bench (BKB) sentence testing, Arthur Boothroyd (AB) words and the mode of stimulation (EAS vs fully electrical).

Results: 38 patients were implanted unilaterally using hearing preservation surgical techniques and with an EAS intent. The mean duration of follow-up was 5.1 years (range 3 months to 13 years). Eight patients (21.1%) experienced a complete loss of all residual hearing in the immediate or early post-operative period (within four weeks of surgery) and required a fully electrical switch-on. The other 30 patients (78.9%) had sufficient hearing preservation to enable EAS at least initially. All 38 patients had improvement in their speech perception scores post-implantation. Of the 30 patients who started with EAS, ten patients (26.3% of total) had progressive deterioration of residual hearing over a period of 3 months to 7 years and required a switch-over from EAS to fully electrical stimulation. In eight out of these 10 patients, the implant performance was maintained. In the other two patients, some deterioration in their implant performance was observed following the change in stimulation modality, but their speech perception scores with fully electrical stimulation were still better than the pre-CI scores.

Conclusion: In our cohort, patients continue to benefit from implantation even when the residual hearing was lost and fully electrical stimulation was required. In cases of late hearing loss necessitating a switch-over from EAS to fully electrical stimulation, the implant performance was successfully maintained in the majority of patients even after the change in stimulation modality. When considering hearing rehabilitation options in individuals who still have significant residual hearing that could be lost through cochlear implantation, it is important to be able to provide patients with as accurate, realistic and comprehensible information as possible regarding their prognosis.

Current global programming techniques and effects

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Objectives: Cochlear implant performance is dependent upon several factors including, but not limited to, patient demographics, surgical issues, programming and rehabilitation. A global survey of professionals involved in cochlear implant programming conducted several years ago found a lack of programming standardization across cochlear implant centers which appeared to affect patient outcomes across the centers completing the survey.

Materials and Methods: Since devices have changed over the years, we sought to conduct an updated survey to evaluate current global cochlear implant programming practices in adults. Data captured in this updated global sample include demographic data including preoperative, surgical, performance outcomes and current programming methodology for all devices. Details regarding specific programming parameters for all devices will be summarized.

Results and Conclusions: While statistical analyses are planned, preliminary data show a similar pattern to the previous study (Vaerenberg et al, 2014) revealing varying programming methods used both across continents and across centers. By in large, programming methods did not vary substantially from those reported previously despite advances in technology. We will report the results, compare them to the previous study, and outline similarities and differences between centers and attempt to define various methods applicable for different populations and devices in order to maximize performance. Additionally, since more implant recipients appear to be receiving services remotely or outside of the implanting center, we will attempt to evaluate the impact of these issues. The effects of these various factors will be examined with the intent of sharing this information across centers and suggesting possible best practices.

Instructional Courses

How I do it: the Fundamentals of the AMEI implants Bone Bridge and Vibrant Sound Bridge

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The criteria for treatment of patients with a Vibrant Soundbridge (VSB) have been vastly extended to care for patients with conductive as well as mixed hearing loss. Although patients undergoing appropriate reconstructive middle ear surgery, hearing restoration sometimes remains inadequate. These patients with unsuccessful conventional hearing rehabilitation and a variety of middle ear conditions are possible candidates for an active middle ear implant with floating mass transducer (FMT) technology.

A minimum of 17 different positions and approaches for cochlea stimulation by this active middle ear implant have been described. The aim of this lecture is to discuss the clinical impact of this diversity of stimulation sites in clinical practice as well as experience from experimental data obtained in temporal bones.

Surgical techniques have changed over time with focus now on standardized and reproducible coupling of the FMT. Experimental and long term clinical data show remarkable aspects for the therapeutic margin in mechanical stimulation of the cochlea.

CI fitting with FOX artificial intelligence

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FOX is the first Artificial Intelligence driven application to assist the audiologist in programming cochlear implants. The second generation (FOX 2G) runs on probabilistic A.I. algorithms and has been rolled out in a number of CI centres in the USA for a field trial.

Like a car navigation system, FOX analyses the current state of the implanted ear and the electrical behaviour of the current MAP. It then calculates millions of alternative MAPs and for each such theoretical MAP, it calculates the predicted effect on the audiological outcome. The MAP with the highest probability to improve the outcome most, is then presented by FOX as new MAP. FOX shares with the audiologist the outcome predictions and the expected benefit. The audiologist then decides to either accept or to overrule FOX's recommendation.

In addition, the cloud-based FOX knowledge base is subject to machine learning algorithms. This learning capacity is an inherent feature of FOX 2G. It can be demonstrated that FOX becomes better over time in target-driven CI fitting.

In this course, the underlying concept of target-driven, computer-assisted CI fitting will be developed. The working principles of FOX will be demonstrated and the impact on outcome and on the follow-up of CI recipients will be shown.

Programming cochlear implant. Manual fitting & artificial intelligence fitting

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Introduction and aim: Currently, the fitting of cochlear implants (CI) is carried out by clinicians, including audiologists, speech therapists and physicians. The variability in the training background of those who program CI leads to very disparate programming.

Several parameters can be changed in CI fitting to improve the cortical perception of the electric field created from an acoustic sound through the MAP: the dynamics of the microphone, the compressions and the frequency at which electrical stimulations and acoustic analysis can be performed by the voice processor, among others.

In order to facilitate the CI programming through this wide spectrum of parameters, an application based on artificial intelligence has been developed by the Eargroup (Antwerp), named „Fitting to Outcome eXpert" (FOX).

To understand whether FOX improves the functional results obtained with a CI and the speed of adaptation, and whether, in patients with limited CI results, FOX improves the fitting and the quality of life hearing.

To this end, we compared functional results and the time required for programming.

Material and methods: We will compare two methods of programming cochlear implants. The manual programming method (the audiologist looks for the level of electrical stimulation producing an effective and comfortable hearing perception at each electrode) versus the programming with FOX.

We also will compare the auditory results (pure tone audiometry, speech audiometry, loudness scalings) over time with both methods.

Results: Using the classical manual fitting, only few parameters are modified with time. Only T and M/C levels are statistically modified. In Cochlear CI only the C levels increase with time ($p<0.05$). T- and C-SPL are sometimes modified, some electrodes (1 to 5) are deactivated but these modifications remain not statistically significant for all the studied population.

HTA scores continue to improve after 12 months of CI experience. ICA results show large disparities in the population and remain limited in some subjects.

We present our first results (parameters and auditory) on some patients with fox fitting.

Conclusion: Due to the complexity and unclear interaction of the various fitting parameters, they are not all frequently modified with time. Their adaptations remain limited even if the auditory outcomes are not optimal in all the subjects. Programming a cochlear implant is a „challenge" because various factors are playing a role in the hearing performance. FOX is one useful tool to help audiologists in fitting CI.

Focus Sessions

FS 30: CI in Syndromic and Complex Severe Hearing loss

Results of cochlear implantation according to the preoperative social maturity score in patients with syndromes or disabilities

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Background and Objectives: Intellectual ability is a crucial factor in the outcome of a cochlear implant, and Social maturity score (SMS) is an indirect predictor of intellectual capacity. The purpose of this study was to investigate the effect of SMS on cochlear implant and clinical significance in children with syndromes or disabilities.

Methods: This study included children who underwent cochlear implant before seven years and diagnosed with various syndromes or disabilities during the preoperative examination. We analyzed the score of SMS and result of a cochlear implant by retrospective chart review.

Results: We analyzed data from a total of 36 pediatric patients with cochlear implants diagnosed various syndromes or disabilities. Mean operation age was 2.5±1.4 years, and mean follow up period was 53.5±39.6 months. Mean SMS score was 70.4±29.2, and 20 patients (55.6%) showed a deterioration of SMS. Sixteen patients (44.4%) were normal, 11 (30.1%) were mild (50-69), 4 (11.1%) were moderate (35-49), 4 (11.1%) were severe (20-34), and 1 (2.8%) was profound (<20). Mean MAIS (Meaningful Auditory Integration Scale) and CAP (Categories of Auditory performance) of mild to moderate SMS deterioration group (Group 2) were 69.6±27.4 and 3.9±1.7, that was not significantly inferior to that of normal SMS group (Group 1). Mean MAIS and CAP of the severe to profound SMS deterioration group (Group 3) were 74.6±23.5 and 3.4±1.4. Although CAP of Group 3 was significantly lower than that of Group 1 (5.2±2.1, p=0.05), MAIS of Group 3 was not inferior to that of Group 1 or Group 2, and MAIS and CAP of Group 3 showed gradual improvement after the cochlear implant.

Conclusion: Children with syndromes or disabilities frequently showed SMS deterioration. MAIS and CAP were not worse in SMS deteriorated patients, and gradual auditory improvement also detected even in the severe to profound SMS deterioration group.

Hearing loss among patients with Osteogenesis imperfecta - Experience of World Hearing Center

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Osteogenesis imperfecta is a congenital disorder of connective tissue, which results in malformations of organs with high amount of collagene. The main symptoms are numerous fractures of bones,blue sclerea, hipermobility of joints, flexible skin, dentinogenesis and almost half of the patients have different type of hearing loss.

Objectives: The aims of this study are to characterize group of patients with hearing loss treated in World Hearing Center and assessment of hearing results of surgeries.

Material and methods: In World Hearing Center 21 patients were treated due to hearing loss with clinical diagnosis of Osteogenesis imperfect, 19 underwent surgeries due to hearing loss. Stapedotomies, revisions after staedotomy, restapedotomies and ossiculoplasties were performed. We excluded ears which underwent surgeries in other hospitals. We analyzed results of surgeries of 22 ears. We assesed pure tone audiometry results before and after surgeries in short -term and long-term follow up.

Results:Results of postop air bone gap were very good [ABG <=10dB] and good[ABG >=11dB and <20dB] in 95,5% of cases. Hearing gain >=10dB was obtained in 86% cases in short term observation, 14% of results were between >0dB and <10dB. Sensorineural hearing loss [BC tresholds decrease >15dB] was observed in 1 case.

Conclusions:Hearing loss in Osteogenesis imperfecta in most cases is connected with disorders within middle ear. The most common is stapes pathology. Surgeries of stapes allow to obtain air bone closure in many cases of Osteogenesis imperfecta. However some cases need reoperations and hearing gain diminish. Due to high level of malforamations of the structures of middle ear it is advised to perform surgery in this groupe of patients only by the most experienced surgeons.

Development of auditory, verbal and communicative skills in CI children with autistic disorder

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Objectives: Deaf children with autism spectrum disorder (ASD) is complicated group for cochlear implantation. Today deaf children with ASD can get CI as other deaf patients. But postsurgical rehabilitation of such children is sophisticated process and a choice of rehabilitation's approaches for better outcomes is still controversial.

Methods: Participants - 4 cochlear implanted children with ASD. Age of implantation - 2 years, 3 years, 3,5 years, 17 years, the duration of CI using varied from 1 year to 7 years. All children permanently used HA before cochlear implantation without progress in speech. After implantation children visited various educational institutions and got different therapy approaches. The long-term assessment of auditory, speech and communication skills in children was perform with formal tests and questionnaires. The battery EARS was used to assess auditory reaction on speech.

Results: All children wear CI permanently. 3 children including teenager have a significant progress in auditory skills. 2 children understand speech by listening in daily life and develop communicative skills with written speech and dactylology. One child uses oral speech for communication. These children got auditory and speech therapy in combination with ABA therapy and alternative communication with PECS at initial period of CI using. 4-th child during 3 years after surgery got standard speech therapy with oral method without progress in speech, communication, behavior and little progress in listening skills. The progress in behavior, communication and listening skills was achieved after adding ABA therapy and alternative communication with PECS.

Conclusions: To increase CI efficacy for deaf children with ASD it is important to combine the development of auditory skills with traditional approaches for teaching children with ASD - ABA therapy, alternative communication, visual schedule.

Two cases of cochlear implantation in young children with Goldenhar syndrome (oculo-auriculo-vertebral)

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Objective: The oculo-auriculo-vertebral dysplasia is a rare congenital malformation that is characterized by a hemifacial microsomia with ocular abnormalities and disorders in the spinal column. The degree of hearing loss can range from mild to moderate conductive type in cases of chronic otitis media with effusion and severe to profound sensorineural hearing impairment with malformations of the inner ear in various forms of cochlear hypoplasia. The aim of the study was to show the surgical technique used for cochlear implantation in two patients with OAVD (Goldenhar syndrome) and discuss the results obtained after surgical treatment.

Material and Methods: Two patients with OAV syndrome were qualified for CI treatment because of the bilateral sensorineural hearing loss and no effect with hearing aids. They presented complex inner ear malformations with cochlear dysplasia. In both cases the technique of cochlear implantation was facial recess.

Results and Conclusions: The operations went without complications. We did not observe also late complications. Both children after several years are still CI users. We achieved satisfactory hearing results in both. The results of cochlear implant surgery in young patients with middle and inner ear malformation in OAV syndrome are satisfactory, however during the surgical procedure one has to be prepared for various anatomical deformations and unusual problems.

Cochlear implantation in children born prematurely: who does well?

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Objectives: Advancement in neonatal medicine has led to greater survival of those born prematurely. Several factors associated with prematurity are known risk factors for hearing loss. Hearing outcomes were analysed in this heterogeneous group.

Methods: Retrospective study with prematurity defined as birth before 34 weeks gestation. Primary outcomes were speech perception and language development and secondary outcome was compliance.

Results: Mean gestational age was 27.1 weeks (22.9-33 weeks). Mean pre-operative and post-operative M- CAP scores were 1 (0-4) and 5 (2-6). Mean pre-operative and post-operative MSLDS scores were 3 (1-5) and 6 (1-9). Gestation and outcome scores were not correlated. Children with cognitive disability had a mean post-operative M-CAP score (13/28) 2 points lower and a mean post-operative MSLDS (12/28) 3 points lower than children without cognitive disability.

Conclusions: Cognitive impairment and subsequent autism were negative prognostic factors, and the possibility of greater variance in outcome should be discussed with parents pre-operatively.

Study of the effect of the cochlear implant on auditory perception in children with and without auditory neuropathy spectrum disorder in Rasool Akram hospital between 2005-2011

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Recognition of the treatment outcomes with cochlear implant in children with hearing loss with and without auditory neuropathy would result in better prognosis in patients. This study was performed to determine the outcomes of cochlear implant in children with hearing loss with and without auditory neuropathy in Rasool Akram hospital since 2016 to 2011. In this observational study ,27 consecutive children with hearing loss with and without auditory neuropathy were enrolled and treatment outcomes were determined in them and compared across the groups with repeated-measured ANOVA . it was seen that SIR and NRT were same across two groups but CAP results were significantly better in those without auditory neuropathy.

Finally according to obtained results , it may be concluded that treatment outcomes with cochlear implant in children with auditory neuropathy is relatively poor but still cochlear implant can be considered as an appropriate approach in the management of this children

FS 31: CI Outcome in Specific Congenital Inner Ear Anomalies

Cochlear implantation for pediatric X-linked deafness patients: preoperation assessment and postoperation evaluation

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X-linked deafness (DFNX) accounts for less than 2% of cases of non-syndromic hearing impairment. Patients with DFNX often exhibit abnormalities of the petrous temporal bone, consisting of a dilated internal auditory meatus and an abnormally wide communication between the internal auditory meatus (IAM) and the basal turn of the cochlea. In this case series, we aimed to describe audiometric measures, surgical techniques, and cochlear implant (CI) outcomes in patients with DFNX. A retrospective chart review was performed with 13 paediatric patients with DFNX who received a CI in our hospital. CI outcome measures included the results of Categories of Auditory Performance (CAP) and Speech Intelligibility Rating (SIR) tests. Successful implantation was achieved in all cases, with no cerebrospinal fluid (CSF) leakage or major complications. The length of the basal turn of the cochlea and the insertion angle were measured preoperatively to avoid insertion into the internal auditory canal (IAC) and to optimize placement of the electrode. A modified cochleostomy was used in two patients and a modified round window approach was used in the remaining 11 patients. Mean CAP and SIR scores were 4.4 ± 1.3 and 2.5 ± 1.3, respectively. In patients with DFNX who receive CI, the absence of bony separation between the basal turn of the cochlea and the IAC can add a unique risk factor for misplacement of the electrode within the IAC, as well as CSF gusher during surgery. Opening of the horizontal semi-circular canal and the round window can form an outlet for the CSF gusher and a spot for packing fat tissue and fascia after inserting the electrode.

X-linked malformation deafness, a comparison of hearing augmentation with either bone-anchored hearing aid or cochlear implantation

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X-linked malformation deafness is a rare hereditary cause of congenital or rapid progressive hearing loss. The affected children present with a severe-profound mixed hearing loss and temporal bone imaging shows a typical inner

ear malformation classified as Incomplete Partition type 3. Cochlear implantation (CI) is one option of hearing restoration in severe cases, however a combination of a bone-anchored and a regular hearing aid (BAHA/HA) also improve hearing and speech development. Due to the rarity of this syndrome it is difficult to develop a consensus towards effective management of these children. We have compared the hearing, speech and cognitive development of two groups of children with x-linked hearing loss utilising the above strategies.

Children with x-linked deafness in general showed low level of speech recognition, especially in noise, delayed or impaired spoken language abilities and executive functioning deficits which correlated with mental ill-health issues. Although this was low, both treatment groups developed relatively acceptable hearing and receptive language where the CI group developed better expressive language than the BAHA/HA group. However, the CI group showed a progressive loss of hearing several years after treatment which was not seen in the BAHA/HA group. Due to the advantages of both strategies, the first patient has been treated with a bimodal hearing strategy with BAHA/HA in one ear and CI in the other. This is thought to maximise both the advantages of CI hearing as well as the stability of BAHA augmented hearing. The results from this child will be reported.

Children with X-linked deafness display poorer performance on measures of spoken language and executive function when compared to children without cochlear malformations. Both CI and BAHA/HA are feasible options for treatment however a combination of both treatment modalities may present the best hearing and speech result.

Bilateral cochlear implantation in children with inner ear malformations

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Objectives: Bilateral CI are now the standard procedure for children who are bilaterally deaf. Binaural hearing is also an essential ability for children with inner ear malformations (IEMs) for a daily life. However only very limited publications are available in terms of bilateral CI in children with IEMs, which simply describes the surgical risk, postoperative hearing threshold, and speech perception test results in quiet situation. To our knowledge, there has been no published information with regard to ear-specific speech perception and binaural processing in children with IEMs who received bilateral CI.

Methods : Thirty-nine children with IEMs who received bilateral CI were included in this study. The surgical and audiological outcomes were investigated.

Results: The procedures were performed safely without additional risks. The bilaterally implanted children with mild forms of IEMs including incomplete partition type II, enlarged vestibular aqueduct, and vestibular anomalies showed comparable outcome to those without IEMs in terms of ear-specific performance and binaural speech perception in noise. Children with severe forms of IEMs including cochlear aplasia and cochlear hypoplasia, and narrow internal auditory canal demonstrated suboptimal outcomes after bilateral CI, but they realized the functional benefit in a daily life by adding second implant. All of them showed that binaural squelch and binaural summation effects were realized.

Conclusion : These findings suggest that bilateral CI should be considered the standard for children with IEMs as for those without IEMs.

Effect of congenital inner ear malformations on auditory nerve response in cochlear implant children

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Objectives: The study was designed to assess the electrically evoked compound action potential (ECAP) responses in children with inner ear malformations compared to children with normal cochlea.

Material and Method: The study included 203 patients with severe to profound hearing loss. All subjects had been approved for implantation through a rigorous assessment protocol of cochlear implant unit in King Fahad University hospital– Imam Abdulrahman Bin Faisel University. The age at implantation ranged from 1.2 to 5 years. Subjects were implanted with either Cochlear Nucleus or Medel cochlear implant devices. Hundred and eight patients had congenital inner ear malformations and 95 patients had no cochlear anomalies. According to our protocol of assessment, the electrically evoked compound action potential (ECAP) responses were measured intra-operatively, at the time of activation, and three months post activation of speech processors. ECAP thresholds were evoked by stimulation of basal, mid, and apical electrodes.

Results and conclusions: ECAP responses measured after activation will be analyzed in different cochlear malformations and compared to results in patients with no cochlear anomalies.

Cochlear implantation outcomes in cases of cochlear malformations

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Objective: To demonstrate the benefits of implantation in patients with inner ear malformations.

Patients and Methods: It has been performed 26 Cochlear Implantations (CI) on pediatric patients with Cochlear malformations to date. According to L. Sennaroglu, the malformations encountered included 3 common cavity (CC), 1 cochlear hypoplasia type II, type III and type IV, 2 common cavities, 3 incomplete partitions of of the cochlea type I (IP-I, cystic cochlea), 8 IP-II (Mondini deformity) and 7 IP-III. In cases of round window membrane presence, the CI was perform by classical method with transmembrane electrode insertion. In cases of common cavity and one IP I case, the round window membrane was not identifies and the electrode was insert via cochleostomy. CSF leak occurred in all cases of IP and common cavity.

Results: The full insertion of electrodes of previously chosen length (from 11 to 27 mm) has been achieved in all 26 cases. In cases, whith gushers due to the absence of bone wall between the cochlea and IAC cerebrospinal fluid leakage were successfully stop by reliable packing cohleostomy/round window niche using muscle flap and silicon stopper of electrode array.

After 6 months sound processor activation, 5-7 years old children - understand words with an open choice of more than 90%. Children up to 5 years reached similar results closer to 12 months of using the systems. Speech of 5-7 years old children after 1 year using of the system was easy to understand by all. CI was less effective in cases with a CC. Children with malformed cochlea required an increasing of the adjustment session number.

Conclusion: Good visualization of round window and transmembrane insertion of active electrode into spiral canal of cochlea in patients with inner ear malformations help to minimize the trauma of the spiral organ, control liquorrhea and improve postoperative auditory performance.

Outcome of cochlear implantation in children with Enlarged Vestibular Aqueduct (EVA) and Mondini Dysplasia (incomplete partition type II)

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Background: Congenital inner ear abnormality is a major cause of sensorineural hearing loss in children, about 20% of children with congenital sensorineural hearing loss (SNHL) have associated malformations of the temporal bone, and increased experience in cochlear implantation has led to more children with abnormal cochleovestibular anatomy submitted to this procedure. Aim: To evaluate the outcome of cochlear implantation in cases with enlarged vestibular aqueduct (EVA) and Mondini deformity (incomplete partition type II) following cochlear implantation and comparing the results with cochlear implant cases without inner ear anomalies.

Patients and methods: 69children all less than 6 years of age, CI surgeries underwent from April 2014 to December 2015 at the National Hearing & Speech institute (HSI) Giza-Egypt. Eight patients were congenital prelingual severe to profound hearing loss with enlarged vestibular aqueduct (EVA) and Mondini deformity (incomplete partition type II) Isolated EVA was detected in four cases, two cases with bilateral incomplete partition type II (Mondini deformity) and two cases with bilateral incomplete partition II (Mondini deformity) associated with dilated vestibule & vestibular aqueducts bilaterally with short lateral, SCC (semicircular canal),Beside those 8 cases, a random sample (16 control cases) . The ECAP thresholds determined with neural response telemetry (NRT) or Auditory response threshold (ART) software provide a good starting point for locating the behavioral T and C levels. Auditory skills were evaluated before start of rehabilitation and after 6 months of rehabilitation using LittlEARS Questionnaire and Auditory Checklists and compared to the auditory skills of other cochlear implantees with normal inner ear. Results: This study showed that the auditory skills and audiological performance of children with congenital ear anomalies developed over a period of 6 months after cochlear implantation, in a similar manner to those of young children with radiologically normal inner ears. Conclusion:Cochlear implantation can be successfully performed in children with enlarged vestibular aqueduct (EVA) and Mondini dysplasia (incomplete partition type II) .These children and their parents can expect significant auditory benefits from this intervention.

FS 32: Bone Conduction Implants in Unilateral Hearing Loss

Single-sided deafness – Bone conduction implant or cochlear implant

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Objectives: Current guidelines for those with single-sided deafness (SSD) allow for fitting of either a bone conduction implant (BCI) or cochlear implant (CI). The aim of this study was to compare the outcomes of a BCI fitting to a CI fitting for those with SSD.

Methods: In a retrospective analysis of an implant programme, recipients were classified as having SSD if they had an unaidable, severe to profound sensorineural hearing loss in one ear and hearing threshold levels of ≤30 dBHL up to 4kHz in the better hearing ear. The primary outcome measure was quality of life, assessed using the

Abbreviated Profile of Hearing Aid Benefit (APHAB) and sub-scores pre-operatively, and then at 6 and 12 months, with outcomes for CI recipients compared to those of BCI recipients.

Results: A total of 50 recipients were included; 39 received a BCI (average age at implantation 53.3 yrs) and 21 received a CI (average age 54.0 yrs). CI recipients had a significant improvement in APHAB score after implantation which was retained at least for 12 months. In comparison, BCI recipients had a significantly better APHAB score pre-operatively, but had a significantly lower level of improvement. The APHAB subscales of Ease of Communication, Background Noise and Aversion showed the largest differences between the two groups.

Discussion: Clinicians should favour a CI over a BCI for those with SSD, taking into account the candidate's expectations and pre-operative goals.

Bone conduction implants: poorer outcomes for those with single-sided deafness

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Objectives: Bone conduction implants (BCI) have been used for >35 years initially for those with conductive (CHL) or mixed hearing (MHL) losses, and for around 15 years for those with single-sided deafness (SSD). The aim of this study was to compare the outcomes of those with SSD to those with CHL or MHL.

Methods: In a retrospective analysis of all BCI recipients in an implant programme, recipients were classified as having SSD if they had an unaidable, severe to profound sensorineural hearing loss in one ear and hearing threshold levels of ≤30 dBHL up to 4kHz in the better-hearing ear. The primary outcome measure was quality of life, assessed using the Abbreviated Profile of Hearing Aid Benefit (APHAB) and sub-scores pre-operatively, and then at 3, 6 and 12 months.

Results: Of the 150 recipients, 39 had SSD (average age at implantation 53.3 yrs) and 111 had CHL/MHL (average age 54.7 yrs). Recipients with CHL/MHL hearing loss had significant improvement in APHAB score after implantation which was retained at least for 12 months. In comparison, recipients with SSD had a significantly better APHAB score pre-operatively, did not have the same level of improvement, and regressed back towards pre-operative scores. The APHAB subscales of Ease of Communication and Background Noise showed the largest differences between the two groups.

Discussion: Clinicians should not expect the same outcomes for BCI recipients with SSD as they can for those with CHL/MHL. Careful consideration of the candidate's pre-operative goals is vital when considering BCI for SSD.

Restoration of binaural Hearing in SSD patients with cochlear implants versus Bone Bridge

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Objectives:Patients with Single Sided Deafness are restricted in their ability to communicate. Especially the lack of directional hearing and their reduced word recognition in noisy surroundings are a great discomfort. There are two options in the treatment of SSD patients. Either the use of an cochleaimplant or a CROS solution with a conventional or a bone anchored hearing aid.

Methods: In our study we included 16 patients with single sided deafness and contrlateral normal hearing. The implant experience in the CI group was 1-6 years and in the BB group 4 month up to 3 years. We used 8 MedEl Concerto/Synchrony implants with a standard electrode and 8 Bone Bridge implants. Binaural summation, squelch effect and the head shadow effect and the SRM was measured with the OLSA sentence test to assess the improvement of word recognition. The RMS and BIAS in sound source localization was determined with the 7.1 loud speaker array. The SSQ and Bern Benefit in SSD questionnaire were used to view the improvement in quality of life.

Results/Conclusion: Our study showed a restoration of binaural hearing in the CI group. In the Bone Bridge group there was an improvement of word recognition only in the head shadow Situation and no benefit in directional hearing.

Predictive factors for successful rehabilitation with transcutaneous Bone-Anchored Hearing Aids in patients with unilateral deafness

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Objectives: This study aimed to evaluate the predictive factors for successful auditory rehabilitation with transcutaneous bone-anchored hearing aids (tBAHA) in patients with single-sided deafness (SSD) or asymmetric hearing loss (AHL).

Design: This study included 28 subjects with unilateral deafness who received tBAHA implants in the contralateral routing of signal (CROS) pattern. Audiological outcomes were evaluated 3 months after implantation, and pure-tone audiometry findings acquired in the unaided and tBAHA-aided conditions were compared. The root-mean-square errors of the hearing in noise (HINT) and sound localization tests were calculated at the point of best fitting. Subjective satisfaction regarding the tBAHA

implants was evaluated using the International Outcome Inventory for Hearing Aids (IOI-HA).

Results: There were no significant differences in the IOI-HA scores of CROS-tBAHA between patients with SSD and AHL. Although hearing threshold in the tBAHA-aided condition was better than that in the unaided condition, there was no significant increase in patient satisfaction in the tBAHA-aided condition. There was an increase in signal-to-noise (SNR) ratio the tBAHA-aided condition, especially when the noise originated from the contralateral side and the signal from the front of the subject; nevertheless, the increase in SNR had no effect on IOI-HA scores. However, duration of deafness was a positive predictive factor for better subjective satisfaction regarding CROS-tBAHA among patients with SSD or AHL. The longer the duration of deafness, the higher was the IOI-HA score, which suggests that patients with longer durations of deafness would be good candidates for CROS-tBAHA implantation.

Conclusions: Duration of deafness in patients with unilateral hearing loss is an important predictive factor for successful auditory rehabilitation by CROS-tBAHA implantation.

The benefit of a bone-conduction device/ active middle ear implant in patients with unilateral conductive hearing loss is not necessarily owing to processing of binaural cues

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Listeners who suffer from unilateral conductive hearing loss (UCHL) experience difficulties regarding spatial hearing and understanding speech in noisy environments. Distorted binaural hearing is the underlying cause, limiting meaningful processing of binaural cues (ITDs and ILDs).

Treatment of UCHL is not always evidence-based and often the decision for a specific hearing implant is related to local roles and available funding. Possible hearing implants are; the bone-anchored hearing aids (bone-conduction device, BCD), active middle ear implants (Vibrant Soundbridge), and active bone-conduction devices (Bonebridge). All options aim to give access to binaural cues.

In the present study sound localization abilities of listeners with congenital UCHL fitted with either a BCD (n = 16), a VSB (n = 14) or a Bonebridge (n = 9), implanted in two different clinics, are compared. The Selection criteria for the patients was not uniform. Acoustic stimuli were presented from invisible speakers, randomly positioned in the azimuthal (-70°, +70°) and vertical (-30°, +40°) plane. Listeners were asked to point with a LED mounted on a head frame towards the position of the perceived sound location. Both horizontal and vertical head movements were recorded via an infrared optical tracking camera. Stimuli consisted of broadband (0.5 – 20 kHz and 0.5 – 6 kHz), low-pass (0.5 – 1.5 kHz) and high-pass (3 – 20 kHz) Gaussian noise with intensities roved over a broad range (45 – 65 dBA). Listeners were tested in both the aided and unaided listening condition. Localization tests were performed at least 4 months post-fitting.

The localization abilities of the tested aided subjects improved but were not as good as that of normal-hearing subjects. Localization ability of stimuli presented at the side of the impaired (aided) ear, improved clearly when listening with a hearing device. In contrast, responses to stimuli presented at the side of the healthy ear were hardly affected when listening with the device, indicating that the benefit was not related to processing of binaural cues.

Treatment of SSD: rerouting versus direct electrical stimulation

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Potential treatment options for patients with single sided deafness (SSD) are; i) a conventional contralateral routing of sound (CROS) hearing aid, ii) a CROS bone-conduction devices (C-BCD), iii) a cochlear implant (CI). In some countries, cochlear implantation is becoming the standard treatment. Whereas the CI enables bilateral input, which might lead to some form of binaural hearing (Dillon et al., 2017), most countries only offer and reimburse CROS devices which do not restore binaural hearing, as they only lift the head shadow and stimulate the contralateral hearing ear. We present an overview of localization behaviour of SSD patients listening with one normal-hearing ear and a contralateral C-BCD, a contralateral CI, and when they are listening in the unaided condition. Several studies reported moderate to good unilateral sound-localization abilities in unaided SSD listeners. We demonstrate that this ability is related to processing of monaural cues which are only available when SSD listeners demonstrate thresholds better than 40 dB HL for 4 and 8 KHz. Listening with a CI potentially can improve the localization abilities, listening with a C-BCD might deteriorate these localization abilities. Especially listeners with acquired SSD experience serious problems in daily life. The loss of binaural hearing is causing problems related to feeling of wellbeing and safety as well as problems in localization of sounds. Although a CI provides bilateral input by way of direct stimulation to the impaired ear, true processing of binaural cues might not be restored. In case of C-BCDs, there are a growing number of reports suggesting non-use is rising with increasing time after BCD implantation. Both the CI and C-BCD might be used only because SSD listeners are experiencing serious problems

and are searching for treatment. Initially both interventions are helpful. In the long term it might be that the auditory system adapts to unilateral input and that the CI and C-BCD are no longer used because processing of binaural cues is insufficient.

Is binaural hearing achievable in subjects with congenital unilateral conductive hearing loss?

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The main problem of rehabilitation of unilateral conductive hearing loss (UCHL) with a hearing device or surgical repair is that the treated impaired ear has to compete with the normal hearing ear. Because of the impressive capacities of a normal hearing ear, rehabilitation results in a significant hearing asymmetry (20 -30 dB in children), and unilateral absence of spectral information processing.

We review binaural hearing data as obtained after treatment in a population of subjects with congenital UCHL. Several measures addressing binaural hearing after treatment have been studied, e.g. directional hearing (detection of interaural time and level differences), binaural summation, binaural squelch and the effective use of head shadow.

Whenever possible, binaural outcomes are compared with values obtained in normal hearing subjects, using the same tests. Included in this review are 11 papers, describing results in 169 subjects with treated unilateral aural atresia.

Six papers presented binaural data gathered after atresia repair and five papers after application of either a percutaneous bone-conduction device (BCD), an active transcutaneous BCD, a passive transcutaneous BCD or an active middle ear implant. Binaural scores were collected and compared to norm values. Mean binaural scores are expressed, as z-scores; if $z < 2$ then the mean score falls within the normal range.

Subjects with unilateral amplification do not perform as good as normal hearing listeners. It remains uncertain to conclude whether subjects with congenital UCHL have an equal chance for optimal rehabilitation compared to subjects with acquired UCHL. Subjects from the latter group can benefit from a maturated auditory system once they are aided. The congenital group might benefit from auditory system development while in the aided situation. When consistent amplification, although resulting in an asymmetrical input, is present during a certain critical period, it might result in better handling of the listening situation.

FS 33: Focus on ABI Rehab Aspects

Auditory brainstem implant in children: surgical experience and clinical outcomes from Hannover Medical School

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Objectives: the auditory brainstem implant (ABI) is an option for hearing rehabilitation in profoundly deaf patients ineligible for cochlear implantation (CI). Over the past recent years, surgeons have started implanting ABIs in pediatric subjects who cannot benefit from cochlear implantation due to malformations or absence of either inner ear or auditory nerve. In this study will be discussed the experience with ABI in children of a tertiary referral center that for many years have implemented a broad program in auditory implants.

Material and methods: the study run on a group of circa 20 children who received a ABI given to diverse etiologies of deafness : cochlear nerve aplasia, auditory neuropathy, cochlear malformations, neurofibromatosis type 2. A group of individuals showed also congenital comorbidities. The children were examined on the Categories of Auditory Performance (CAP) scale. When possible audiograms, Freiburg monosillable test were also taken in account. Moreover were reported the preoperative investigations for children candidates to ABI as well as the corresponding surgical approaches.

Results and conclusion: Long-run audiological outcomes indicate that children benefit from ABI in terms of hearing and language development. However the achievements of ABI in children did not reach the goals obtained by children using CIs. We learnt that at very limited benefit from CI, e.g. in cases of uncertain nerve/cochlear aplasia, the time-gap to ABI should be shortened, in order to obtain the best possible results. Performing ABI surgery in a child gathers undoubted risks, altought in experienced centers the complications are very rare.

Performance with an auditory brainstem implant and contralateral cochlear implant in pediatric patients

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Objectives: To assess bimodal auditory performance in children with a cochlear implant (CI) and contralateral auditory brainstem implant (ABI).

Materials and Methods: Four patients with cochlear nerve deficiency initially underwent cochlear implantation but were not benefiting from their devices and underwent ABI in the contralateral ear. Age appropriate speech perception and production assessments were performed to measure performance.

Results: Three subjects performed better on their auditory perception assessments using both of their devices than with either device alone. One subject has only preliminary outcomes, but subjectively performs best with both devices.

Conclusions: We observed continued improvement in CI performance over time, even if no benefit was evident before the decision for ABI. This could suggest that the ABI and CI have a synergistic effect or simply the adaptive ability of the developing brain to utilize the signals coming from these devices. There is preliminary evidence to support choosing the ear contralateral to the CI for an ABI in a pediatric patient with bilateral cochlear nerve deficiency.

Evaluation of written language skills in children with auditory brainstem implant

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Objectives: The purpose of the study was to assess the written language skills of children with auditory brainstem implants.

Material and Method(s) when relevant: In this study 12 children with auditory brainstem implants were evaluated in terms of their written language abilities. The children were between 2nd and 8th grades and A Written Expression Skills Assessment Form was used. Five different features of written expression points were scored and analysed, yielding composite score for written expression skills.

Result(s): The results of this study showed that all of children with ABI needed more verbal cues than spontaneously written samples. This study show that children with auditory brainstem implant use simple and short sentences with limited vocabulary and repetition of a word and a sentence. Children with ABI are deficient in writing an introduction, body and conclusion paragraphs or in logical sequences of events.

Conclusion(s): Variables, which explain written language skills of the children who use ABI, depend on age at implantation, duration of implant use and additional handicaps. The findings of this study highlight the importance of auditory brainstem implantation during the critical period of language development and also enhancing training programmes for written language skills for the children who underwent ABI. Also, written expression skills in children with ABI is a highly complex skill.

Pediatric auditory brainstem implants: issues and outcomes

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Background: Prelingually deafened children with severe inner ear and or 8th nerve anomalies are implanted with auditory Brainstem İmplants (ABİ) to gain sound access and enable speech development. Typically, programming of an ABİ is challenging. Maximum comfort level (MCL) can rarely be set objectively, required charge may not be attainable due to side effects. Typically, speech and language development is slow. Reasons include: inadequate access to sound; poor pitch perception; older age at and unilateral implantation; additional disorders and inadequate educational/familial support. ABİ users need intensive support to develop listening and speech skills.

Aim: Discuss issues and outcomes associated with programming and habilitation of paediatric ABİ users.

Method: Data from 10 MEDEL, paediatric ABİ users, fit and followed up by the authors was analysed, retrospectively. Data on program characteristics, fitting methods, sound access and cortical auditory evoked potentials, educational placements, speech perception and production was collected. Results: Mean age at switch on of ABI was late at 33 months (m); mean length of ABI use was 4 years (y) and mean age at latest session was 6 y. Mean MCL range was high 132-200qu; mean rate was slow at 487pps; mean number of active electrodes was low at 7/12. Mean sound field thresholds (0.25-6KHZ) were 42,41,43,43,47 and 42 dBHL. Typically, these ABİ users have aided P1 responses to speech tokens /g/ and /t/ at 55 dBSPL and to /m/ at 65 dBSPL with slightly long latencies. All use their ABİ all waking hours, all detect their names and recognise some environmental sounds. Speech production varies from using 1-2 names, to stringing 3-4 words together. All but 1, can recognise words in closed sets and 6/10 can recognise common phrases in closed sets and in conversation to varying degrees, without lip reading. All receive habilitation using a natural auditory oral approach. Five attend mainstream and 5 special schools for the hearing impaired. Conclusions: All 10 benefit from the ABI which aids development of spoken language. Factors effecting outcomes are amount of sound access and amount and quality of parental and educational support focusing on listening and talking. An ABİ is a worthwhile intervention despite surgical, programming and educational challenges.

Paediatric auditory brainstem implantation - impact on audiological rehabilitation and tonal language development

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Objective: This is a retrospective review of the impact of Auditory Brainstem Implant (ABI) on the audiological rehabilitation and tonal language development of paediatric patients with prelingual profound deafness in Hong Kong.

Results: From January 2009 to February 2015, 11 paediatric patients with profound prelingual deafness received Auditory Brainstem Implants (ABI) in Hong Kong (age range 1.67-3.75 years). Aetiologies include Cochlear Nerve Deficiency in 7, Severe Cochlear Malformations in 2 and Retrocochlear Deafness in 2. All were rehabilitated in Cantonese

(a Chinese dialect). Standard paediatric cochlear implant outcome measurements were used in this study and comprise of the 7-Sound Detection, Syllable Identification, Vowel Identification, Consonant Identification, Tone Imitation, Tone Production and Speech Perception Category. Audiological rehabilitation and speech development outcomes were reviewed. Age-matched outcomes of paediatric cochlear implant users were used for comparison. Encouraging results of speech development were found, especially with continued use of ABI. There is a considerable variation in the outcome. Children with coexisting developmental and non-auditory cognitive disabilities do not perform as well.

Conclusion: Auditory Brainstem Implant (ABI) is a safe and beneficial treatment for profound prelingual deafness in Cantonese-speaking paediatric patients.

ABI fitting: Is it possible to predict nonauditory side effects in ABI children?

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Objectives: To develop a reliable and objective fitting method for use with young children with an auditory brainstem implant (ABI).

Materials and Methods: Subjects were 17 young children implanted with an ABI with the mean age 2 years and 4 months (8–64 months). Evoked auditory brainstem response (eABR) measurements were performed intraoperatively and at activation in order to record the auditory response and non-auditory side effects. Each child was tested to observe any subjective responses to the electric stimuli and non-auditory side effects. All children were fitted based on the postoperative eABR. The minimum follow up time is 12 months.

Results: Intraoperatively an eABR could be obtained in all children. The responses were recordable from 75-100 % of all electrodes. At initial stimulation eABR were recordable in all children. The eABR was obtained in 79.7 % of all electrodes (25-100 %) with a mean eABR threshold of 22.3 nC. eABR without any non-auditory stimulation was recorded on all electrodes in 11 children. Mixed eABR and non-auditory responses were recorded on 2-6 electrodes in 6 children. The subjective auditory responses for at least 1 electrode were noted in 15 children. In the 2 remaining cases the auditory response was obtained only when the device was activated. In all children the subjective responses were within the estimated dynamic range for each electrode. Each child was able to accept up to 100 % of volume of the created map. The non-auditory response was observed only on children and electrodes with mixed eABR and non-auditory responses. The mean CAP score at 6 months after the activation was 2.4 (1-4).

Conclusions: eABR seems to be a reliable tool to judge ABI electrode placement and a reliable method for fitting of young children with an ABI. The data suggest that eABR-based fitting helps children to more quickly achieve auditory perception and development. eABR seems to be a suitable method to predict possible non-auditory stimulation.

FS 34: Tonotopic Mismatch

A cross over trial comparing the fine structure sound coding strategy FS4 high rate to FSP in cochlear implants

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Introduction: New versions of coding strategies for cochlear implants have aimed at the transmission of temporal fine structure to the cochlear implant recipient. FS4 is the latest development transmitting fine structure on 4 apical electrodes. In a previous study the addition of a high stimulation with FS4 has shown improved subjective sound quality and improved speech perception in an acute setting.

Objective: The aim of the present study is to compare FS4 using a high stimulation rate with the previously available fine structure strategy FSP in a clinical setting with 3 months adaptation time per strategy.

Methods: 34 adult Ci patients with a minimum of 1 year cochlear implant experience are included. Patients need to have a minimum of 10 active electrodes of a long (≥ 28mm) electrode array. Each patient uses each coding strategy for 3 months in a randomized sequence. Outcome measures include a monosyllables test in quiet and the speech reception threshold of an adaptive sentence test in noise (Oldenburger Sentence test). Formant frequency discrimination thresholds (FFDT) are used to assess the ability to resolve timbre information. In addition, the subjective sound quality using VAS scales as well as a quality of life questionnaire is evaluated after each 3 month period

Results: Speech perception in noise and quiet is similar with both coding strategies. The extended fine structure range of FS4 yields a statistically significant improvement ($p<0.03$) in FFDT for sounds ocurring in this frequency range. Furthermore, there is a significant interaction ($p=0.04$) between the extend of fine structure coverage and FFDT performance. Sound quality was rated very heterogeneously, showing that the availability of both strategies in CI fitting practice is important. - Conclusion -

This study evaluates the potential benefit of a high stimulation rate with the FS4 fine structure coding strategy compared to FSP.

Tontopic mismatch and its effect on postoperative speech recognition

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Introduction: Cochlear implants heavily rely on the tonotopic organization of the organ of corti. However, the

electrode array of a cochlear implant typically only covers a part of the length of the basilar membrane and, consequently, only a limited frequency range on the organ of corti. Nevertheless, a frequency range of typically 100 Hz – 8500 Hz is mapped onto the electrodes, resulting in a tonotopic mismatch between the input signal frequencies and the place frequencies of the electrodes. This tonotopic mismatch may result in a longer adaptation time and, ultimately, in a limit on the patient's performance with the CI.

The aim of the presented study was to quantify the tonotopic mismatch and analyze its effect on the patients' speech recognition performance.

Methods: The intracochlear location of the CI electrodes was measured in CBCT imaging data of N = 70 ears implanted with MED-EL implants and electrode arrays FLEX20, FLEX24, or FLEX28. Using a method based on the Greenwood function, the place frequency of the electrodes and their tonotopic mismatch with the clinically fitted frequency mapping was determined. The tonotopic mismatch was then correlated with postoperative speech recognition scores at different dates up to two years after the first fitting.

Results: A significant correlation was found between the tonotopic mismatch and the difference in speech recognition scores at 6 months and 3 months after the first fitting, respectively ($R = 0.3076$, $p < 0.01$). However, no correlation was found between the tonotopic mismatch and the difference in speech recognition scores at more than 6 months after first fitting and the scores 3 months after first fitting. These results suggest that the tonotopic mismatch plays a role in the patients' postoperative development, and that optimized frequency mapping methods may reduce the time a patient needs to reach their optimal performance with the CI.

Is the frequency-place mismatch measured by the flat-panel computed tomography related to the CI performances?

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Objectives: To evaluate the relation between the cochlear implant (CI) electrode frequency-place mismatch and auditory performances in a selected group of adult CI recipients.

Materials and methods: 15 adult subjects (10 females and 5 males, mean age 64 ± 11) have been selected on a homogeneous series of CI patients admitted at a tertiary University medical center. All the subjects underwent a post-operative flat-panel computed tomography (FPCT): the predicted spiral ganglion frequency determined by FPCT was compared with the center frequency provided by the corresponding electrode checking the frequency-to-electrode allocation in each CI recipients and the mismatch was related to the CI performances. Speech perception tests were performed in quiet and noise using vocal-consonant-vocal (VCV), bysillabic words and sentences, with and without lip-reading. Data from a pitch discrimination test with phonemes and from the Montreal suprasegmental cues identification test have also been collected.

Results and conclusions: Electrode frequency-place mismatch resulted lower in patients with better outcomes. ($p=0,019$). While most of the subjects gave good and comparable results at the bysillabic and sentence test in quiet and in noise, the phonemes discrimination test (asse test), the VCV recognition score in noise and the suprasegmental cues identification gave interesting results that will be discussed.

Variants of flexible lateral wall electrode lengths and the patient specific choice of electrode insertion length

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Background: The variety of flexible lateral wall electrodes in difference length (16mm-31mm) allows for an individualized cochlea implantation meaning a patient specific choice of electrode insertion length and target modality (electric stimulation (ES) or EAS) to achieve best possible hearing outcome for every patient.

Methods: More than n=500 Patients with different degrees of residual hearing were treated with atraumatic electrode arrays of different lengths. To document hearing preservation, differences between pre- and postoperative thresholds in low frequencies are determined. For speech outcomes the HSM sentence test in noise (10 dB SNR) is analyzed. Using pre- and postoperative Cone Beam CT scans the cochlear length and coverage are measured.

Results: At first activation the median hearing loss after cochlear implantation ranges from 12.0 dB for a 16 mm electrode (n=12) to 24.0 dB for a 28 mm electrode (n=40) showing that hearing preservation depends on electrode length and insertion depths.

Hence, short electrodes would be preferable. However, if no function residual hearing can be used for EAS, patients with longer electrodes (28 mm) (n=31) and higher cochlear coverage (avg. 75%) achieve significantly better hearing results in noise with 42% (HSM 10 dB SNR) compared to patients with shorter electrodes (20 mm) (n=20) with 15% in ES. Partial insertion with the choice of a patient specific insertion depth and the option for its adaption could overcome this trade-off. With partial insertion excellent hearing preservation with 13.0 dB (n=15) at first

activation and speech outcomes in EAS with 82.5 % (n=7; HSM 10 dB SNR) at 3 months are achieved.

Conclusion: Taking cochlear geometry and the prediction of postoperative residual hearing into account an optimal electrode insertion depth can be selected to achieve best individual outcomes in EAS or ES. Partial insertion allows for further, patient specific adaptation of the insertion depth if hearing is progressive over time.

Does auditory frequency-to-place mismatch limit the ability to use spectral detail?

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Main Hypothesis: A significant interaction of channels number and spectral shift on speech performance. If frequency-to-place mismatch does indeed limit access to spectral detail, we would see performance reach an upper limit with fewer than 32 channels.

Methodology: Subjects: 10 normal hearing (NH) adult native speakers of British English

Speech materials: b-vowel-d words in a carrier phrase from a single female talker

Speech processing:

This study used vocoder stimulations of CI to:
- Vary the number of channels of spectral information available to NH listeners
- Simulate place mismatch by imposing a spectral shift on the vocoded sounds

Procedure: The S/N ratio was adaptively varied, and measured at 50% and 71% performance levels, with different:

Spectral channels (8, 16, and 32)

Shift conditions (0 and 3 mm)

Results:
- Performance improved as a function of number of unshifted channels
- Vowel recognition declined significantly with a 3mm linear shift
- Yet, performance continued to improve as a function of channels number even in the shifted condition

Conclusion:

•It is unlikely that the frequency to place mismatch is limiting CI users to make use of additional spectral detail as the number of channels increases.

•Further research is required to quantify the role of different factors on the ability to use spectral detail.

Electrode localization and variability of angular insertion depth of mid scala cochlear implant electrodes

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Objectives: Functional outcomes in cochlear implanted patients have recently been correlated with the optimal positioning of electrode array within the cochlea. A new precurved mid scala electrode was designed to fill these technical characteristics. The aim of this study was to analyse the electrode localization within the cochlea and to calculate the angular insertion depth (AID) of mid scala electrode arrays.

Material and methods: A prospective study was conducted from february 2015 to December 2017 in Grenoble University Hospital.

Precurved mid scala electrode arrays were implanted by pure round window insertion technique.

CT scan were performed after cochlear implant surgery and analysed by an otorhinolaryngologist and two blinded neuroradiologists. Volume reconstructions were performed to determine the scalar localization at 0°, 180°, 270°and 360°. Coronal oblique sections were reconstructed to calculate the angular insertion depth.

Results: 46 patients from 21 to 90 years of age were included (49 implanted ears).

Twenty one (42,9%) scalar translocations were observed.

Fifteen (30,6%) electrodes were mid scala and thirty-four (69,3%) partially mid scala.

The mean AID was 475° (340-610°).

Conclusion/discussion: The mid scala electrode array is not strictly mid scala, and have an increasing number of translocation. More analyses are required to demonstrate the correlation between the AID, the scalar localization and patients' functional outcomes.

FS 35: Language, Education and Parents

Executive functioning – A comparison between children with CI or hearing aid

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Executive functioning refers to cognitive processes, involved in self-regulation of thought, action and emotion. It includes mental processes such as planning, working memory, inhibition of inappropriate responses, flexibility in adaptation to changes and decision making. It is an important factor in educational attainment, as it is predictive of learning-related behavior such as listening to instructions, following directions, and accomplishment of tasks in a limited period of time.

The aim of the study was to assess EF in children with CI or HA and to analyze relations with speech perception and receptive vocabulary. The study group comprised 59 children aged 8 to 14 yrs. The CI group comprised 36 deaf children, the HA group 23 hearing impaired children.

A phoneme recognition score at 45 dB was determined. A word quotient was obtained with the Peabody Picture Vocabulary Test. Verbal memory was assessed with the Dutch 15-words test. Planning was assessed with a subtest of the Delis-Kaplan Executive Function System.

Independent sample T-tests showed a higher speech perception in CI children. Chi-square tests showed for both CI and HA children fewer above average vocabulary scores as compared to hearing peers. Chi-square tests showed a showed a larger proportion of below average Verbal memory scores in both CI and HA children. Finally, fewer above average and more below average scores were obtained on the planning task for both CI and HA children. Associations were found for the HA group between speech perception and vocabulary, verbal memory and planning. These associations were not present in the CI group.

These results indicate that better speech perception for the HA group might improve their vocabulary, verbal memory and planning skills. The implications for CI indication criteria will be discussed.

Parental expectation from children with cochlear implant: questionnaire based study on KAESC patients

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Objective: To measure parental expectation about their children with cochlear implant from many different prospective.

Methodology: A cross sectional study in form of a questionnaire conducted on parents the children who underwent cochlear implant in King Abdullah Ear Specialist Center. Questions related to communication abilities, social skills, academic achievements, change in future life, rehabilitation demand and stress on the family due to hearing impairment.

Results: We are still analyzing the Data from 100 questionnaires and it will be ready to be present soon

Conclusion: We are still analyzing the Data and the conclusion will be ready soon after that

The impact of inconsistent device use on language in young cochlear implant users

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Objectives: This study examines inconsistent device use (<8 hours/day) in young children with cochlear implant(s) (CIs) via an objective measure of daily device use, datalogging, to establish prevalence, assess implications for early language outcomes, and determine risk factors.

Methods: A retrospective chart review identified all young pediatric CI users (0-5 years) with at least one datalogging record. Clinical records were used to obtain demographic, audiologic, communication, and caregiver data. Datalogging measurements served as an objective measure of daily device use.

Results: Data collection is ongoing. Preliminary analyses include 36 children with a mean age of 3.0 years, mean age at CI of 2.1 years, and mean device experience of 0.9 years. Mean objective daily device was 6.1 hours/day. 67% of children in this sample wore their device(s) inconsistently. A subset of our sample (n=8) completed the Receptive-Expressive Emergent Language test. Results revealed a mean expressive standard score of 68.6 and a strong positive correlation between daily device use and expressive language score (rho=.90, p<.01). Risk factors related to poorer device use in children in the sample included: lower maternal education (x2(2)=8.4, p=.02), smaller electric dynamic range (rho=.49, p<.01), and presence of additional disabilities (U=52, p=.048).

Conclusions: Preliminary results suggest a higher prevalence of inconsistent CI use in young children than previously reported, potentially due to methodological differences (parent report vs datalogging). The high prevalence of inconsistent use in young children is alarming given young children with fewer hours of daily device use show poorer expressive language outcomes. Finally, clinicians should pay attention to risk factors of inconsistent device use to identify families that may need additional support to attain consistent, full-time device use to maximize the

opportunity for CI users to achieve age-appropriate language outcomes.

The use of facilitative language techniques by mothers with hearing-impaired children using cochlear implants

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Objectives: Role of parents in early childhood language development is quite important. The children of young age learn the language from their daily life experiences and especially during their interactions with their parents. However, families with hearing-impaired children have difficulty communicating with their children. The language development characteristics of hearing-impaired children using hearing aids or cochlear implants are closely related to the characteristics of the language input provided to them by their families. The purpose of this study is to assess the use of facilitative language techniques by families of hearing-impaired children using cochlear implants

Material and Method: Study was carried out with eight children who are hearing-impaired, aged one to three years, have severe to profound sensorineural hearing loss, use a cochlear implant (uni/bilateral) and were trained with the Auditory-Verbal Therapy (AVT) and the mothers of these children. In order to collect the data, the interactions of the mother with the child were recorded for 15 minutes. The techniques used by the mothers are marked according to their frequency in the entry form developed by the researcher.

Results and Conclusions: A result of the study, a significant increase in both the number and variety of the use of facilitative language techniques were determined for all of the surveyed mothers in comparison to the preliminary evaluation. The use of facilitative language techniques by mothers has been found out to be feasible and it is thought to be beneficial to include these techniques in early childhood intervention programs.

The role of the families in the rehabilitation of children after cochlear implantation. Remote rehabilitation

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Learning Objective: Young children spend all their time in the family, so parents are responsible for ensuring that the child learns to hear and speak.

Methodology: Video course where in an accessible form experienced parents and leading experts in the field of auditory rehabilitation talk about how to deal with a child after CI. The course consists of 40 video tutorials that will demonstrate how to engage and communicate with a child with a cochlear implant, how to develop his auditory perception and how to transfer learning skills into everyday life.

Results: As a result of participation in our project, children receive rehabilitation in the family, in situations of everyday communication. Families receive information and psychological support.

Conclusion: It is very important to teach parents what to do with the child to achieve the maximum language potential.

The child with CI:the reconstraction of child's interaction with the parents on the new sensory base

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FS 36: Signal Processing and Psychacoustics

Temporal processing performance in cochlear implant users

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Objectives: Auditory temporal resolution one of the main capabilities of the central auditory system and it is the main feature of speech processing abilities. Gap in noise test (GIN) is the one of the tests for assessing temporal resolution. In this study we aimed to assess and compare temporal resolution ability of subjects who wear cochlear implants (CI) and normal-hearing listeners with GIN test.

Material and methods: It was a cross-sectional and descriptive study, with a non-probabilistic sample for convenience. In the study subjects was divided into two groups. First one is consisted of 14 adult users of cochlear implants who have approximately normal hearing in free field and second one is consisted of 14 adults with normal hearing, matched for age and gender with the study group. The Gaps in Noise test were conducted in free-field and was applied at 50 dB SL. Data was analyzed by independent paired t- test using SPSS software version 23.

Results: The average of free field threshold was 29.3±6.8 dB HL at CI users. The average of pure tone threshold was 18± 2.7 dB HL at normal hearing subjects. The mean of GIN threshold was significantly higher and total percentage score was significantly lower in the CI user group compared to the normal hearing group. There was significant difference in approximate threshold and percent of corrected response between CI users and normal-hearing subjects ($p<0.05$).

Conclusions: The results demonstrated that subjects with CI can never have as good temporal resolution as normals,

although they have normal hearing. They have significant alterations in temporal processing abilities in comparison to subjects of the same age with normal hearing.

Comparison of impedance fluctuations and mapping changes using the Cochlear Nucleus Profile Slim Modiolar (CI532) implant to the Cochlear CI512 implant: a retrospective cohort study

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Objective: To evaluate our early experience with the Cochlear Nucleus Profile Slim Modiolar (CI532) implant in direct comparison to the Cochlear CI512 with respect to impedance fluctuations.

Methods: A retrospective chart review was performed of all patients who underwent cochlear implantation with the CI532 and the CI512 at our centre. The parameters of interest included the presence of post-operative electrode impedance fluctuations and the need for subsequent mapping adjustments. Significant impedance fluctuations were noted as post-operative increases greater than 4kOhms in any one electrode after first day of initial switch-on.

Results: Overall, data from 125 CI532 patients and 107 CI512 patients were reviewed. There appeared to be greater total post-operative impedance changes with the CI532 (37% vs. 46%, p = 0.165) that resulted in a statistically significant increase in patients requiring subsequent mapping adjustments (15% vs. 28%, p = 0.017).

Conclusion: Patients receiving the newer CI532 implant have a significantly increased rate of encountering post-operative impedance fluctuations that require subsequent electrode re-mapping, a process which may affect patient's hearing performance due to changes in perceived loudness and poor sound quality. Further work is warranted to determine if these findings are replicable at other centres using the CI532 implant and what impact, if any, they have on patient care.

Subjective inter-aural differences in pitch perception related to depth of electrode array insertion after sequential bilateral cochlear implants

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This paper will present a case study of a post-lingually deaf adult who reported a significant difference in pitch perception between the two ears after receiving sequential bilateral cochlear implants. In spite of one ear sounding lower in pitch than the other, speech perception tests using open set sentences showed maximum scores in each individual ear. Inter-aural comparison of pitch perception of every electrode in each ear confirmed patient's report that one side sounded lower in pitch than the other. Imaging studies of the petrous temporal bones using high resolution CT-scans revealed cochlear implant electrode array insertion to be deeper in the ear with lower pitch perception in comparison to the side with higher pitch perception. Interestingly, 6 months after consistent usage of bilateral cochlear implants, the difference in pitch between the two ears was no longer noticed suggesting that neural plasticity had taken place.

Programming with Nucleus Fitting software versus Custom Sound: comparison of map characteristics and outcomes in experienced cochlear implant recipients

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Accurate programming is essential in order to maximize the benefits from cochlear implants (CI), is dependent on clinician's knowledge and skills, and is a time consuming process. In face of the increasing numbers of CI recipients, and the subsequent growing demand for CI clinical care, Cochlear Ltd. created a simplified programming software, aimed at shortening and streamlining the programming process. The purpose of the present study was to compare map characteristics and outcomes in experienced CI users programmed with the new Nucleus Fitting software (NFS) and the conventional Custom Sound software (CS). Participants were twelve postlingually deafened adults, 42 -75 years old, implanted with Cochlear Freedom or Profile implants. Map minimum and maximum levels, aided thresholds, speech perception outcomes, and the speech, spatial and qualities of hearing scale (SSQ) were compared between CI recipients programmed with each software. At the first and second programming sessions, four weeks apart, CS and NFS were alternated randomly, followed by four weeks of CI use with each map. At the third session both maps were loaded on the processor and the recipient was instructed to use both and choose the preferred map. Four weeks after the third session participants reported their preference. Programming with CS versus NFS resulted in: Similar map minimum levels and marginally higher maximum levels using NFS, mainly in the apical and medial segments; Non-significant differences in aided thresholds, monosyllabic word scores, and sentence recognition in noise (0-5dB, <10%, 0.5-1dBSNR, respectively); Although SSQ results were also similar, map preferences were not uniform; 4) Programming duration with NFS was shorter by ~ 30% (4-12 minutes in over 90% of sessions). In conclusion, programming by means of NFS versus CS in experienced CI recipients did not yield significant differences in map characteristics, speech perception outcomes, and self-reported quality of hearing.

Superior voice pitch perception with perimodiolar versus straight electrodes

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An important aspect of speech perception is voice pitch, or fundamental frequency F0, which is a strong cue to speaker identity and emotional state, and clarifies meaning via prosody in Western languages and tone identity in Oriental languages.

We investigated voice pitch perception by cochlear implant (CI) users using a simple vowel pitch ranking test (F0 range; 126-212 Hz) and a Question/Statement discrimination test as defined by Patel et al. (Music Perception 2008). We firstly used a novel experimental sound coder "STEP" to separately control spectral and temporal pitch cues. Second we studied voice pitch perception in a cohort of sixty-one cochlear implant subjects using clinical processors.

Voice pitch perception varied widely across CI subjects in both studies, for example from no discrimination (d' = 0) to near perfect scores (d' ≥2) for F0 differences of ~1 octave. The conventional approach to improving voice pitch perception by enhancing temporal envelope modulation at F0 did not improve performance. However improvements were seen in prosody perception for poorer-performing subjects by doubling spectral resolution below 1000 Hz. In the large cohort Nucleus subjects with perimodiolar electrodes performed significantly better than those with straight electrodes. Performance on the vowel pitch ranking task which forced subjects to use temporal cues was generally poor across the cohort and the correlation between scores on the two tasks was weak.

CI subjects using standard clinical processors had a wide range of prosody discrimination as seen in the literature. Temporal enhancement of F0 cues did not improve vowel pitch ranking or prosody discrimination. Having a perimodiolar electrode array was necessary but not sufficient for good prosody discrimination (e.g. d' ≥2). Both studies suggest that better spectral resolution, either in the filter bank or in spatial selectivity, may be the key to improving voice pitch perception for CI users.

Psychoacoustic and electrophysiological correlates with speech intelligibility in simulated and actual CI patients

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Aim: To determine the correlation of speech intelligibility in noisy environment and spectral resolution of simulated and actual cochlear implant (CI) patients with spatial spread of electrical excitation measurements.

Materials and methods: 22 subjects implanted with different Nucleus CI systems ("Cochlear Ltd", Australia) were included in the study. All patients had more than 3 years of CI experience. To assess the spatial spread of electrical excitation (SOE) neural response telemetry (NRT) was performed. Speech intelligibility in noisy environment was evaluated with the Russian matrix test (RUMatrix), and spectral resolution with the spectral-temporally modulated ripple test (SMRT). The control group, consisting of 15 normal-hearing Russian-speaking subjects, was examined using SMRT and RUMatrix tests with and without vocoder. The latest vocoder version developed by Williges et al. (2015), which included CI signal processing and physiologically plausible details like electrode position and spatial spread of the electric field inside the cochlea, was used for simulating electric hearing. Three different spatial spread configurations were tested: 1mm, 3.6mm and 7mm with the hypothesis that larger spatial spread would lead to higher SRTs and poorer SMRT results.

Results: The results of the study revealed a high correlation of test-retest data in the control group with R2=0.79 for RUmatrix and R2=0.85 for the SMRT test. In CI listeners the reliability of the RUmatrix and SMRT was R2 =0.8 and R2 =0.46, respectively. A strong correlation between SMRT and RUmatrix test was found for the control group (all conditions analyzed together): R2=0.78 for linear regression and R2=0.83 with a polynomial fit. CI listeners showed weaker correlations, but still a clear trend for better intelligibility with higher spectral resolution measured with the SMRT.

Conclusion: High correlations of SMRT-test and RUmatrix test in the control group, and clear trends in CI listeners indicate the possibility of its use in CI patients.

A predictive model of sentence recognition scores for adult cochlear implant patients

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Objective: Normal listeners listening to acoustic simulations of cochlear implants (CI) can obtain sentence scores near 100% in quiet. In the current study we analysed the longitudinally collected sentence recognition scores of 118 CI users. Our aim was to see what factors may prevent CI users from achieving early, 1-month scores as high as normal-listener-acoustic-simulation scores.

Design: Sentence recognition scores and demographic, device and medical data were collected for 118 subjects who met standard CI candidacy criteria: Computed tomography of the electrode array was available for 96. Predictive factors for initial scores were selected using stepwise multiple linear regression. Results: Labyrinthitis related etiologies chronic otitis and autoimmune disease were associated with lower, widely variable scores in the short and long term. Congenital hearing loss was associated with significantly lower scores in quiet (r2 0.23, $p<0.001$), as was longer duration of hearing loss (r2 0.12, $p<0.001$, -0.76 pts per year). Scores were negatively correlated with insertion depth (r2 0.09, $p<0.001$, -0.1 pts per degree). Scores were also negatively correlated with proportion of the active electrode array found in scala vestibuli (r2 0.14, $p<0.01$, coefficient -25). Thus a simple predictive model was devised by assuming that surgical planning and electrode design can allow insertion depth to be targeted to 360° and that scala dislocation can be avoided. The model predicts 1-month sentence recognition scores using only etiology and duration of deafness as input.

Conclusions: The predictive model of sentence scores allows us to define a target range of performance at one month post activation for adult, newly implanted CI patients based only on demographic factors. If surgical technique can be standardised then only longer durations of deafness and congenital hearing loss should negatively impact early sentence scores to bring them to below ~90%.

FS 37: Experiences with Bone Anchored Hearing Implants

Efficacy of non-skin penetrating transcutaneous implantable bone anchored hearing device (cochlear BAHA attract) in southern area of South Korea

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Background & Objective : To date, percutaneous bone anchored hearing aids has been used for treatment of hearing-impaired patients with satisfactory hearing outcome. However, percutaneous abutment has concerning problems such as hygine, adverse soft tissue reaction and biofilm formation. Transcutaneous BAHA attract was developed for prevention of complications by skin penetrating abutment. To assess surgical, audiological benefits, and quality of life, in bone-achored hearing device users (transcutaneous cochlear BAHA attract 5).

Materials and method : It is a retrospective evaluation of sixteen patients fitted unilaterally by single surgeon. Patients assessed with audiometric measurements and application of Glasgow Benefit Inventory(GBI) and Korean Version-Profile of Hearing Aid Benefit(K-PHAB).

Results : All surgery was done by typical C-shape incision under local anesthetics except one case. The implant was used with 4 mm length except two children with 3 mm length due to cortical bone thickness. Skin reduction was performed in 13 patients except three patient. The patients were divided two type; single side deafness or sensorineural hearing loss (n=12), mixed or conductive hearing loss (n=4). The seroma was complicated after operation in one patient with wafarin user. The seroma was released by conventional dressing. The barovac drain was used for the other patients for prevention of seroma after surgery. There was no wound healing problem. The BAHA attract device was attached 6 or 8 weeks post-surgery. With the device, sound-field pure-tone audiometry results revealed an increase gain in all frequencies. However, KPHAB and GBI showed polarized results because of the inconvenience the patients experience in their daily lives.

Conclusions : The surgery was relatively simple and can be local anesthesia except children. Transcutaneous BAHA attract device can provide good hearing benefit and subjective satisfaction, but sufficient consideration is needed to select for operating patient.

On the evaluation of (super-)power sound processors for bone-anchored hearing

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Ojectives: For patients with a severe-to-profound mixed hearing loss consisting of a moderate sensorineural loss and a large air-bone gap, a powerful percutaneous, direct-drive, bone-conduction device (BCD) is a viable alternative for a conventional hearing aid, owing to the relatively favourable bone-conduction thresholds.

Methods: In 10 patients with profound mixed loss and a percutaneous bone-anchored implant, performance of the Cochlear Baha 5 SuperPower sound processor (BCD2) was evaluated relative to its predecessor, the Baha Cordelle II (BCD1). As a reference, 5 patients with severe mixed loss and a Cochlear Baha 5 Power (BCD-P) were included. BCD2 and BCD-P differ only in maximum force output (MFO).

Results: Speech reception thresholds for the digits-in-noise test were significantly lower for BCD2 than for BCD1. The SRTs for the patients fitted with BCD-P were not significantly different from those with BCD2. With the APHAB questionnaire scores were significantly more favourable for ease of communication and background noise for BCD2 than for BCD1. Scores for the speech and quality domains of the SSQ questionnaire were significantly more favourable for BCD2 than for BCD1. APHAB and SSQ scores for BCD-P were not significantly different from those for BCD2.

Conclusions: Data for BCD2 in profound mixed loss are similar to those for BCD-P and a severe mixed loss. Of 10 patients, two expressed a strong preference for BCD2 over BCD1, and seven patients had a preference for BCD2 over BCD1. One patient preferred BCD1 because of its built-in telecoil facility

BAHA Attract System- Long term postoperative outcome with modified surgical technique

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Objectives: Newly developed transcutaneous BAHA Attract systems have gained increasing popularity. To reduce surgical time and possible postoperative complications, the originally recommended surgical technique and implant loading have been modified.

Materials and methods: In a preliminary study with MRA, Doppler ultrasound measurement and cadaver dissection (n=50 subject), we have proved, that the prevalence of major arteries is low in the upper-posterior area, although large in proximity to the auricle region. Therefore, in our 47 BAHA Attract implantees, incision line was performed in the superior-posterior region of the temporal area. Also implant loading was modified to avoid bone surface drilling. Patients have been followed for 2 years postoperatively. A one page questionnaire -focusing on the hearing performance/wearing/comfort- was filled in all case. Audiological outcome was tested and compared in the two Attract groups: in Group1 (n=11) implant loading was performed in the recommended way, in Group2 (n=10) the implant was screwed out with 180o-360o (~0.5-1mm) and periosteum was preserved around the implant.

Results: Implantation was performed mostly under local anesthesia, average surgical time was ~ 15 min. Sound processor loading could be performed at the 4th week, but necessary magnet strength was lower, compared to the literature. Pain and tissue numbness was negligible according to the result of the questionnaire. Skin irritation (n=4) was solved with less strong magnet. Severe skin complication was detected in only 1 of the total 47 cases. Long term follow-up showed no further complication.

Postoperative audiometry showed significantly better results compared to preoperative tests in both implanted groups. There was no significant difference between the groups in pure tone audiometry results.

Conclusion: Based on our studies, superior-posterior incision line preserves the neurovascular integrity of the implant area, contributes to less postoperative complication, and provides better wearing comfort/aesthetic outcome.

Long-term clinical outcomes of a transcutaneous bone conduction hearing implant: 2-year results from a multicenter study

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Objectives: Evaluating the long-term clinical outcomes of a transcutaneous bone conduction hearing implant. Furthermore, comparing health-related quality of life (HRQoL) before and after implantation.

Study design: Prospective multicenter study

Patients: Fifty-four unilaterally implanted adult patients

Methods: Baseline data were collected during a preoperative visit and after a softband trial. Seven visits were scheduled after implantation of a transcutaneous bone implant in a follow-up period of 2 years. Main outcome measures are soft tissue status, pain, numbness, implant survival, and HRQoL. The average free field aided hearing threshold is compared to the unaided situation and to a pre-operative test using the sound processor on a softband. Furthermore, individual free field hearing thresholds, speech recognition in quiet and in noise are evaluated.

Results: One implanted magnet was removed because of pain, one because of infection. One implant was converted to the percutaneous counterpart because of pain, one because of insufficient audiological benefit. After sound processor loading, soft tissue complications were observed in 3.8%-7.7% of the patients per visit. Pain/discomfort and numbness declined to 15% respectively 9% at final follow-up. Statistically significant improvements were observed on HRQoL-questionnaires (APHAB and SSQ), and on the hearing attribute of HUI3. The device provided significant improvement in hearing performance when compared to the unaided situation. Compared to the preoperative measurement with softband, no difference was observed, except for worsened speech in quiet (65dB:-5.67%, SD16.48%; p=0.024).

Conclusions: The test device significantly improved HRQoL and has a soft-tissue complication rate of 6.5 percent at 24 months follow-up. Pain/discomfort and numbness are reported more frequently at 6 months compared to 24 months. Hearing performance significantly improved compared to the unaided condition and was similar/slightly worse compared to the sound processor on a softband. In conclusion, the test device could be considered a treatment option for appropriately selected and counseled patients.

A multi-center randomized controlled trial of soft tissue preservation using a hydroxyapatite-coated abutment in percutaneous bone conduction hearing implant surgery – 3-year clinical and health economic outcomes

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Introduction: Soft tissue preservation using a hydroxyapatite-coated abutment may lead to a reduction in complications, surgical time savings and associated costs in percutaneous bone conduction hearing implant surgery.

Objectives: The primary outcomes include one clinical endpoint, which combines the occurrence of pain, numbness, peri-abutment dermatitis and skin thickening/overgrowth and a cost-consequence analysis. The outcomes are analysed after three years of clinical follow-up.

Materials and Methods: In this open multi-center, randomized(1:1), controlled clinical trial, eligible subjects were assigned to receive the conventional intervention, a titanium abutment (Cochlear Baha® BA300) with soft tissue reduction, or a new intervention, a hydroxyapatite-coated abutment (BA400) with soft tissue preservation.

Results: 106 subjects were randomized. Previously it was shown that the difference between the groups after one year of follow-up as measured by the primary efficacy variable was not statistically significant (p=0.12) in the ITT population (n=103), but was statistically significant (p=0.03) in the Per-protocol population (n=96). It showed an advantage for the test group, with over twice as many subjects (29%) with none of these important medical events during the first year compared to the control group (13%). Secondary outcome measures, such as surgical time (15 vs. 25 minutes, p<0.01), numbness (90% vs. 69% of subjects experienced no numbness at one year, p<0.01), neuropathic pain (mean score at 3 months, 1.06±0.25 vs. 1.70±1.53, p=0.015) and the overall opinion of the esthetic outcome were favourable for the test group. Five abutments with tissue overgrowth had to be changed in the control group versus one in the test group. No significant differences existed in the occurrence of peri-abutment dermatitis (Holgers index). One implant extrusion was recorded in each group.

The 3 year follow-up is now completed for all subjects. The health economic results will be presented for the first time.

Conclusions: Soft tissue preservation with a hydroxyapatite-coated abutment led to a statistically significant and clinically meaningful reduction in numbness, neuropathic pain and surgical time, and improved cosmetic outcomes in comparison to soft tissue reduction surgery with a titanium abutment after one year. The long-term results, after 3 years of follow-up, will be presented.

Transcutaneous BAHA attract system: long-term outcomes of the French multicenter study

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Background: Bone conduction implants based on abutment-driven acoustic transmission result in good hearing outcomes; however, skin complications impact the quality of life (QOL) and possibly the viability of the device for many patients. The transcutaneous magnetic Baha® Attract technology was developed with the goal of minimizing skin complications.

Objectives: To analyze surgical, auditory, and QOL outcomes for patients implanted with the Baha® Attract.

Design: Prospective multicenter cohort study.

Setting: Four French tertiary referral centers.

Participants: Thirty-two patients implanted with the Baha® Attract.

Main outcome measures: Post-operative follow-up involved measurement of soft tissue thickness and sound processor magnet strength. The audiometric outcomes were evaluated in quiet and noise, and the QOL was assessed using the APHAB, GHSI, and GBI questionnaires.

Results: After 12 months of use, soft tissue was thinner and mean magnet strength was significantly decreased (3.7 to 3.1, $p<0.05$) relative to measures during surgery. The speech recognition threshold in quiet significantly improved compared to unaided situation (73 to 44 dB respectively, $p<0.001$) as did discrimination gain in noise (+2.8). All QOL scores improved, and the APHAB questionnaire score correlated with the audiometric outcomes.

Conclusions: The Baha® Attract technology results in significant hearing gain and improves QOL. Skin complications were not observed, although surgeons, audiologists, and patients should be aware of soft tissue evolution during the first post-operative year. The reversibility of this implant is a major advantage that allows switching to another system if hearing degrades.

FS 38: Application of Evoked Potential Measurements

Audiological indications of extra-cochlear electrodes, how can we find them?

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Objective : "Electrode migration is an underrecognized complication of cochlear implant (CI) surgery." Connell et al. (2008).Rader et al. (2016) examined electrode migration and suggested a flowchart for clinical management of suspected electrode migration where the investigation would start after loss of sound-quality or decreased speech perception despite not finding a significant change in speech perception scores. Extra-cochlear electrodes might be present without noticeable decrement in speech perception since migration might occur gradually and effects on sound quality might go unnoticed. This study examined the audiological indications of the presence of extra-cochlear electrodes (EE)s which are not usually examined in routine clinical practice with radiological confirmation in case of suspicion.

Methods and materials :150 CI device for 122 uni- or bilaterally recipients implanted between 1995 and 2015 went under evaluation for the presence of (EE)s during routine CI clinical programming sessions. 23 adults and 99 implanted as children, Devices included: 90 Cochlea; 40 AB; 8 Med-El and 7 Oticon-Neurelec. All devices were evaluated for a set of possible audiological indications of EEs which included impedance telemetry, T & M/C/MCL levels, Electric compound action potential (ECAP)s and performance with the CI. Radiological confirmation was done in the presence of any suspicion.

Results : 18 (12.5%) CI recipients had EEs which were previously undetected based on routine clinical practice with an average of 2.7 extra-cochlear electrodes (± 1.7) per recipient. Pain was reported by two out of 18 CI recipients only. The most prevalent indications of EEs were elevated or absent ECAPs, elevated T levels at the basal end, limited DR/ abnormal loudness growth at the basal end and fluctuating impedances.

Conclusion : Present clinical practice must be modified to uncover any hidden extra-cochlear electrodes to improve out-come.

The practical applications of objectives intraoperatory and postoperatory measurements

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The cochlear implant is a technical and surgical creation, being the first direct connection between the brain and an electronic device, opening new perspectives in the field of neurobiology.

The purpose of the study was to investigate the variations in the impedance values of intraohlear electrodes in implanted patients, taking measurements in three different stages: intraoperatively, upon activation of the cochlear implant (1 month after surgery) and to the first fitting after activation.

This study is a retrospective view on patients who underwent implantation of a cochlear implant.

The general objective of this paper, what we are focusing on, will show the change in impedance measurement before and after nerve stimulation, meaning during the operation, at the time of device activation and at the first fitting. This monitors the function of- and the healing process around the electrode which reflects the success rate.

This may show that continuous electrical stimulation and repeated measurement of electrical is important for sufficient setting and functioning of the complete device and each electrode, and might be beneficial as not only a diagnostic or monitoring, but also as a therapeutic tool in cochlear implantation and fitting process.

The evaluation of the development of the cortical auditory evoked potentials in cochlear implant users

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Prelingual hearing loss of patients who are found to not benefit sufficiently from hearing aids is applied to cochlear implants before the age of 4.If implemented cochlear implants at an early age,it was better language development and have been shown to develop close to normal language development.A non-invasive technique that the device Aided Cortical Assesmant(ACA) is possible to show cortical development of pediatric cochlear implant users.

In our clinic, 30 patients applied cochlear implant due to prelingual cangenital hearing loss evaluated using the ACA modul p1 n1 formation of waves,after and before implementation.

Development of p1.n1 values recorded in control and study group and results compared.The relationship between implant application age and cortical auditory development evaluated.The obtained data compared with behavioral audiometry and it revelad how much that benefit from the implant.

Relationship between eABR and communication outcomes in children with auditory brainstem implant

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Objective: The objective of the study is to establish the relationship between number of auditory electrodes and communication outcomes, using Electrically Evoked Auditory Brainstem Response (eABR) and scales used to measure auditory and communication performance.

Materials and Methods: Total of 15 subjects were included in the study. They were classified as Good, Poor and No Response groups based on the presence of eABR intraoperatively. All subjects received Med El Pulsar/Concherto implants with Opus 2 Sound Processor.

Good Response means presence of eABR in > 50% of electrodes.Poor Response: eABR in <50% of electrodes and No Response meanseABRcould not be measured in any of the electrodes.

Development of auditory and communication skills were measured using Categories of Auditory Performance (CAP), Speech Intelligibility Rating (SIR)., Meaningful Auditory Integration Scale(MAIS) and Meaningful Use of Speech Sentences (MUSS) across six intervals.

Results : Though the performances weree variable the result suggest that children were able to progress over a period of time.There was a significant difference in CAP scores between the three groups; the Good response group outperformed the poor and no response group. Though the scores were variable, there was no significant difference in SIR scores between the groups. There was a significant difference in MAIS score between good and poor performance, but there no significant difference between poor and no response group. The scores of MUSS revealed significant difference between the groups. The auditory performance in some of the subjects was quite comparable to age matched Cochlear Implant users. However the Speech scores were far below the performance of age matched Cochlear implant users.

Conclusion : ABI is a excellent option for children who are traditionally not a candidate for CI. In difficult situations where the decision making is crucial the expertise and knowledge based on the experience and evidences are very important. In this new field of ABI were the data are very limited to refer, the findings from this study gives some guidance that even if the eABR responses are obtained in less than 50% of the electrodes, the children are like to achieve reasonable level of performance post –operatively.

Test - retest variability of the eCAP threshold in Advanced Bionics implant users: a Monte Carlo simulation study

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Objectives : The stimulation threshold across channels is an essential component of cochlear implant fitting. Thresholds can be obtained objectively by recording the electrically evoked compound action potential (eCAP). A commonly applied approach to determine the eCAP threshold is based on linear extrapolation of the eCAP amplitude growth function (AGF) to zero amplitude. The present study determines the precision of the eCAP threshold as a function of the number of waveform averages.

Material and methods : AGFs were obtained in 7 Advanced Bionics cochlear implant users from 3 electrode contacts: one in the base, one in the middle of the array, and one in the apical region. We recorded 256 eCAP waveforms per stimulus level. All 256 waveforms were averaged to obtain the best-estimate eCAP threshold (the reference). The precision of the eCAP threshold was determined by generating probability distributions using a Monte Carlo approach. To this end, AGFs were reconstructed using only a random subset of the 256 eCAP waveforms available per stimulus level. The precision of eCAP thresholds was determined for 8 to 128 eCAP averages. From these probability distributions the standard deviation was determined and expressed as fractions of the reference threshold.

Results and Conclusions : At the default of 32 averages, the median SD of the eCAP threshold was approximately 1% at all three electrode positions. However, the SD of individual subjects could be >10%. Doubling of the number of averages improved the SD of the eCAP threshold by a factor of approximately 1.4. This factor corresponds to the theoretical improvement in a noisy signal when the number averages is doubled, namely the square root of 2.

We conclude that at default settings, the median standard deviation of the eCAP threshold in the AB system is about 1%. Individual SDs may exceed the median by an order of a magnitude.

Early subjective and objective results with electrode types of different perimodiolar properties and the same cochlear implant electronics

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Background : The authors' aim was to compare the influence of various electrode designs on selected objective and subjective clinical outcomes for cochlear implant recipients using the same model of receiver-stimulator, Cochlear™ Nucleus® Profile Series and sound processor.

Methods : A multicenter study with subjects with profound sensorineural hearing loss, who were implanted and followed up in two tertiary centers. A total of 54 ears were implanted with Cochlear™ Nucleus® CI532, 51 with Cochlear™ Nucleus® CI522 and 54 with the Cochlear™ Nucleus® CI512. Implant loss and intraoperative electrophysiological tests (electrically evoked stapedial reflex threshold [ESRT], neural response telemetry threshold [T-NRT] and impedance), postoperative data (C-level, T-level, dynamic range, T-NRT and power consumption) and intracochlear position of the active electrode were analyzed with Nucleus Custom Sound 4.4 software.

Results : No complications were observed. Outcomes for mean intraoperative ESRT, T-NRT and postoperative T-NRT values were lower in the CI532 group compared to groups using the CI512 or CI522 electrodes. Despite similar mean C-levels measured for groups using the CI532 and CI512, power consumption was significantly lower for CI532 users.

Conclusions : The three electrode arrays from the same implant family Nucleus Profile Series were implanted successfully and safely. The Slim Modiolar electrode takes the position that is relatively closest to the modiolus, in turn, resulting in more efficient stimulation and reduced power consumption.

Soft surgery with perimodiolar array: impact on impedances

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Cochlear implantation has become a common method of rehabilitation in severe to profound deaf children and adults. However, factors such as electrode position and preservation of hearing structures are paramount for better results. Technological improvements have been made both situations possible with thinner electrode arrays that allow round window approach and perimodiolar positioning.

The aim of this multicenter study is to verify whether a new and thinner perimodiolar array show differences in impedances in the intraoperative room that may suggest less trauma than the previous generation of perimodiolar arrays. The impedances of all electrodes of twelve consecutive surgeries of the new perimodiolar device were compared with the impedances of randomly selected twelve surgeries in recent years of the previous generation of perimodiolar device performed by the same surgeons.

Mean values of impedances in the apical region (electrode 22 to 15) were 6.66 kohms and 11.46 kohms for the new and the previous device, respectively. In the medial region (electrode 14 to 8) were 7.37 kohms and 10.97 kohms for the new and the previous device, respectively; and for the basal electrodes (from 7 to 1) they were 8.06 kohms and 11.41 kohms, for the new and the previous device, respectively, with statistical significance for all electrodes.

Discussion will be directed towards whether this findings may lead to postoperative benefits such as lower stimulation levels and longer battery life.

FS 39: CI in Severe Inner Ear Malformation

Radiological and audiological features of a recently defined inner ear malformation: Cochlear Hypoplasia Type 4

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Objectives: To point out the radiological and audiological characteristics of a recently defined cochlear hypoplasia type: cochlear hypoplasia type 4.

To describe this malformation in relation to adjacent anatomial structures within temporal bone.

Material and Methods: This study was a reprospective chart review of the cochlear hypoplasia type 4 (CH-IV). Cases were selected from our departments' database and their CT and MRI images together with audiological evaluation data were revised.Inclusion criteria was having CH-IV diagnosis in at least one ear and having both CT and MRI carried out in hospital. Axial and coronal CT of the temporal bone were evaluated to delineate the features of the malformation appropriately. MRI images were reviewed to evaluate the statos of the cochlear nerve (CN). CN was evaluated on axial and especially on sagittal-oblique T2 weighted images and classified as aplastic, hypoplastic, or normal.

Results: There were 26 ears with CH-IV in our database. In CH-IV; the cochlea has a normal basal turn, but middle and apical turns are severely hypoplastic and located anterior and medially rather than in their normal central position. The labyrinthine segment of the facial nerve is usually located antero-superior to the cochlea rather than in its normal location. Six (27.3%) out of 26 with CH-IV had cochlear nerve hypoplasia. Four ears had naroow IAC. On axial CT scan; facial recess was evaluated also. An imaginary line crosses from the mastoid segment of the facial nerve to the basal turn and round window was created. In CH-IV cases; mastoid segment was anterior to this line. In transmastoid approach; exposure of the round window might be difficult because of this rotational malformation. 22 ears (84.6%) anomalous route of the labyrinthine segment of the facial route. In those cases labyrinthine segment was anterosuperoriorly displaced. 7.7% of the cases had slight to mild hearing loss(HL), 46.2% had moderate to moderately severe HL and 46.2% had severe to profound HL. Some selected cases did not require hearing aids and cochlear implantation. As the number of turns are smaller with narrower scalae, it is strongly advisable to use thin and shorter electrodes. Thick and long electrodes may not be inserted fully into the cochlea. It is important to diagnose CH-IV since the visualization of round window may be challenging and this anomaly has diverse audiological features which directly affect the treatment plan.

A predictive model for cochlear implant outcome in the children with cochlear nerve deficiency

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Objectives: We hypothesized that the outcome of cochlear implant (CI) in the patients having cochlear nerve deficiency might be correlated with the amount of cochlear nerve fiber. To assess this, we determined the size of cochlear nerve and evaluated the correlation with CI outcome.

Material and Methods: A total of 25 CI recipients who had cochlear nerve deficiency were enrolled. The speech performance of patients was evaluated with the Categories of Auditory Performance (CAP) score preoperatively and for 2 years after CI. The amount of cochlear nerve fiber was evaluated with size of bony cochlear nerve canal, internal auditory canal, and vestibulocochlear nerve at the cerebellopontine angle.

Results: The CAP score of the participants at 2 years after CI was variable and ranged from 0 to 6 (3.2±1.8). The patients who had no response in auditory brainstem response test showed significant lower CAP score at 2 years after CI than the patients who had positive responses (2.5±1.7, 4.8±0.7, respectively) (P=0.001). The size ratio of vestibulocochlear nerve to facial nerve at cerebellopontine angle was positively correlated with CAP score at 2 years after CI (P<0.001). In multiple regression analysis to find the predictive factor for CI, the response of preoperative auditory brainstem response test and the size ratio of vestibulocochlear nerve to facial nerve were found to be significant independent factors affecting the CAP score at 2

years after CI. The predictive equation was: CAP score = 0.7+1.9*(ABR) + 1.2*(VCN/FN).

Conclusion: Preoperative auditory brainstem response and size ratio of vestibulocochlear nerve to facial nerve at cerebellopontine angle might predict the outcome of CI in the patients who had cochlear nerve deficiency.

Cochlear nerve canal stenosis and associated semicircular canal abnormalities in paediatric sensorineural hearing loss: a single centre study

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Objectives: This study aimed to evaluate the association between cochlear nerve canal (CNC) stenosis and semicircular canal (SCC) abnormalities and to determine the bony labyrinth anomalies in patients with CNC stenosis. This study was approved by our Medical Rearch Committee, UKMMC (FF-2017-357).

Material and methods: We retrospectively reviewed high resolution computed tomography (HRCT) images of pediatric patients with severe to profound sensorineural hearing loss (SNHL) planned for cochlear implantation from January 2008 until December 2017. A total of 265 ears from 125 patients were included in this study. The diameter of the CNC was measured using calipers on the axial images in each ear along the inner margin of its bony wall at its mid-portion through the base of the modiolus. The CNC diameter of 1.5mm and less were defined as stenosis. An experienced radiologist evaluated the semicircular canals and other bony labyrinth morphology and abnormality.

Results: CNC stenosis was detected in 65 out of 265 ears (24%). The mean axial CNC measurement for 65 ears was 1.26 mm (ranged between 0-1.49 mm). Of the 65 ears, 17 ears had abnormal SCC (26%). Significant correlation was demonstrated between CNC stenosis and SCC abnormalities ($p<0.01$). The most frequent accompanying SCC abnormality was lateral SCC (LSCC) aplasia. Cochlea anomaly of incomplete partition type II (IP-II) was the commonest accompanying abnormality of CNC stenosis. The study also found that there were 8 ears (3%) with isolated SCC abnormalities without CNC stenosis or cochlear anomalies.

Conclusion: CNC stenosis is associated with semicircular canal abnormalities. Whenever a CNC stenosis is present in a HRCT performed for patients with SNHL, the SCC should be scrutinized carefully for presence of abnormalities.

Analysis of postoperative outcomes of cochlear implantation in patients with common cavity deformity

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Introduction: Common Cavity Deformity (CCD) is an inner ear malformation (IEM) with ill-defined and rudimentary but nonetheless distinguishable cochlea, vestibule, and semicircular canals. The cochlea is round or ovoid and the internal auditory meatus (IAM) usually enters the cavity at its center. Since CI in the ear with Common Cavity Deformity (CCD) was firstly reported by Jackler in 1987, it has been widely accepted as a safe and effective treatment for CCD. However , the intraoperative and postoperative complications in CCD patients have always been challenges for otologist. Such as intraoperative cerebrospinal fluid (CSF) gusher, anomalous course of the facial nerve, penetration of the electrode array into the internal auditory canal (IAC) and post-operative meningitis. The previous studies reported that the outcomes of CI in different CCD individuals varied a lot. Whether the electrode stays sticking to the outer wall of the CC has an influence on the outcomes. To make the electrode sticking to the wall, the traditional electrode isn't suitable for CCD patients. What's more, the long-term postoperative audiological and speech development are effective evaluation tools.

Methods: A retrospective review of eighteen patients with CCD malformations. Seven patients underwent cochlear implantation surgery with traditional recess approach, and other eleven patients went through cochlear implantation with slotted labyrinthotomy approach. For patients with slotted labyrinthotomy, temporal muscle was used to seal the labyrinthotomy. Intraoperative and postoperative complications were reviewed. Auditory Performance (CAP), Speech Intelligibility Rating (SIR), Meaningful Use of Speech Scale (MUSS) and meaningful auditory integration scale/infant-toddler meaningful auditory integration scale (MAIS/IT-MAIS) were used to evaluate speech reception. We tested the children at 1, 3, 6, 12, 18, 24 months post first fitting. And postoperative imaging examination high-resolution computed tomography (CT) of the temporal bone were obtained to confirm the position of electrodes.

Results: The transmastoid slotted labyrinthotomy approach filled with muscle was used in eleven patients, and the facial recess approach was used in seven patients. Intraoperative CSF leakage was found in one patient with single-slit cochleostomy approach and three patients with traditional facial recess approach. None occurred postoperative complications. MED-EL short electrodes were used in all seven patients. Eleven patients received customized electrode which was designed based on the character of their cochlea. Now the patients recovered well. Speech reception tests were performed two years regularly after implantation, their CAP, SIR, MUSS, IT-MAIS median score are 5.12, 3.12, 7, 16.87, respectively. And the short electrodes speech reception tests median score are 1.67, 1.5, 4.6, 5.2, respectively. The auditory perception results measured in this study show a chronological improvement over time.

One year postoperative CT scans results confirmed that the electrode arrays were situated along the outer wall of the cavity for all patients with no anomalies.

Conclusion: For patients with common cavity malformation, optimized surgical approach should be selected according to their cochlea characters. Temporal muscle fascia can be utilized to seal the labyrinthotomy in slotted labyrinthotomy approach. Customized electrodes can be considered for patients with severe inner ear malformation.

FS 40: Experiences in CI and Single-Sided Deafness

Long-term results of auditory abilities after cochlear implantation in subjects with unilateral deafness

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Objective: Conventional treatments for single sided deaf subjects (SSD) are very limited. If treated at all, acoustic signals are only picked up from the deaf side and routed to the hearing side either as an electrical signal (CROS) or through bone conduction (BAHA). Both methods use for the transmission of auditory signals only the contra lateral hearing cochlea and do not utilize the peripheral auditory pathways on both sides. However, through electrical stimulation via a cochlear implant the deaf side can be activated. The aim of our present study was to demonstrate that in such a case speech reception in noise and localization can be improved.

Study design: Nine adult participants with short-term unilateral deafness (<5 yr) participated. All had sudden onset of severe-to-profound hearing loss in 1 ear, which then received a CI, and normal or near normal hearing in the other ear. Speech recognition in quiet and noise with an adaptive sentence test was tested after 3 months, 6 months and 12 months. Three binaural effects were calculated: summation effect (S0N0), squelch effect (S0NCI) and combined head shadow effect (SCIN0). For localization, a 7 loudspeaker setup (± 90°, 30° distance) was used. Discrimination was tested preoperatively (normal hearing (NH) ear alone) and after 12 months bilaterally (CI and NH).

Results: One subject quit the study after 3 months due to subjectively limited benefit. All other participants had open-set speech recognition and excellent audibility with the CI. Sentence recognition in the various noise conditions show significant bilateral improvement over time, i.e. in the condition S0N0 from -3.1 dB preoperatively to -5.7 dB after 12 months. Localization improved bilaterally compared with the NH ear alone up to 10° RMS. The 8 participants wore the CI full time, and subjective reports were positive.

Conclusion: Overall, the CI recipients with unilateral deafness obtained open-set speech recognition in quiet and in noise and improved localization. However, careful patient selection is a decisive factor for a successful treatment of this patient group. Under these conditions, CI implantation is a viable treatment of single sided deaf subjects.

Quality of life before and after cochlear implantation in cases of unilateral and asymmetric hearing loss

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Objective: Patients with moderate-to-profound unilateral hearing loss (UHL) and asymmetric hearing loss (AHL) experience poorer quality of life as compared to normal hearers. Current treatment options limit the ability to use binaural cues for improved spatial hearing. Patients may experience improved quality of life with use of a cochlear implant (CI) in the affected ear. Quality of life assessment before and after cochlear implantation may reveal changes to aspects of hearing beyond those explicitly evaluated with behavioral measures.

Methods: Thirty-five subjects with UHL or AHL underwent cochlear implantation of the affected ear as part of a clinical trial investigating outcomes over the first year of device use. Quality of life was assessed with the Speech, Spatial, and Qualities of Hearing Scale (SSQ), the Abbreviated Profile of Hearing Aid Benefit (APHAB), and the Tinnitus Handicap Inventory (THI). Subjects were evaluated preoperatively, and at one, three, six, nine, and twelve months post-activation. Responses were compared over time and between groups (UHL and AHL).

Results: Subjects demonstrated a significant improvement in quality of life after receipt of the CI, with benefits noted early after initial activation. The UHL group reported less perceived difficulty at the preoperative compared to the AHL group, which may be due to the presence of the normal-hearing ear.

Conclusions: Cochlear implantation in cases of substantial UHL and AHL may offer significant improvements in quality of life. Quality of life measures revealed a reduction in perceived tinnitus severity, and subjective improvements in speech perception in noise, spatial hearing, and listening effort.

Unilateral hearing loss and cochlear implants : speech perception, sound localisation and tinnitus benefits

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Objectives: Whilst the cochlear implant is often regarded as the intervention of choice for adults with bilateral severe hearing loss or worse, benefits for adults with a unilateral hearing loss have recently been reported in the literature. This study aims to quantify the changes in free-field and direct-input speech perception and sound localization abilities over a period of two years, for a group of adults who have a unilateral hearing loss and received a cochlear implant at the Royal Victorian Eye and Ear Hospital Cochlear Implant Clinic.

Method: The test battery involved spatially separated speech-in-noise presented free field and sound localization utilizing pink noise presented across a 13-speaker array administered pre-implantation and at 3, 12 and 24 months post-implantation, as well as a monosyllabic word test post-implantation presented to the cochlear implant sound processor alone). Participants also completed three questionnaires: the SSQ, the Iowa Tinnitus Questionnaire, and the International Outcome Inventory- Hearing Aid (IOI-HA), at the same test points. In this preliminary analysis, the pre-operative results for each participant were compared with their most recent post-operative results.

Results: A comparison of results from the spatially separated speech-in-noise test obtained post-operatively versus pre-operatively revealed a significant improvement of 5.08 dB for the group ($p<0.001$). A significant improvement in localization of 12.25RMS ($p=0.001$) and in self-reported tinnitus of 17.93% ($p=0.002$) was also found. The group's average CVC phoneme score was not significantly different to the average score obtained by the clinics bilaterally hearing-impaired adult group.

Conclusions: Preliminary results for 29 adults with a unilateral hearing loss who received a cochlear implant, show an improvement in hearing abilities and tinnitus symptoms post-operatively, although considerable variation in outcomes is observed for individuals. Further results will be obtained as more adults are recruited into the study.

Benefits of a cochlear implant in adults with single-sided deafness / asymmetric hearing loss acquired within a unified testing framework

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Objective: Treatment options for patients with single-sided deafness (SSD) and for patients with asymmetric hearing loss (AHL) are: conventional (bilateral) contralateral routing of signal ((Bi)CROS) hearing aid, bone conduction implant (BCI) and cochlear implant (CI). Only a CI allows restoration of binaural hearing. Advantages of binaural hearing with a CI have been shown in previous studies. Due to the heterogeneity of the studies, it is impossible to compare the results. The aim of our study is to collect comparable data by respecting a unified testing protocol designed for use in multicenter studies.

Methods: At present seven SSD and AHL adult patients have been included in the study. Outcome measures are assessed pre- and postoperatively 1, 3, 6, and 12 months after activation of CI. Four patients have already completed the 6 months examinations. Amongst others, speech reception thresholds (SRT) unaided and CI-aided are measured for two different noises (olnoise and 2-talker babble noise (TTBN)) and for five different presentation conditions (SSSDNAH, SSSDN0, S0N0, S0NAH, SAHNSSD; SSD: stimulus presented to the deaf ear, AH: stimulus presented to the acoustically hearing ear, presentation angles -90°,0° and 90°). Thresholds were obtained using a modified Oldenburg sentence test (OLSA).

Results: Six months after CI activation all patients performed much better with CI than preoperatively unaided: SRT benefits in TTBN range from 5.4 to 11.7 dB in the SSSDNAH condition (Head shadow effect), from 3.2 to 5.3 dB in S0N0 (Summation effect) and from 4.6 to 6.3 dB in S0NSSD (Squelch effect). Use of the CI was favorable in all tested hearing conditions, even in the SAHNSSD condition, for which benefits range from 1.1 to 6.5 dB.

Conclusion: Our preliminary results show benefits in speech comprehension in noise with CI, for both noise types and in all hearing conditions from -90° to +90°.

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Audiological rehabilitation as an e-health app on tablet: feasibility study with adults with SSD

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Audiological rehabilitation (AR) is important to improve auditory and communication skills of persons with hearing impairment (HI), in order to optimize participation in society. The complexity of encountered difficulties due to HI requires a holistic approach to AR, consisting of sensory management, auditory-cognitive training and counselling. Although the importance of providing a comprehensive AR program is widely acknowledged, the majority of people with HI is not entitled to it (e.g., people with SSD). Computerized AR offers an efficient, cost- and time-effective method for a large group of persons with disabling HI, adapted to their personal needs.

We developed a prototype of the LUISTER AR e-health scheme that consists of an assessment battery to determine the communication status, a variety of linguistic auditory-cognitive exercises as well as a generic, non-linguistic

training task and a binaural training task. We are currently evaluating the feasibility and usability of this prototype e-health scheme on a tablet in adults with SSD and a CI. These data will be presented, as well as on-task improvement and data logging of the intensity and frequency of training.

Cochlear implantation in single-sided deaf adults with tinnitus

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Objectives: This study investigates the benefit of cochlear implantation (CI) in subjects with adult-onset single-sided deafness and invalidating tinnitus.

Methods: Prospective study design in which 5 persons with adult-onset severe single-sided hearing loss and disabling tinnitus received an Advanced Bionics HiRes90K cochlear implant. Outcome measures obtained before implantation, and 3, 6 and 12 months after implantation were speech discrimination in quiet and noise, localisation and tinnitus severity on 10-point visual analogue scale (VAS). Speech recognition in noise was evaluated in conditions S0N0, S0N90 and S0N-90, comparing the binaural signal-to-noise ratio (SNR) pre- and post-implantation and utilising the better ear only. Localisation was analysed in a horizontal half circle configuration with 9 loudspeakers. Repeated-measures ANOVA was conducted.

Results: Mean phoneme scores in the implanted ear improved significantly from 0% to 78% (SD 7.3) at 3 months and remained stable up to 12 months (81%, SD 7.4) postoperatively ($P<0.001$). In binaural condition, no significant differences in SNR could be demonstrated in any set-up compared to the preoperative measurements or the better ear only condition. Tinnitus severity improved significantly with a mean VAS-score of 7.6 (SD 2.1) pre-implantation to 2.2 (SD 3.0) at 3 months postoperatively and remained stable up to 12 months (2.3, SD 1.9) postoperatively ($P<0.05$). Localisation abilities improved significantly from an overall mean rms error score of 81° (SD 12.2) pre-implantation to 27° (SD 6.8) 3 months postoperatively and remained stable up to 12 months postoperatively (<0.05).

Conclusion: CI in adults with single-sided deafness and invalidating tinnitus improves localisation abilities and reduces tinnitus complaints which last for at least 12 months post-implantation. Therefore, it should continue to be considered as a treatment option in patients with unilateral hearing loss and disabling tinnitus.

Cochelar implantation effects on tinnitus: A systematic review

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Background: Cochlear implantation (CI) is recognised to influence tinnitus perception to a variable extent. Expansion of CI indications has stimulated increased research into its use for both single-sided deafness and severe tinnitus.

Objectives: To systematically review the quality of the evidence for tinnitus outcomes after CI and to determine the effects of CI on tinnitus (using level 1-2 evidence).

Methods: A systematic review of evidence from the research literature was performed as per The Cochrane Collaboration guidelines. A structured search strategy was applied to eight major biomedical bibliographic databases (from inception to December 2017). Electronic searches were supplemented by manual searching of references from articles. Researchers independently screened studies using predetermined inclusion criteria (English, multichannel cochlear implant, validated tinnitus outcome described, level 1-2 evidence). Data from each study was extracted using a pretested data form for assessing patient population, study design and outcomes. Any discrepancy between reviewers was resolved through discussion.

Results: Most studies were of moderate to poor quality but there were also a minority of good quality methodological studies on the effect of CI on tinnitus.

In the included studies incorporating over 1270 patients, over 70% of CI recipients reported complete or partial tinnitus suppression (with significant reductions of handicap/distress on validated outcome measures). There was complete elimination of tinnitus in over 40% with even better results in those with single sided deafness and severe tinnitus. Tinnitus could be induced in under 10% of patients who had no tinnitus prior to cochlear implantation. Ipsilateral and contralateral differential effects were also seen.

Conclusions: To the best of our knowledge, this is the most comprehensive systematic review in the world literature on the effects of CI on tinnitus. Increasing quality of evidence demonstrates significant reductions of tinnitus handicap/distress with CI.

FS 41: Patient Reported Outcome Measures

The role of datalogging and functional listening in monitoring client outcomes

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Introduction : The introduction of datalogging into cochlear implant technology provides valuable information to facilitate optimisation of listening environments for both client and clinicans. Quality of life can be reflected in the environment scene analysis of datalogging when combined with other measurement tools including the SSQ. The importance of using a test battery to identify potential areas of improvement for clients was investigated.

Method : Datalogging of 100 adult CI recipients were examined over a period of 3 months post cochlear implant device activation. During that time, the SSQ was administered and compared to preoperative SSQ measures.

Results : The scene analysis of datalogging correlated with subtests on the SSQ in particular the quality and the speech scales. Trends in datalogging of various age groups were identified, in particular younger adults and older adults. This information provided a platform for counselling for adults in determining "normative data" for device use and for developing strategies to improve outcomes and performance with the CI .

Conclusion: Datalogging is a quick accessible ongoing measure of factors that impact on a cochlear implant recipients quality of life. Regular review of datalogging can provide insights that can assist clinicians in supporting improvements in quality of life of their clients. It is cautioned that datalogging cannot be used in isolation and should be matched with a QOL measure such as the SSQ.

Interchangeability and sensitivity of longitudinal self assessment scores via the SSQ12 and SSQ49 for a large cohort of implant recipients.

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Objective: To assess the relationship and agreement between outcomes derived via the shorter SSQ12 and the original SSQ49 self-assessment scales for a large cohort of hearing implant users, longitudinally. Interchangeability and sensitivity of change scores were examined.

Design: Prospective, multicenter, multinational, observational study (e-registry).

Setting: Seventy hearing implant centers.

Methods: Responses to the SSQ49 from 915 registered hearing implant users (cochlear implant, acoustic implant and bone conduction devices), assessed at preimplant and 1, 2 and 3-years postimplant, were extracted from a centrally-hosted database of an ongoing, voluntary registry (Cochlear-IROS, @July 2017). Pearson and Spearman analysis of correlation between SSQ49 and SSQ12 responses for total and sub-domain scores was performed. Sensitivity of change scores using longitudinal mixed-effects models were also compared.

Results: Pearson and Spearman correlations indicate high agreement of outcomes derived with longer and shorter scale versions ($r > 0.93$) at preimplant, while Bland-Altman agreement methods showed that respective mean group scores cannot be considered interchangeable. Longitudinal change scores for each scale version were confirmed to be interchangeable, demonstrating statistically and clinically significant improvements from preimplant to 1-year post implant ($p<0.001$; >2.1 units increase in all SSQ scores), that remain stable at 2 and 3-years.

Conclusions: Clinically, the SSQ12 can be considered an effective, sensitive and time-efficient alternative to the SSQ49, with interchangeability of change scores derived from each scale version confirmed as appropriate, but not group mean scores. Inclusion of the SSQ12 as part of routine clinical practice to assess daily hearing function benefits from implant treatment can be a practical step towards establishing comparable and aggregable cross-cultural outcome data and evidence of treatment benefits at large.

Longitudinal observational study of patient related benefits for adult cochlear implant recipients

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Objective: A number of factors influence cochlear implant outcomes. Outcomes are usually reported in speech perception scores which is a challenge in South Africa as there are no comparable material in the eleven different official languages. In 2011, our Cochlear Implant Unit started using the Cochlear IROS registry in order to obtain and assess consistent voluntary data collection of subjectively reported patients related real-world benefits longitudinally for cochlear implant users.

Material and Methods: A descriptive retrospective repeated measures longitudinal study with intra-subject controls and intergroup comparisons, using standardised evaluation tools for both hearing benefit via the Speech Spatial Qualities (SSQ) Questionnaire and general quality of life via the Health Utilities Index (HUI III). Data of 74 recipients were collected in parallel to routine clinical visits: preoperatively, 1,2,and 3 years post-operatively.

Results and Conclusions: For all the subscales of the SSQ there were statistically significant changes between the preoperative scores and the follow-up at the 1 year interval for all recipients. These results were stable over time. In the HUI III domains of Hearing, Speech and Emotion, there were significant improvements at the 1-year interval. This

was shown by the significance of >0.05 at the 95% confidence interval which suggested the change was not due to chance, but confirms the effect of cochlear implantation. These changes were consistent over time. Pre-operative patient characteristics such as comorbidities, dizziness, tinnitus, telephone use, contra-lateral hearing aid use, educational level and socio-economic status will be discussed as possible predictors of cochlear implant outcomes.

Knowledge of how factors affect performance will influence counselling.Speech perception testing needs to be supplemented with real-life benefit outcomes measures in real-world experiences. The IROS registry could lead to predicting outcomes.

Health Related Quality of Life improvement after cochlear implantation

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Objectives: According to Health Technology Assessment guidelines it is required to include the Health Related Quality of Life (HRQoL) evaluation in the assessment of health effects. Moreover a standardized and validated generic (non-disease-specific) instruments are recommended. So far most studies related to HRQoL assessment in the field of cochlear implants (CI) were performed with disease-specific questionnaires. The aim of this research is to assess the HRQoL in adult cochlear implant users with a generic questionnaire.

Material and Method: HRQoL was assessed in 62 adult cochlear implant users with AQoL-8D questionnaire. Mean age at CI in the group was 54 years. The AQoL-8D was distributed to the patients at CI activation and at 9 and 24 months of CI use. The HRQoL was analyzed in eight dimensions (Independent Living, Pain, Senses, Mental Health, Happiness, Coping, Relationships, Self-Worth), in two super dimensions (Physical and Psycho-Social), and as Health Utility Index.

Results: The median of Health Utility Index increased significantly from 0.59 to 0.73 after two years of CI use (p=0.0009). The significant improvement over two years of CI use was observed in dimensions related to Independent Living (p=0.003), Senses (p=0.00004), Relationships (p=0.0008) and Self-Worth (p=0.006) as well as in Physical (p=0.004) and Psycho-Social (p=0.003) super dimensions.

Conclusion: Cochlear implantation improves quality of life in both physical and psycho-social dimensions.

Self-assessment of speech recognition at home by adult cochlear implant users

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Introduction: The number of cochlear implant (CI) users increases annually, resulting in a higher workload for CI centres. There is a general trend worldwide to increase patient involvement and to use eHealth technologies in audiological rehabilitation. Self-administered home testing could result in time and cost savings for CI centres and patients. We performed several studies to develop, validate and use self-administered home tests of speech recognition in quiet and in noise by experienced and newly-implanted adult CI users.

Methods: First, we developed tests for CI users to self-assess speech recognition at home. The standard Dutch speech recognition tests (monosyllable words in quiet and digit-triplets in noise) were implemented on a tablet computer. Stimuli were calibrated and directly presented to the processor using an audio cable. Second, speech recognition of experienced CI users was assessed in the clinic with a loudspeaker in a sound-treated booth and compared to self-assessed speech recognition at home. Finally, newly-implanted CI users self-assessed speech recognition at home twice a week during the first three months of rehabilitation.

Results: It was demonstrated that the use of an audio cable is a viable alternative to the use of a loudspeaker for the presentation of stimuli. Both new and experienced CI users were positive about the self-assessment of speech recognition at home. The frequent assessment of speech recognition during the first three months of rehabilitation provided additional information as compared to care as usual, without the need of additional visits to the clinic.

Conclusions: Self-administered tests to assess speech recognition within the home environment could serve as a reliable and valid alternative to tests administered in the clinic. In the future, self-administered home tests could be used to gather information prior to regular appointments of CI users, or to gather additional test results independent of scheduled appointments.

Quality of life of school and college-goers with post lingual deafness with cochlear implant in National University of Malaysia

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Introduction : Some school or college-goers with post lingual deafness have found it difficult to comprehend teachings in classes or participate in outdoors academic activities with conventional hearing aids. It has soon disturbed their performance at certain stage after years with the old aids. This also indirectly may affect their quality of lives. However, in view of variable results among cochlear implant recipients, we are interested to subjectively measure the quality of life and academic and social performances in these population in our centre.

Objectives : To subjectively measure the quality of life and academic and social performances in these population in our centre.

Methods : A cross-sectional study in a group of 9 school or college-goers with post lingual deafness of both genders, with mean duration of cochlear implant use of 3.5 years. The Nijmegen Cochlear Implantation Questionnaire and the generic World Health Organization Quality of Life questionnaire were used.

Results : Amongst the best assessed domains for the quality of life questionnaire are the social and psychological domains. Academic or social participations improved significantly. The variables including level of education and social backgrounds also influenced the results of both questionnaires. Otherwise, variables such as gender or time of implantation did not show significant effect on the quality of life.

Conclusion : From the cochlear implant users perspectives, both questionnaires showed that cochlear implant has given benefits in different aspects related to quality of life

FS 42: Aspects of CI and Pediatric Rehabilitation

Our experience with the Nucleus CI532 electrode in a paediatric population

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Objectives: To prove that the Nucleus electrode CI532 is a good primary choice in a paediatric population of congenitally deaf children

Materials and method: There were 120 children implanted in the period 6/2014 till now. Vast majority of these children were implanted bilaterally simultaneously. Out of this number, 51 children were implanted with the Nucleus CI532 electrode (thin perimodiolar).

Results: The surgery is described in detailed way. Complications with this type of electrode are described (tip foldover, depth mismatch).

Conclusion: For the reasons of its atraumatic insertion and perimodiolar position, this type of electrode is used as a primary choice in small children with congenital deafness.

Cochlear implantation in prelingual and postlingual hearing impaired children

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Objectives: A perfect understanding of relationship between receptive and expressive language in CI users, especially in children, is still not possible. We know that age at implantation, duration of CI use, inappropriate family environments, inner ear malformations, dysfunction of the synapses in auditory pathway or neurocognitive disorder are negatively associated with success in cochlear implantation. In some studies it was observed that the most influent factor to the auditory result after CI is not the age at the implantation, but the time that the patient remained with hearing loss.

Material ant methods: We analysed speech perception abilities after cochlear implantation in children with prelingual and post lingual, progressive hearing loss. Children with prelingual hearing loss were dived in 2 groups regarding the age at the implantation. For all participants we applied closed and open set for monosyllable words 12 months after implantation, open set for polysyllable words in quiet and noise 24 and 36 months after surgery and sentence perception test 36 months postoperatively.

Results: All participants showed significant improvement in speech perception abilities over the time. The lowest speech perception score 1 year after surgery was observed in group of children implanted between 3 and 5 years of age, but difference was not significant. Children with post lingual progressive hearing los achieved significantly better speech perception score in all tests two and three years after implantation (89-90,8%) comparing with the those implanted up to 2 years (73,6 - 81,2%) and between 3 and 5 years of age (63,2-74,8%).

Conclusions: Continuance of implant use played a major role and significantly improves speech perception in CI children. The duration of auditory privation is better related to the CI outcomes then the age that patient was implanted.

Residual disability of children with bilateral implants - Which everyday situations are difficult and how does their performance compare with that of their peers?

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Objectives : Aim 1 was to use parent ratings of performance to indicate the relative degree of difficulty experienced in different everyday listening scenarios by children using bilateral cochlear implants (CIs). Aim 2 was to compare ratings with those from parents of children with normal hearing (NH).

Materials/Methods: 81 parents of children aged 7.5-9.5y, including 21 with NH, participated. Mean age at first and bilateral implantation was 1.4y and 3.3y. The Speech, Spatial and Qualities of Hearing Scale for Parents was administered. The 9 items in Section A focused on speech perception in single speaker or group conversations in varied backgrounds. The 6 items in Section B focused on spatial hearing (i.e., location and movement of sound sources). The 8 items in Section C focused on other qualities of hearing, including sound segregation and listening effort.

Results/Conclusions : In Section A, the parent ratings for the CI group were high (mean 9.6 out of 10) for a single speaker in quiet but decreased with the addition of more speakers, background noise and an absence of visual cues. Mean ratings in the most difficult scenarios involving group conversation in background noise were only around 4 to 5. In Section B, the CI group demonstrated more difficulty in locating environmental sounds than locating speakers. In Section C, there was more variation, with the lowest ratings were for items related to listening effort, ignoring extraneous sounds and identifying or distinguishing between environmental sounds. Across all items, except a single speaker in quiet, the group ratings were significantly lower for the CI group; however, on each item, ≥50% of CI children were rated at least equal to the lowest-rated NH children, and many CI children were rated as performing exceptionally well. There was a significant correlation between ratings for each group, indicating a similar pattern of low and high performance ratings across scenarios.

Get real in ear before CI - How accurate is accurate in hearing aid fitting

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Given that hearing aid trial is an important stage of cochlear implant (CI)candidacy evaluation, it is critical for hearing aid providers to use best practice and employ evidence-based through this process. To assess benefit of hearing aids before proceeding with cochlear implantation, an optimal hearing aid fitting to ensure audibility is important. For successful fitting in pediatrics and adults, certain steps should be completed and taken into considerations to reach the appropriate health management for our patients.

Since the 90s, best practice guidelines have been powerfully arguing the use of probe –mic to verify appropriate fitting of hearing aids. Numerous research have published compelling findings that support verification when fitting pediatric and adult populations (Gustav Mueller, 2016, Best Practice is a Matter of Ethics-JAAA, Catherine Palmer, 2009,Mueller,H.G., 2014,McCreery,R.,Bentler,R., &Roush, P. 2013,..etc). Researchers have recently found that the two prescription methods (The National Acoustics Laboratories -NAL , since 1976 and The desired Sensational Level-DSL, since 1984) that are available in all hearing aids' manufacturers, provide similar outcomes only if they were verified in the ear canals.Moreover, today hearing aids offer more special features to use but needs to be verified as well. For example, using late-onset for patients with Auditory Neuropathy Spectrum Disorder -ANSD (Mathai,J. P., &Yathiraj, A.2017), and using frequency shifting when audibility can not be obtained in high frequencies (scollie et al, JAAA, 2016).

The purpose of this talk is to cover the importance of verifying accuracy in clinical practice and review compelling research of hearing aid verification. It will also argue the importance of audibility in successful hearing aid trial before cochlear implantation. Furthermore, it will discuss the main neglected steps by hearing providers in hearing aid fitting and verification:why and how to overcome that.

Peripheral brain-derived neurotrophic changes following pediatric cochlear implantation

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Brain-Derived Neurotrophic Factor (BDNF) plays an important role in synaptic functions and experience-related plasticity. Peripheral BDNF blood concentration changes could be a marker of plasticity which might help scientists to determine the prognosis of CI as in the candidacy procedure or enhancing prosthesis function by adding the exact needed amount of BDNF to the electrode array.

In the current study, we evaluated the plasma BDNF concentration before CI surgery and 6 months after using CI device in 15 pediatric CI recipients and compared this level with changes of BDNF concentration in 10 children who were using hearing aid (HA). In addition, we searched for a possible correlation between post-surgery plasma BDNF concentration and electrical compound action potential (ECAP) and comfort-level (C-level) thresholds.

Results showed that plasma BDNF level in children with CI increased significantly after CI surgery, while this difference in HA group was not significant. Analysis of repeated measures of ECAP and C-level thresholds in CI group showed that there were some kinds of steadiness during follow- up sessions for ECAP thresholds in basal and E16 of middle electrodes, whereas C-level thresholds for all selected electrodes increased significantly up to six months follow-up. Interestingly, we did not find any significant correlation between post-surgery plasma BDNF concentration and ECAP or C-level threshold changes.

It is concluded that changes in C-level threshold and steady state of ECAP thresholds and significant changes in BDNF concentration could be regarded as an indicator of experienced-related plasticity after CI stimulation.

Towards a questionnaire regarding management and performance outcomes for pediatric CI populations

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Objectives :Deafness affects the lives of children which were born deaf. Cochlear implantation offers a solution for the development of language skills, and often, the implanted children manage to catch up with their hearing peers. Early diagnosis and implantation, as well as the appropriate type of intervention are of upmost importance for the efficiency of cochlear implantation.

In this paper, we deal with factors of pediatric patients' management strongly impacting the development of communication skills early after cochlear implantation.

The literature reports several investigations on the management of the hearing recovery procedures after cochlear implantation, or the achievement indicators in communication of preschool implanted children, however examined in isolation from each other.

In this work, we move towards the development of a questionnaire that will encompass both of these factors and will attempt to investigate their potential relations and relevance.

Methods: We propose a novel questionnaire resulting from the reprocessing of established and commonly used questionnaires (CAP, SIR, GBI, MEDEL LittlEARS Auditory Questionnaire and a questionnaire constructed after a joint research project between the Attikon Hospital 2nd ENT University Clinic, Athens, Greece and the AHEPA Hospital 1st ENT University Clinic, Thessaloniki, Greece), with item selection based on comparative and correlational control in which communality between questions was compensated by exclusion after expert paneling.

Results and Conclusions: Aspects of the construction and initial evaluation are presented together with a planning towards analyzing of relations between factors of pediatric CI population management and performance achievement. The application of the questionnaire to a larger sample will hopefully provide important information and constitute a useful guide for parents and specialists involved in the restoration and rehabilitation process chain of implanted children.

FS 43: Experiences with Non-Implantable Bone Conduction Devices

First experiences with a new pressure free, adhesive bone conduction hearing device - ADHEAR

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Objectives: The aim of this study was to evaluate the hearing benefit, advantages and disadvantages with a new, non-implantable, pressure-free, adhesive bone conduction hearing aid in a series of patients.

Methods: 12 patients were included in the study at the ENT department of the Medical University of Vienna. All patients suffered from conductive hearing loss for at least three months. A sound field audiometry, Freiburg monosyllables word test and Oldenburg sentence test were performed. Additionally, sound quality (SSQ12) and quality of life (AQoL-8D) were assessed using questionnaires.

Results: Analysis revealed an average aided threshold of 30.1 dB HL (±7.0 SD) and an unaided threshold of 45.0 dB HL (±6.8 SD), resulting in an average functional gain of 14.9 dB with a statistically significant difference ($p < 0.001$). Additionally, participants experienced about 30% gain in word recognition scores at 65 dB, SRT in quiet was 56.8 dB (±6.1) and improved to 44.5 dB (±6.4). Both the SSQ12 and the AQoL-8D showed a statistically significant improvement.

Conclusion: In conclusion, this new, adhesive bone conduction hearing aid has a high patient satisfaction rate while causing no skin irritation or pain. The hearing gain was similar to other conventional bone conduction devices without the usual esthetical and pressure associated disadvantages.

Comparison of the performance of two non-implantable wearing options for bone conduction devices

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Objectives: To asses and to compare the performance of a bone conduction device (Baha 5, Cochlear Inc.) attached to either (i) a Softband and (ii) to a novel non-invasive wearing device (SoundArc) in adults with normal conductive hearing losses and normal inner ear functions.

Materials and Methods: Fifteen normal hearing subjects participated in this study. Both ears

were occluded to simulate a bilateral conductive hearing loss, resulting in an unaided hearing loss of 48 dB (Pure tone average 500 to 4000 Hz). The following measurements were performed in unaided conditions, and with unilateral and bilateral bone conduction devices:

sound field thresholds, speech reception thresholds in quiet and in diffuse noise (German Matrix Test, OLSA), and sound localization (unilateral and bilateral aided conditions).

Results: All outcome measures were significantly better in the aided conditions with either the Softband or the SoundArc than in the unaided conditions. Sound field thresholds improved by 24 dB ($p < .001$), speech reception thresholds in quiet by 20 dB ($p < .001$) and in noise by 4 dB ($p < .001$). Sound localization and speech understanding in noise was improved significantly when using the bone conduction devices bilaterally, rather than unilaterally. Differences between the Softband and the SoundArc waering options were not statistically statistically in any test or in any condition.

Conclusions: Both non-implantable wearing options bone conduction systems showed significant improvements in speech understanding in quiet and in noise, when compared to the unaided condition. No significant difference between the 2 wearing options Softband or SoundArc was found. Using 2 devices bilaterally instead of just one improved speech understanding in noise and sound localization.

Speech understanding and sound localization with the ADHEAR system in uni- and bilateral conditions

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Introduction: The objective of this prospective study was to assess the audiological benefit of a new non-invasive bone conduction implant (ADHEAR, Med-El, Austria) in normal hearing adults with induced bilateral conductive hearing loss. Moreover, the additional benefit of bilateral fitting compared with a unilateral situation was assessed.

Methods: Fifteen subjects were included in the study. All subjects had normal hearing (i.e., bone and air conduction thresholds ≤ 15 dB HL). Both ears of the subjects were occluded, leading to an averaged sound field PTA of 49 dB HL. Outcomes were assessed in the unaided, unilateral, and bilateral treatment conditions: sound field thresholds, speech reception thresholds in quiet (Freiburg numbers) and in noise (multi noise, German Matrix Test, OLSA). In addition, sound localization was measured in the uni- and bilateral treatment conditions using 12 loud speakers arranged in the horizontal plane.

Results: Sound field thresholds improved by 24.6 dB in the unilateral and by 26.8 dB in the bilateral condition. Speech reception thresholds (SRTs) in quiet improved by 20.0 dB in the unilateral and 22.7 dB in the bilateral condition. SRTs in noise were improved by 3.6 dB (unilateral) and 4.5 dB (bilateral), if speech was presented from the front. With speech presented from the unilateral side, SRTs were improved by 4.0 dB (unilateral) and 3.8 dB (bilateral) compared to the unaided situation. IF noise was presented form the contralateral side, only small SRT differences (-0.6 dB) were observed. Bilateral fitting, however, improved the SRTs by 3.8 dB. The mean absolute localization error was improved from 81° in the unilateral to 47° in the bilateral condition.

Conclusions: The ADHEAR bone conduction system substantially improved sound field thresholds, speech understanding in quiet and in speech understanding in noise of the subjects. Bilateral fitting additional improved speech understanding in noise and sound localization.

The ADHEAR – a band-aid-fixed bone-conduction hearing aid – is a good treatment option for children with conductive hearing loss

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Objectives: Conventional bone conduction hearing aids for children bear several disadvantages: headband-integrated

systems are frequently not well accepted due to pressure on the head, sweating, or cosmetic stigma. Also, the mechanical conduction loss is higher as for per- or transcutaneous systems. The bone conduction hearing aid ADHEAR seems to overcome a part of these disadvantages by clipping an audio processor on a band-aid fixed behind the ear.

Material and Methods: A clinical study* evaluates the audiometric benefit, the usage and the patients' and parents' satisfaction of 10 children aged 0.5-12:5 years with a permanent conductive hearing loss using a band-aid-fixed ADHEAR system compared with a headband-integrated bone conduction hearing aid. Aided and unaided pure tone/behavioral observational audiometry and speech audiometry both in quiet and noise are assessed initially with both hearing devices and after 8 weeks of ADHEAR use and questionnaires are administered to the parents and children.

Results: At current, 10 children are included in the study. They show a comparable, tendentially better audiometric outcome using the ADHEAR systems compared with head-band-integrated hearing aids. All parents evaluated the ADHEAR as useful or very useful device for their child. For children <2 years of age, adherence problems of the band-aid may occur. Allergic skin reactions occurred in two cases. The other children continue using the ADHEAR.

Conclusion: The ADHEAR system seems to be an excellent technical solution for children with conductive hearing loss or chronical draining ears, given shortcomings regarding the adherence of the band-aid and allergic skin reactions can be overcome.

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Audiological benefit and subjective satisfaction of children with ADHEAR audio processor and adhesive adapter

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Objective: The aim of this study was to evaluate the audiological performance of 2 bone conduction hearing systems in children - the ADHEAR audio processor and adhesive adapter and the bone conduction device on soft-band - and to assess the improvement in free field hearing threshold with the ADHEAR system after 3 weeks of use compared to unaided condition.

Methods: Seven patients aged between 5 and 17 years old (mean age of 10.4 years old) were included in the study. All patients suffered from uni- or bilateral congenital conductive hearing loss or single-sided deafness. Each subject served as their own control.

Results were collected on the first day and after 3 weeks of use. A free field audiometry, a speech audiometry and the sound quality questionnaire SSQ12 were performed.

Results: In free-field at the main frequencies, results showed a similar average improvement in PTA between the unaided condition and the soft-band - improvement of 18 dB - and between the unaided condition and the ADHEAR system - improvement of 21.4 dB. Furthermore, the improvement in speech recognition threshold (SRT) in quiet was of 20.4 dB with the soft-band and of 18.1 dB with the ADHEAR system.

After 3 weeks of use of the ADHEAR system, there was an average improvement of 18.2 dB HL for PTA in free-field. The SRT in unaided condition in quiet, initially of 64.4 dB, improved to 40.6 dB with the device. At the SSQ12 questionnaire, all children showed an improvement between the scores at the beginning of the study and the ones after 3 weeks of device use. There were no skin irritation or pain reported.

Conclusion: In conclusion, the new bone conduction hearing system ADHEAR helped most of the children and could therefore be considered a temporary or definitive solution in all cases of conductive hearing loss or single-sided deafness, or if parents want to wait for a surgical solution. It was aesthetically well accepted and no skin irritation or pain were reported.

Contact MINITM: A new application for bone conduction device trial in single-sided deaf subjects

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Objective: The Contact MiniTM (CM) is a non-implantable, digital bone conduction device (BCD) consisting of two isolated units: an electronic housing, including the microphone, and a vibrator housing. The study investigated whether the CM can be used as an alternative test device for a BCD trial in single-sided deaf (SSD) adults with the microphone placed at the SSD ear and the vibrator at the normal-hearing (NH) ear (i.e. cross-position).

Methods: Twenty SSD adults (mean age: 50 (13.2) years) received a BCD trial of two weeks with the CM on headband in cross-position. Prior to the trial, the subjects performed adaptive speech in noise tests in an unaided condition. After the trial, speech in noise tests were performed with the CM in cross-position (CMcross) and ipsilateral position, i.e. both units at the SSD ear (CMipsi). Five different speech in noise configurations were used (S0N0; S0Nnh; S0Nssd; S0N+/-90 and SssdNnh). Speech reception thresholds (SRT) were analyzed comparing the CMcross condition both to the unaided and the CMipsi condition.

Results: Friedman's test revealed no significant difference in SRTs between the CMcross, CMipsi and the unaided condition for the S0N0, S0N+/-90, S0Nnh and S0Nssd configuration. However, in the SssdNnh configuration, a significant effect was found ($p<0.001$). Wilcoxon pairwise comparisons with Bonferroni correction indicated that SRTs in the CMcross condition were significantly

lower (i.e. better speech understanding) than those in the unaided ($p<0.001$) and the CMipsi condition ($p<0.05$).

Conclusion: The Contact MiniTM may be a good alternative for patients with SSD, resulting in significant better speech recognition when noise is presented to the NH ear and speech to the SSD ear. As the speech recognition results are better in the cross-position, compared to the ipsilateral position, the Contact MiniTM in cross-position might help to overcome the negative effect of transcranial attenuation during BCD trials.

FS 44: Hearing after CI in SSD

Objective measure results x self-perceived benefits in cochlear implant recipients

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Objectives: Cochlear implant is the treatment of choice for people who cannot benefit from hearing aids. Cochlear implant users demonstrate an overall improvement in speech understanding and also in self-evaluation of performance. However great variability in performance is reported by several researches. This project aims to evaluate the objective and subjective results in a cohort of cochlear implant recipient and also to determine if there are any correlations between these results.

Methods: A retrospective data analysis of 160 CI users was performed. Speech understanding was assessed in quiet using CNC words and/or CUNY sentences. Speech understanding in noise was assessed using adaptive BKB-SIN. The results were compared to those of the Speech, Spatial and Quality of hearing (SSQ), Abbreviated Profile of Hearing Aid Benefit (APHAB) and Tinnitus Reaction Questionnaire (TRQ).

Results: A correlation was found between self-assessed hearing outcomes and residual hearing in the contralateral ear and also with speech in noise and APHAB results

Binaural perception in single-sided deafness cochlear implant users with symmetric or asymmetric hearing loss

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Objectives: Cochlear implantation (CI) outcomes have been largely reported for single-sided deafness (SSD) patients with normal contralateral hearing (SYM group). However, SSD patients may have some degree of contralateral hearing loss (ASYM group). We report results from a French clinical trial for cochlear implantation in SSD patients.

Material and methods: Localization, speech understanding in noise, tinnitus severity, and quality of life (QoL) were evaluated in 18 SSD patients, 1 year after CI. Data were also analyzed for two subject groups according to the pure-tone average threshold (PTA) in the non-implanted ear: SYM group (≤ 25 dB HL; n=10), ASYM group (> 25 dB HL; n=8).

Results: Localization was significantly better with the CI on ($p<0.05$); there was no significant difference between groups ($p>0.05$). For the ASYM group, 500-Hz thresholds were significantly correlated with localization performance with the CI on. When speech and noise were co-located, there was no significant difference in speech reception thresholds (SRTs) with the CI on or off ($p>0.05$); SRTs were significantly better for the SYM than for the ASYM group ($p<0.05$). PTA thresholds were significantly correlated with SRTs with the CI on or off ($p<0.05$). When speech and noise were spatially separated, SRTs were significantly better with the CI on than off ($p<0.05$); while SRTs were significantly better for the SYM than for the ASYM group, the benefit of the CI was more than 50% greater for the ASYM group and there was no significant effect of PTA ($p>0.05$). PTA thresholds were significantly correlated with SRTs with the CI off only ($p<0.05$). Tinnitus severity was significantly reduced ($p<0.05$) and QoL was significantly improved ($p<0.05$).

Conclusion: The results suggest that SSD patients with symmetric or asymmetric hearing in the non-implanted ear can benefit from CI and that indications for CI should be broadened to include these patients.

Outcomes of cochlear implantation in patients with unilateral hearing loss

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Objectives : Unilateral hearing loss (UHL), a condition where there is a severe to profound hearing loss in one ear and normal or near-normal hearing (mild hearing loss) in the other ear, has been often underestimated. For a few year patients with UHL are candidates for cochlear implantation. Patients with unilateral hearing loss besides the difficulties in sound localization and speech discrimination in noise, also perceived emotional and social/situational consequences of UHL.

The aim of the study was to evaluate hearing outcomes after cochlear implantation in individuals with unilateral hearing loss.

Material and Method: A group of 104 adult patients with UHL, consecutively implanted at the Institute of Physiology and Pathology of Hearing, Poland, and who achieved 14 months of CI follow-up, were included in the study.

Hearing outcomes in the study group were evaluated with the monosyllabic word test under different listening configurations, a sound localization test, and an APHAB (abbreviated profile of hearing aid benefit) questionnaire.

Results and Conclusion: All subjects used their cochlear implant more than 10 hours a day, 7 days a week. In UHL patients the mean benefit of cochlear implantation was 21% for quiet speech, 16% for speech in noise (with the same signal-to-noise ratio in the implanted and non-implanted ear), 25% for a more favourable speech-to-noise ratio at the implanted ear and 13 for a more favourable speech-to-noise ratio at non-implanted ear. Sound localization error improved by an average of 20°. The global score of APHAB questionnaire improved by 18%.

Cochlear implants improve the hearing abilities of individuals with unilateral hearing loss.

Auditory training after cochlear implantaion in single sided patients

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The aim of this presentation is to show prepared auditory trening for single sided adult pastients after cochlear implantation. Prepared materials consists of: instruction how to conduct the exercises, forms to be completed, and a set of audio material. The whole training is divided into 12 units (one for a month). At the beginning, audio material is based on environmental sounds such as the sounds of animals, vehicles, musical instruments, natural phenomena, sounds of various household appliances, human voices. Then, after about 3 months of intense training, patients move to the next level which is composed of words – for example numbers, days of a week, months, colors, vegetables, furniture, clothes. The last and the most difficult task is word discrimination – patients listen to 3 words and find one that is different.

20 SSD patients were asked to fill the gap in the sentence: I consider the prepared material as a (very good/good/medium/bad/very bad) training tool.

Prepared training material has been implemented in the new model of rehabilitation for SSD patients.

Benefits of a cochlear implant in adults with single-sided deafness / asymmetric hearing loss acquired within a unified testing framework

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Objective: Treatment options for patients with single-sided deafness (SSD) and for patients with asymmetric hearing loss (AHL) are: conventional (bilateral) contralateral routing of signal ((Bi)CROS) hearing aid, bone conduction implant (BCI) and cochlear implant (CI). Only a CI allows restoration of binaural hearing. Advantages of binaural hearing with a CI have been shown in previous studies. Due to the heterogeneity of the studies, it is impossible to compare the results. The aim of our study is to collect comparable data by respecting a unified testing protocol designed for use in multicenter studies.

Methods: At present seven SSD and AHL adult patients have been included in the study. Outcome measures are assessed pre- and postoperatively 1, 3, 6, and 12 months after activation of CI. Four patients have already completed the 6 months examinations. Amongst others, speech reception thresholds (SRT) unaided and CI-aided are measured for two different noises (olnoise and 2-talker babble noise (TTBN)) and for five different presentation conditions (SSSDNAH, SSSDN0, S0N0, S0NAH, SAHNSSD; SSD: stimulus presented to the deaf ear, AH: stimulus presented to the acoustically hearing ear, presentation angles -90°,0° and 90°). Thresholds were obtained using a modified Oldenburg sentence test (OLSA).

Results: Six months after CI activation all patients performed much better with CI than preoperatively unaided: SRT improvements in TTBN range from 5.4 to 11.7 dB in the SSSDNAH condition (Head shadow effect), from 3.2 to 5.3 dB in S0N0 (Summation effect) and from 4.6 to 6.3 dB in S0NSSD (Squelch effect). Use of the CI was favorable in all tested hearing conditions, even in the SAHNSSD condition, for which SRTs improve by 1.1 to 6.5 dB.

Conclusion: Our preliminary results show benefits in speech comprehension in noise with CI, for both noise types and in all hearing conditions from -90° to +90°.

The study is sponsored by MED-EL Elektromedizinische Geräte Gesellschaft m.b.H.

The sound of a cochlear implant investigated in patients with single-sided deafness and a cochlear implant

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Objectives: It is unknown how a cochlear implant sounds. Patients with single-sided deafness (SSD), who have normal hearing in one ear and were implanted with a CI in their deaf ear, can compare the sound of their CI to simulations of the CI sound played to their normal-hearing ear. In our study with SSD patients, we address the intriguing question: ''How does a CI sound?".

Methods: We examined 10 SSD patients implanted with a CI of Cochlear Ltd. We tested six stimuli (speech and music). In Phase I, patients listened to the original stimulus (presented from a loudspeaker) with their CI ear while their normal hearing ear was masked. In Phase II, patients listened to two CI simulations (created with a vocoder) with their normal-hearing ear alone. They selected which of the two CI simulations had greatest similarity to the sound as perceived by their CI ear, and provided grades for similarity (on a scale 1 to 10). We tested three different vocoder scripts: two vocoder scripts from literature and one vocoder script from the CI company. Furthermore, two different carriers (noise, sine) and several frequency bands were tested for each vocoder script.

Results: Carrier noise and the vocoder scripts from literature were most often selected as best match to the sound as perceived by the CI ear. Patients generally selected broad frequency bands. The average grade for similarity was 6.8 for speech stimuli and 6.3 for music stimuli. We did not observe a correlation between the choice for vocoder scripts or carriers and patient characteristics.

Conclusion: Based on the patients' grades for similarity of the CI simulations, we have a fairly good idea of what a CI sounds like to our patients. We are now able to present the CI simulations to clinicians and patients' relatives for education and expectancy management.

Cochlear implantation in single sided deafness arising from sudden sensorineural hearing loss – An Asian experience

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Background: Cochlear implantations have been traditionally performed in patients with bilateral severe to profound sensorineural hearing loss. Recently there has been a move to performing cochlear implants in patients with asymmetrical hearing loss or single sided deafness. Early reports suggest benefits with sound localization, tinnitus control as well as hearing in noisy environments. However these studies have mostly been done in Western countries and few have been reported in Asian countries. Also none of the studies have only focused on the single sided deafness due to sudden sensorineural hearing loss.

Study design and Methodology: This was a prospective cohort study. Eligibility criteria included the following: Adults aged 18-75 years of age. Hearing in the better hearing ear would have to be in the normal-mild hearing loss range (0-40dBHL). Hearing in the poorer hearing ear has to be in the severe to profound range (70-110dBHL). The etiology of the hearing loss has to be due to idiopathic sudden sensorineural hearing loss. The duration of the deafness in the poor hearing ear has to be between 6 months to 5 years duration. Outcome measurements are performed before the surgery and 1 year after the surgery. Tinnitus outcome measures include the Visual Analogue Score (VAS) and the Tinnitus Handicap Inventory (THI) questionnaire. Hearing performance evaluation was performed using hearing or Implant Aided Thresholds, Speech Discrimination Scores and also using the Speech, Spatial and Quality of Hearing (SSQ) Questionnaire. A Hearing In Noise Test (HINT) was also performed.

Results: 8 patients were prospectively recruited and implanted. There were 5 patients with left sided deafness and 3 patients with right sided deafness. The age ranged from 24-70 years of age and the duration of deafness ranged from 11-55 months. The Tinnitus VAS and THI scores improved in 5 out of 8 patients. All 8 patients had significantly improved aided hearing thresholds with the cochlear implant (27-45dBHL) compared to their preoperative hearing thresholds (55- >110dBHL). Speech Discrimination Scores (SDS) improved substantially for 6 out of 8 patients with the cochlear implant (19-59%) compared to preoperatively (0-10%). The SSQ questionnaire showed improvement in 4 out of 8 patients primarily in the spatial hearing category. The HINT test showed that 6 out of 8 patients could hear better on the cochlear implant side when noise is presented to the normal ear 1 year after surgery. 1year after surgery, all 8 patients used their cochlear implants on a daily basis. 3 patients used it between 2-4 hours a day, 3 patients used it 4-8 hours a day and 2 patients used it for more than 8 hours a day.

Summary and conclusion: In the majority of patients, tinnitus was improved and the overall hearing ability was improved in the side with the cochlear implant. This is

the first research study in published literature that documents the benefits of cochlear implantation in Single Sided Deafness due specifically to Idiopathic Sudden Sensorineural Hearing Loss and may prove to be a useful guide to counselling such patients on a novel form of hearing restoration for their hearing loss where previously routing of signal treatments were the mainstay

FS 45: Surgical Challenges in Pediatric CI

Assisted endoscopic procedure for cochlear implantation in children with malformed ear

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Objective: Middle and inner ear malformations cause technical difficulties in cochlear implantation (CI) with the most commonly traditional surgical procedure (posterior tympanotomy with mastoidectomy, using a microscope). The aim of the present study is to describe the endoscopic assisted CI approach in children with malformed ears.

Material and Method: Twenty-five children (mean 3.6 years old; range: 2.8-9 years) with malformed middle and inner ear and bilateral profound hearing loss were operated on using a transattical/endoscopic assisted CI at our tertiary university referral center. The technique is described step-by-step and the outcomes are detailed.

Results: All children were discharged from hospital within one day post-surgery. No immediate or late postoperative complications were noted. All children showed varying degrees of auditory benefit as measured by routine audiometry, speech perception tests and Categories of Auditory Performance (CAP) scores (average: 6).

Conclusions: Endoscopic assisted approach permits to check directly the anatomical auditory distorted structures and even in the most complex conditions it assures a safe cochleostomy, followed by the correct insertion of the array in the scala tympany.

Cochlear implant surgery, endoscopic access

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Our job was based on the classic cochlear implant surgery and it's insertion using endoscopes, without retroauricular incisions. This type of surgery is useful in cases of previous radiotherapy treatment and other causes where devascularization may affect the normal use of the Implant and reduce the risk of extrusion.

Cochlear implantation in dysplasia of the inner ear

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Objective:Dysplasia of the inner ear may be diagnosed late in pediatric patients and it often presents surgical challenge for cochlear implantation. Outcome studies of these subjects are an important aspect for decision makers in the health care system.

Cochlear malformation is often associated with congenital profound sensorineural hearing loss, less frequent with slowly progressive hearing loss in young children or rarely with sudden deafness in children or adolescents. Early detection of hearing loss is enhanced by national programs of newborn hearing screening and monitoring of hearing development in regular pediatric checkups. Diagnostic workup of children with profound hearing loss considered for cochlear implantation includes imaging of the cochlea with MRI and CT. To differentiate the type of malformation is a rather important aspect in order to make appropriate choice of the cochlear implant, particularly the length of the active electrode to be inserted.

Material and Method: We report on 13 children and adolescents with different types of cochlear malformation who received one or two cochlear implants between 2000 and 2018. 9 subjects presented incomplete partition type II, some of them with cochlear aplasia on the other ear. 4 subjects were affected by an enlarged vestibular aqueduct.

Result: Electrodes were successfully inserted without major problems, no postoperative complication occurred. All subjects received significant benefit in sound discrimination, 75% achieved speech discrimination. Benefit varies across subjects according individual factors.

Conclusion: Cochlear implantation is very appropriate for children with dysplasia of the inner ear. Language development in children correlated with the age at implantation.

Vestibular evaluation in sequentially implanted children

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Objectives: Absence of sensory input of the vestibule at a very young age can lead to severe delayed posturomotor milestones. Previous studies have proven modifications and even complete ipsilateral loss of vestibular function after unilateral cochlear implantation.

The objective of this study was to evaluate whether sequential cochlear implantation has an impact on vestibular function.

Methods: Retrospective study from January 2012 to January 2016 including 28 unilaterally implanted patients. The first stage consisted of determining the vestibular status of the 28 hearing impaired children who were candidates for a second cochlear implant. Three months after contralateral implantation we retested the vestibular function of the same patients. The vestibular evaluation consisted of multiple tests for canal and otolith function. A complete clinical vestibular evaluation was performed, including the head thrust test. This was followed by an instrumental assessment composed of the classic bicaloric test and vestibular evoked myogenic potentials (VEMP) testing with tone bursts.

Results: A high prevalence of vestibular dysfunction (69%) was found in our group of unilaterally implanted children. Three patients had a unique functional vestibule at the not yet implanted ear. VEMP responses disappeared in 5 of the 21 patients with a response before contralateral implantation, caloric responses in 1 of the 19 reactive patients before contralateral implantation.

Conclusions: After contralateral implantation 40% of our patients manifested modifications of their vestibular status. Intrasubject comparison of bicaloric and VEMP testing before and after contralateral cochlear implantation showed that canal function was better preserved than saccular function.

Seeing the high prevalence of vestibular dysfunction in our test group of unilateral implanted children, sequential implantation must be preceded by a vestibular assessment to prevent complete bilateral vestibular areflexia and its potential consequences. Presence of hyporeflexia at the yet-to-be implanted ear seems to be a situation particularly at risk of complete loss.

Cochlear implantation in chronic otitis media

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Different options for hearing rehabilitation in chronic otitis media (COM) are available but achieving satisfactory results might be challenging. Here we present our single-center experience with CI in patients with COM. In a retrospective analysis of a series of 425 CI cases we identified seven subjects (1.65%) implanted for deafness due to COM. Five individuals previously underwent modified radical surgery with open cavity, one had myringoplasty, and three were without any previous surgery. The CI was performed in nine ears: four in radical cavity with partial obliteration, three with CWU tympanomastoidectomy and two with subtotal petrosectomy. The complication rate was highest in radical cavity cases with partial obliteration (75%), leading to explantation of the device followed by CI in the other ear in two patients. Cholesteatoma recurrence occurred in three ears (33%). Regarding the CI functional outcomes, five patients were assessed as good performers, whereas two cases had poor outcomes (SDT 30%). In conclusion, deafness and severe hearing loss after COM with cholesteatoma is an appropriate indication for CI. In our experience, the method of choice is subtotal petrosectomy with CI offering the best results in terms of disease eradication, complications and functional outcomes.

FS 46: Experiences with Bimodal Hearing

Effect of bimodal amplification according to the residual hearing level

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Objectives: Bimodal amplification shows better cognition of sounds through the improvement of head shadow effect, binaural squelch effect and binaural summation effect. In patients received unilateral cochlear implantation, the impact of hearing aids in the contralateral ear may depend on the residual hearing level, duration of hearing aid use, and others.

In this study, we collected patients with bimodal amplification and aimed to evaluate the factors related to the hearing performance.

Materials and Methods: This retrospective study included forty-nine patients who used cochlear implantation in one ear and a hearing aid in the contralateral ear for more than one year. Hearing level, an inner ear anomaly, and benefit of amplification were collected. A subjective benefit of amplification was measured by the Korean version of the Speech, Spatial and Qualities of Hearing Scale (K-SSQ). K-SSQ score was calculated by the summation of each point of 12 questions (-5 ~ +5), and +24 points were used to be a cut off value of positive gain.

Results: The average age of cochlear implantation is 6.7 years old. Thirty-six out of 49 (73.5%) showed a positive gain in K-SSQ when the hearing aids were used in the presence of cochlear implantation. Monosyllabic word recognition was better in the bimodal stimulation (8.4% increase). K-SSQ score showed a significant correlation with the low-frequency hearing level with contralateral cochlear implantation only and with the hearing level at 250 and 500Hz with bimodal amplification. There was also a significant correlation between the speech discrimination score and the K-SSQ score after the bimodal amplification. K-SSQ score showed no significant correlation with age at implantation, duration of use of cochlear implantation, and duration of use of hearing aid.

Conclusions: A subjective benefit of amplification has a correlation with the low-frequency residual hearing level in the ear with hearing aid.

Benefits of a contralateral routing of signal device for unilateral Naída CI cochlear implant recipients

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Objectives: This study evaluated the benefit of an additional wireless Contralateral Routing of Signals (CROS) device for unilateral cochlear implant (CI) users.

Design: Thirteen adult subjects with at least 6 months of CI use and no or limited benefit of a hearing aid or CI in the contralateral ear were tested. Speech intelligibility in quiet and noise was measured using the French matrix sentence test. Feedback regarding speech intelligibility, sound quality and usability of the CROS device in everyday life was collected through questionnaires.

Results In quiet, median speech recognition thresholds (SRT) for speech presented from the non-implanted side improved by up to 10 dB SPL (Wilcoxon Z=2.55, p=0.01). In noise, median SRTs improved by up to 4.7 dB (Wilcoxon Z=2.52, p=0.01) for speech presented from the front and noise from the CI side and up to 9.1 dB (Wilcoxon Z=2.52, p=0.01) for speech presented from the CROS side and noise from the CI side. Subjectively, the Abbreviated Profile of Hearing Aid Benefit (APHAB) questionnaire did not reveal any significant differences between listening with the CI alone and listening with CI and CROS, while the Speech, Spatial and Qualities of Hearing Scale (SSQ) revealed a significant improvement in the spatial subscale (Chi squared (N=9, df=3)=9.99, p=0.02). A customized questionnaire showed high subjective satisfaction with the CROS device itself, e.g. appearance, size, battery life.

Conclusions: The CROS device provided a significant speech perception benefit compared to the CI alone in quiet and in noise. Subjective satisfaction with the device design and usability was high. Ten out of thirteen initially recruited subjects chose to keep using the CROS device at the end of the study, indicating the CROS device to be a valuable addition to a unilateral CI.

A directional remote-microphone for bimodal cochlear implant recipients

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Objective: To evaluate the benefit of connecting a wireless remote microphone to the cochlear implant (CI) as well as to the hearing aid (HA) for speech recognition in noise in bimodal CI users. The second aim was to evaluate the additional benefit of the directional microphone mode compared with the omnidirectional microphone mode of the wireless microphone.

Method: This prospective study measured Speech Reception Thresholds (SRT) in noise in a 'within-subjects repeated measures design' for six different listening conditions. Study sample: Eighteen postlingually deafened adult bimodal CI users.

Results: An improvement in SRT of 2.2 dB was found between no wireless microphone use and connecting the wireless microphone to the CI processor only in the bimodal listening condition. No additional benefit was found by connecting the wireless microphone to the HA as well. An improvement of 4.1 dB was found for switching the omnidirectional microphone mode to the directional mode.

Conclusions: The use of a wireless microphone improves speech recognition in noise for bimodal CI users. It seems sufficient to connect the wireless microphone to the CI only in the bimodal condition. The use of the directional microphone mode leads to a substantial additional improvement of speech perception in noise.

Effect of the interaural stimulation-timing mismatch on localization performance of bimodal CI/HA users

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The normal hearing human auditory system is able to perceive very small interaural time differences (ITD) starting from 10 µs. The largest ITD occurring physiologically is about 700 µs. For bimodal users, differences in the processing latency of digital hearing aids (HA) and cochlear implants (CI) up to 9 ms superimpose these tiny ITDs, resulting in a systematic interaural timing mismatch. Our hypothesis in the present study is that this interaural stimulation timing mismatch affects sound localization in bimodal users. Therefore, we conducted localization tests in the horizontal plane first without changes to the devices and afterwards with a delay line applied to the CI. With this delay line we were able to compensate for individual processing latency differences. It was technically

implemented on a portable programmable microcontroller and based on a circular buffer. The amount of delay applied was orientated at the specific HA worn by the patient. The experimental procedure was as follows. A first localization test with the delay line deactivated was conducted in each subject. The delay line was then activated and a familiarization period of 1 hour was applied. Finally, the localization test was repeated. Results showed an improvement of 11 % averaged over 8 bimodal users after compensation. The effect was significant (p<. 05) using a Wilcoxon-signed rank test.

Benefit of balanced sound processing and matching automatic gain control of hearing aid and cochlear implant in bimodal implant users

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Introduction: Patients with single-sided deafness and residual hearing on the contralateral ear can benefit from a cochlear implant on one side and a hearing aid on the other. However, outcome of hearing perception among these patients is various. This may be caused by a mismatch of cochlear implant and hearing aid as well as discrepant signal processing. Creating a balanced sound processing and a matching automatic gain control may help to improve hearing as well as speech perception.

Methods: 12 patients using the AB Naída CI Processor and a conventional hearing aid were enrolled and baseline measurements were obtained. A Phonak Naída Link hearing aid had been adjusted to the patients and linked to the cochlear device. After six and twelve weeks pure-tone audiometry and localization tests were performed. Speech perception was determined in quiet and noise. To evaluate the subjective listening comfort two questionnaires (Oldenburger Inventar and HISQUI19) were assessed.

Results/Discussion: Twelve weeks after the fitting of the new hearing aid an improvement of hearing and speech perception could be determined. Especially, speech perception in noise improved significantly: Directed suppression of noise helped to segregate the target speech signal from a mixture of sounds or competing speakers (Zoom-Control-Function). Evaluation of the questionnaires revealed a positive subjective hearing experience after twelve weeks. To obtain enhanced outcome a detailed patients' introduction to the new hearing aid is needed at the beginning.

Optimum hearing aid gain prescription for bimodal users

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Purpose of the study: Effective and efficient fitting methods for cochlear implant (CI) recipients with aidable contralateral acoustic hearing become more and more important in clinical practice. Recently, a dedicated bimodal fitting formula (APD Bimodal) has been introduced to improve bimodal benefit for patients and simplify the fitting process for audiologists.

Materials and methods: Ten experienced adult bimodal CI recipients were fitted with the same hearing aid and participated in two acute appointments and a chronic trial between the visits. Speech understanding in noise and subjective preference were assessed in two conditions: prescriptive hearing aid fitting according to DSL v5 and APD Bimodal without any further fine-tuning. The Italian matrix test was administered with the international female fluctuating masking noise to assess speech understanding. Subjects indicated their preference for either formula in an A/B comparison task. The number and type of fine-tuning steps were analyzed to quantify the efficiency of the bimodal prescription in the fitting process.

Results: Depending on audiogram and input level, DSL prescribes 5-10 dB more gain than APD Bimodal. While no significant and clinically relevant differences in speech understanding between DSL v5 and APD Bimodal were observed, the majority of subjects indicated a preference for the APD Bimodal, mainly because of a more comfortable loudness perception. However, there is trend that APDB provides better speech understanding at high noise levels, whereas DSL seems to perform better at low levels.

Conclusion: The optimum gain for bimodal users with regards to speech perception seems to allow for variations of about 10 dB. This degree of freedom can be used to find the optimum trade-off between loudness comfort and audibility. A dedicated bimodal acoustic prescription was preferred by the majority of subjects due to more comfortable loudness than provided by DSL – without degrading speech understanding in noise.

Influence of bimodal technologies on speech perception in noise in cochlear implant users

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Background and Purpose: The objective of several studies was to evaluate the improvement of hearing with cochlear implant (CI) and contralateral hearing aid (HA) in terms of speech understanding, listening comfort and sound

quality. Features under investigation were a prescriptive fitting formula, accounting for the specific characteristics of bimodal listening, as well as ear-to-ear communication, allowing an exchange of microphone signals between two hearing instruments and with this the use of directional microphones as well as directivity steering.

Methods: Directional microphones were tested in a variety of setups presenting different speech and noise signals from multiple loudspeakers. HA fittings were optimized by using the bimodal prescription. Speech understanding in noise, sound quality ratings and subjective preference were measured at 10 research sites in Belgium, Germany, the Netherlands and the USA.

Results: Improvements in speech reception threshold (SRT) up to 5 dB were obtained in various noisy environments for a speaker at the front with directional microphones in comparison to the omni-directional setting. For a lateral speaker, improvements of around 2 dB and 4 dB were obtained with directivity steering features, respectively. CI users as well as professionals reported highly positive experience with the binaural technology.

Conclusion: The binaural technology in CI systems led to improved speech understanding as well as a higher comfort for handling and hearing perception for the CI user.

FS 47: Speech and Language Development after Cochlear Implantation

Acoustic environment and language skills in children with cochlear implant

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Objective:
1) To analyses the linguistic development before and post cochlear implant activation in children who received a cochlear implant in their first 3 years of life
2) To analyse the value of listening-data logged in the speech processor on the spontaneous production of children who received a cochlear implant in their first 3 years of life.

Methods: Ten children with profound congenital sensorineural hearing loss (SNHL) were included in the study. The mean age at CI activation was 20.5 months (SD +/- 3.8; range 13-33). Two sessions of game of 20 minutes each, one before surgery and one after three and six months after cochlear implant activation. The ALB protocol (Olswang et al., 1987) was adopted for the evaluation of spontaneous production of children. The sessions were recorded and transcribed.

The overall data of average daily use and acoustic scene-analyses were extracted from Data Logging system after 3 months of CI activation.

Results: All the children have increased the spontaneous production, showing a decrease in the vocalizations in favor of an increase in the varied lallation and first words

A significant positive correlation was found between speech in quiet exposure time at low loudness level (< 70 dB) and spontaneous production.

Conclusion: The listening environment can influence the speech development in children who received a cochlear implant in their first 3 years of life.

Can data logs predict receptive vocabulary of children with cochlear implant?

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The Cochlear™ Nucleus® 6 Cochlear implant (CI) sound processor collects information about the user's sound environment and daily CI use. The study investigates associations between these automatic measures and the receptive vocabulary scores of children with CI. Peabody Picture Vocabulary Test (PPVT) results and data logs were obtained from 45 children (age 1–14) who were prelingually deaf and had received a CI before age 3. The vocabulary scores were modeled as a function of CI use and exposure to speech and noise throughout the 12 months preceding the test, as well as other potential predictors of language performance (gender, chronological age, age at implantation, hearing age, implantation mode, speech understanding, etiology of deafness and educational placement). Different statistical models were compared to evaluate the predictive value of data logging measures. We found that information from the data logs predicted receptive vocabulary. More specifically, children who were exposed to more speech and had higher daily CI use had better receptive vocabulary scores. The model fit was comparable to the best models without data logging information. The study provides evidence that CI data logs capture meaningful information about a child's sound environment. This suggests that they can be used to detect and address problems in children's environment and improve their language development and auditory rehabilitation.

Language development in children with cochlear implants from a mental health perspective

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Introduction: Even though the cochlear implant (CI) offers good results when it comes to access to sounds, the path to the fluent use of oral language entwines to multiple factors (social, psychical, organic), where there can be mishaps.

Objectives: to demonstrate the varieties we found in language development of children with CI and to highlight aspects that are common to most of the them.

Methodology: 17 children from 3 years and 3 months old to 10 years and 8 months old were evaluated with the "Psychoanalytical Monitoring of Children in Schools, Groups and Institutions"; hearing age varied from 2 to 7 years. From the data collected, we used only information related to "Spoken language and position in language", which basic questions were: "Does the child sustain a dialog?"; "Can you understand what the child says?" and "How is the child's spoken language?".

Results: results related to sustaining the dialog with the evaluator were: 4 were fully capable, 3 were intermittently capable and 10 were unable. When it comes to understanding what the child says, results show that 8 children only vocalize; and with the other nine we could, at least partially, understand what is said. The results concerning child's spoken language were categorized as fluent or not fluent, considering the construction and use of language in exchange with other people, and we found that 6 children are fluent and 11 are not fluent.

Conclusion: CI does offer certain conditions, ie, all children have some oral production; but the access to sounds doesn't guarantee language development nor a fluent use of language. Results show that even though children "make themselves understood", it doesn't mean they have a domain of the language nor that they are able to sustain a dialog. Social and mental health must be considered so that children can use the CI as a sensorial tool which will allow them to have meaningful and consistent exchange with the hearing world.

My personal clinical experience related to 592 cochlear implantations in Chang-Gung Memorial Hospital (Taiwan)

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Objectives: To retrospectively review the outcomes of 592 cochlear implantation (519 unilateral and 73 bilateral) and related characteristics in these patients for surgical and rehabilitation concerns.

Methods: 519 patients (430 children and 89 adults) received CI between 1999 and January 2018. Tests regarding their auditory performance, intellectual ability, sound perception, speech production, language development and reading skills were administered. Their genetic characteristics and radiological data were also examined.

Results: So far, we have published a total of 32 SCI journal articles related to CI. Among the 519 patients, 499 (96.1%) received continuous follow-up over the 18 years, and 89 (17.1%) after 18 years of age. The results of 3-dimensional magnetic resonance imaging (MRI) showed a incidence of 21.2% for cochlear nerve deficiency in all children. Most of the implanted children had normal performance intelligence quotient (IQ), but their verbal IQ dragged behind their normal-hearing peers. A significant prevalence of genetic mutations (33.5%) was identified in children with CIs. The presence of genetic mutations was associated with good long-term auditory performance outcomes after implantation. After 2.5 years of implant use, most of the children were intelligible to people who had a little experience of deaf people's speech and understood common phrases without lipreading. After 4 years of use, they can communicate over the telephone with familiar talkers. The Chinese literacy and reading skill of the children who received CI at a young age fell within the normal range of their hearing age mates, at least after 5 years of implant use.

Conclusion: With 18 years of follow up, we acquire a more comprehensive knowledge of the effectiveness of CI and postoperative rehabilitation. Our patients with cochlear implants show visible improvements in their language and reading skills, and many of them fall within the normal range of their hearing age mates.

Salient predictors of normal speech development in long-term pediatric cochlear implant users

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Objective: This study sought to determine which variables contribute to attainment of age-appropriate phoneme production skills in pediatric cochlear implant (CI) users between 4 and 8 years post-CI.

Methods: Participants include 161 children with CIs enrolled in a longitudinal, multi-center project, the Childhood Development after Cochlear Implantation study. All received a CI by 5 years of age (M=2.4 years). Children completed the Goldman-Fristoe Test of Articulation (GFTA) between 4 and 8 years post-CI. Participants were grouped by attainment of age-appropriate production skills (GFTA<85: Below normal range; GFTA≥85: Within normal range) at 4 and 8 years post-CI. Error scores were computed for each child. Data were analyzed using a mixed-effects linear model utilizing all available GFTA data 4-8 years post-CI.

Results: One-half of participants had normal phoneme production at 4 years post-CI. Number of errors across participant groups decreased from 21.3 at 4 years post-CI to 10.2 at 8 years post-CI. Presence of residual hearing at baseline (p<.01) and better language scores at baseline (p<.05) and 36 months post-CI (p<.0001) significantly related to better GFTA scores over the 4-8 year follow-up period. Children who scored <85 on GFTA at both 4 and 8 years post-CI had significantly less residual hearing, lower speech perception scores, and poorer language outcomes at baseline and 3 years post-CI relative to other participant groups.

Conclusions: Pediatric CI users who attain age-appropriate speech production scores at 4 and 8 years post-CI likely derived benefit from hearing aids pre-CI because of useable residual hearing, with a subsequent language advantage from the outset. Children with CI without usable residual hearing or adequate language skills by 3 years post-CI have greater risk of persistently delayed speech production skills after implantation, and may require more therapeutic intervention and support to maximize communication outcomes.

Effect of early and late implantation on the speech perception in noise performance of cochlear implant recipients

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Objective: Early intervention has important effects on the auditory maturation of individuals with hearing loss since the developing auditory cortex is highly plastic. Cochlear implantation (CI) is a major choice for such patients to establish a normal auditory development. Speech perception in noise (SPN) requires a very high degree of auditory development, therefore our aim is to evaluate the SPN performance of early and late implanted CI recipients.

Materials and Methods: 16 CI recipients with a prelingual hearing loss was assessed with Matrix Sentence Test (MST). Half of the patients were early implanted (4 years of age) and half of the patients were late implanted (>4 years of age). All patients have a profound sensorineural hearing loss that was diagnosed before 1 years of age. MST was conducted in a soundproof room with noise and speech signal was presented at 0-degree azimuth. Scores were calculated as the signal to noise ratio which was half of the words were repeated correctly.

Results: Average age of early implanted and late implanted groups were 13,5 years and 18,9 years respectively. Average signal to noise ratio of early and late implanted group was 5,65 (1,34) dB and 30,95 (11,23) dB respectively. The difference of MST between groups was statistically significant (p<0.01).

Conclusion: Advantages of early implantation was revealed with different methods like cortical evoked potentials or assessment of language skills in the literature. Our study suggests that early implanted CI recipients perform better in noisy conditions than late implanted peers. This finding supports the effectivity of CI on the plasticity of auditory cortex especially before the 4 years of age that was suggested as a sensitive period for auditory maturation.

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FS 48: New Electrode Design

Electrode insertion force measurements in porcine cochlea specimens

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In the process of cochlear implant electrode array development and characterization the measurement of insertion forces in a cochlea bench model is a standard procedure for estimating trauma. Bench models made of various materials, like PTFE, glass, acrylic, epoxy, etc. in combination with various lubricants, are commonly used for these measurements. The question is if these materials are a valid model in respect to the frictional properties in comparison to a live patient. The measurement of insertion forces in a live patient is not possible at the moment and therefore we decided to use fresh never frozen temporal bones. As fresh never frozen human temporal bones are not easy to obtain, we decided to work with fresh never frozen animal temporal bones in this initial study.

The cochlea of a pig was chosen because of its similar proportion to the human. Furthermore it provides straightforward surgical access and is readily available. For the insertion force measurement an automated insertion tool was used and a single axis load cell was equipped with the cut down fresh never frozen porcine temporal bone specimens. Dummy electrodes based on the Cochlear Slim Straight electrode were inserted in the porcine cochlea to a depth of approximately 15 mm or one turn. The measurements could be repeated in each bone.

Based on the corresponding DVT scans of the porcine specimen a Teflon bench model was built matching the dimensions of the porcine cochlea. This bench model was also used for insertion measurements in the same automated setup with using the similar dummy electrodes based on the Slim Straight electrode. The obtained insertion forces of both sets of measurements were compared to check the accuracy of the bench model.

Insertion properties and hearing performance of a new straight electrode – First results

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Introduction: Electrode shape and diameter can play an important role in preservation of residual hearing and more important in hearing outcome after cochlear implantation. Roughly there can be distinguished between straight and precurved electrodes of different diameters. Recently there has been developed a new straight electrode, the Slim J Electrode ®, manufactured by Advanced Bionics ® Company. It was aim of the study to investigate insertion feasibility and first hearing results.

Methods and Materials: 10 patients, 5 provided with an AB Midscala Electrode and 5 provided with the new Slim J Electrode by two surgeons, matched according to age and pre-operative residual hearing, were evaluated as far as pre and postoperative residual hearing and postoperative speech understanding after 3 months are concerned. Additionally development of ECAP (electrically evoked action potentials) values was analyzed and position of electrodes was determined using intraoperative flat panel technology. Insertion properties were documented by surgical staff.

Results: There were no difficulties and pitfalls concerning the insertion mode. All electrodes were placed regularly and showed a position next to the cochlear modiolus (Midscala) and next to the outer cochlear circumference (Slim J) respectively. Residual hearing could be preserved in both groups in a comparable number of patients. ECAP values showed an analog performance to earlier measurements with different electrode shapes as the perimodiolar electrode presents lower thresholds than the straight one.

Discussion/Conclusion: The new straight Slim J Electrode® represents a useful supplement to the existing opportunities of electrodes and has similar properties as far as short term preservation of residual hearing is concerned.

Design rationale of a new thin cochlear implant electrode array

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Objective: Today's cochlear implants (CIs) have to reliably preserve intracochlear structures and nonetheless provide sufficient electrical coverage in order to guarantee best possible speech outcomes. It is key for the electrode array to be optimally designed to achieve this goal.

Materials and Methods: A microCT analysis was used to provide detailed design information for specifications of a new atraumatic electrode array. Several generations of the array were developed and tested using a 3D force measurement system to measure insertion forces and provide stiffness data of the new electrode array. The electrode array was tested in temporal bones by an automated arm as well by surgeons. X-ray, histology and surgical feedback were used to validate the final design.

Results and Conclusion : Dimensional analysis of the cochlea showed a lateral wall electrode with a length of 23mm to be optimal for structure preservation, whereby covering the main spiral ganglion. A specific stiffness profile of the electrode array was shown to be important to minimize translocations and thereby needing lower insertion forces. The electrode array included a blue marker to mark end of the insertion and a wing which allows an optimal gripping of the electrode array. The final validation study was performed by 5 surgeons and a total of 40 temporal bones. Surgeons gave positive feedback about ease of insertion, achieving an average insertion depth of 412 degrees. In 2 out of 40 insertions, major trauma was observed.

In conclusion, a new thin CI electrode array with a length of 23mm was developed. The final prototype of the electrode array was inserted in 40 fresh temporal bones and judged easy to insert and has a low trauma rating in 2 out of 40 cases.

A new thin lateral wall electrode: initial in vitro and clinical experience in adults

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Introduction and objectives: In hearing preservation surgeries a meaningful balance between shallow insertion and a sufficient cochlear coverage to address sufficient neural elements for the electrical-only hearing is essential. The electrode array has to be thin, easy to insert and suitable for both round window and cochleostomy access.

A new electrode array the HiFocusTM SlimJ was designed considering the variability of a human cochlea.

We tested the SlimJ in human temporal bones initially and later in vivo. The objective of this work is to present the results from the temporal bone study and report on the initial clinical experience with the SlimJ.

Methods: Eleven freshly frozen temporal bones were implanted following the standard surgical procedure for cochlear implantation. The SlimJ was inserted using a dedicated micro forceps. Each bone was scanned by a cone beam computed tomography (CBCT) before and following the SlimJ insertion. Through dedicated fusion and image processing technique a detailed assessment of the electrode position and trauma grading based on Eshraghi scale was conducted.

For the in vivo part five adults were implanted with the SlimJ electrode within the clinical routine. Postoperative CBCT was performed in all five patients for assessing the electrode position. A pure tone audiometry and speech understanding using a Finish matrix test is conducted to evaluate the level of residual hearing and monitor performance.

Results: A successful insertion of the SlimJ electrode was achieved through the round window in all eleven temporal bones as well as in all 5 patients.

Scala tympani insertion was confirmed in 10 temporal bones with one translocation occurring in one bone at 180°. Further clinical results with the SlimJ in vivo will be presented and discussed.

Conclusion: The new SlimJ array shows a good stiffness and mechanical properties with a good pushability and possibility for a round window insertions.

FS 49: Inner Ear Physiopathology

The Molecular of human „cochlear battery" - Aspects on hearing preservation CI surgery

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Objectives: Atraumatic CI-surgery is a requisite for preservation of residual hearing, also at long term. Round window electrode insertion seems more atraumatic but the anatomy can vary surprisingly and this can challenge preservation of the soft tissue. Further understanding of human cochlear physiology is necessary to understand the impact of different electrode trajectories.

Material and Methods: We analysed the molecular constituents the human, so-called "cochlear battery" or generator of the endo-cochlear potential in the lateral wall essential for hair cell function/transduction. We used fluorescence immunohistochemistry, including super-resolution structured illumination microscopy (SR-SIM), of the human cochlear tissue at Uppsala SciLife national facilities (http://www.scilifelab.se/#). A lateral precision of approximately 80 nm and 250 nm axially were obtained.

Results and Conclusions: The battery isolator was disclosed as specialized cells expressing protein Claudin-11. It forms a "wall" around the ion channel and transporter cells. A breach of this barrier, such as caused by CI insertion trauma, may cause loss of residual hearing and deafness. The unique and separate distribution of homomeric connexin26/30 isoforms was demonstrated. The significance of the findings related to hearing preservation CI surgery is discussed

The suspension of the basilar membrane in the hook region of the human cochlea: implications for trajectory planning in cochlear implantation

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Objective: The anatomy of the human basal cochlea, including the round window (RW), is highly variable. It also includes the architecture of the basilar membrane (BM) and its suspension, which can challenge structural preservation during cochlear implantation (CI) surgery.

Material and Methods: We used micro-CT and synchrotron-phase contrast imaging (SR-PCI) of an archival collection of micro-dissected and undissected macerated human temporal bones and an additional sixteen freshly fixed bones. Data were processed by volume-rendering software using bony and soft tissue algorithms. Anatomic variations and outcomes of different approaches during CI were investigated.

Results: Micro-CT with 3D rendering displayed the RW and osseous spiral laminae, while synchrotron imaging allowed reproduction of the BM and its suspension around the RW membrane and lateral wall. Anterior (ACOs) and antero-inferior (AICOs) cochleostomies invariably damaged intra-cochlear tissue while inferior cochleostomies (ICOs) sporadically left structures unaffected. The RW trajectory was also examined.

Conclusions: The 3D organization of the suspensory apparatus of the BM in the hook region can be reproduced using SR-PCI. The variable anatomy should be considered during CI surgery aimed at hearing and structural preservation.

Perilymph analysis in human cochlear implantation

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The size and the complex architecture of the cochlea make biopsy and in-depth histological analysis impossible without severe damage of the organ. Thus, histopathology correlated to inner disease is only possible after death. The establishment of a technique for perilymph sampling during cochlear implantation may enable a liquid biopsy and characterization of disease.

Among the many thousand of proteins that can be identified by a shot-gun proteomics approach and data-dependent analysis using orbitrap mass spectrometry (Thermo Fisher Scientific) and Max Quant software, disease specific proteins and proteins indicating endogenous reparative approaches or damage have to be determined. Analysing patient cohorts with known disease such as enlarged vestibular aqueduct (EVA), otosclerosis, and Menière's disease could be helpful for the identification of disease specific proteins.

Inflammatory processes may participate in disease onset and progression in the inner ear. However, little is known about cytokines and chemokines associated with these disease entities. First attempts to use a multiplex protein analysis assay for inflammation markers were successful for the identification of cytokines, chemokines and endothelial markers present in the human perilymph.

With the present approach, we may be able to identify disease-specific perilymph biomarker candidates in patients with inner ear disease. Based on these results, novel insights into the pathophysiology of inner ear diseases and their treatment might be expected in the near future.

Microglia impact on hearing preservation

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Objectives: Atraumatic CI-surgery may not only be a requisite for preservation of residual hearing but also for long term hearing.The human inner ear, which is segregated by a blood/labyrinth barrier, contains resident macrophages/microglia (CD163, IBA1-, and CD68-positive cells) within the connective tissue, neurons and supporting cells. In the lateral wall of the cochlea, these cells frequently lie close to blood vessels as perivascular macrophages.

Macrophages are also shown to be recruited from blood-borne monocytes to damaged and dying hair cells induced by noise, ototoxic drugs, aging and diphtheria toxin-induced hair cell degeneration. Precise monitoring may be crucial to avoid self-targeting. Macrophage biology has recently shown that populations of resident tissue macrophages may be fundamentally different from circulating macrophages. These cells may be detrimental and their priming should be avoided during and after CI surgery.

Material and Methods: We removed uniquely preserved human cochleae during surgery for treating petro-clival meningioma compressing the brain stem, after ethical consent. Molecular and cellular characterization using antibodies against IBA1, TUJ1, CX3CL1 and type IV collagen, and super-resolution structured illumination microscopy (SR-SIM) were made together with transmission electron microscopy.

Results and Conclusions: High resolution microscopy disclosed remarkable phenotypic variants of IBA1 cells closely associated with the spiral ganglion cells. Monitoring cells adhered to neurons with "synapse-like" specializations and protrusions. Active macrophages migrated occasionally nearby damaged hair cells. Results suggest that the human auditory nerve is under the surveillance and possible neurotrophic stimulation of a well-developed resident macrophage system. It may be alleviated by the non-myelinated nerve soma partly explaining why, in contrary to most mammals, the human's auditory nerve is conserved following deafferentiation. It makes cochlear implantation possible, for the advantage of the profoundly deaf. The IBA1 cells may serve additional purposes such as immune modulation, waste disposal and nerve regeneration. Their role in future stem cell-based therapy needs further exploration.The cells can be drug-influenced and corticosteroids may play an essential role to arrest their immune reactivity in connections with CI surgery. Results from experimental cochlear electrode studies will also be presented.

Pharmacology of the inner ear

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The isolated anatomical position and blood-labyrinth barrier hampers systemic drug delivery to the mammalian inner ear. Intratympanic placement of drugs and permeation via the round- and oval window are established methods for local pharmaceutical treatment. Mechanisms of drug uptake and pathways for distribution within the inner ear are hard to predict. The complex microanatomy with fluid-filled spaces separated by tight- and leaky barriers compose various compartments that connect via active and passive transport mechanisms. Here we provide a review on the inner ear architecture at light- and electron microscopy level, relevant for drug delivery. Focus is laid on the human inner ear architecture. Some new data add information on the human inner ear fluid spaces generated with high resolution micro-computed tomography at 15 micrometer resolution. Perilymphatic spaces are connected with the central modiolus by active transport mechanisms of mesothelial cells that provide access to spiral ganglion neurons. Reports on leaky barriers between scala tympani and the so-called Cortilymph compartment likely open the best path for hair cell targeting. The complex barrier system of tight junction proteins such as occludins, claudins and tricellulin isolates the endolymphatic space for most drugs. Comparison of relevant differences of barriers, target cells and cell types involved in drug spread between main animal models and human shall provide some translational aspects for inner ear drug applications.

FS 50: CI in Children - Complications - Adherence

Predictability of vestibular function tests in children before and after cochlear implantation

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Introduction: It remains unclear what the effects of cochlear implantation are on vestibular function in children. It is likely that a substantial number of children have poor or absent vestibular function pre-operatively. However, this is not always routinely tested as it can be complicated to investigate vestibular function in young subjects.

Objective: To ascertain the usability of various tests to assess vestibular function in young children.

Methods:Children were assessed based on a combination of clinical information from a child's motor development and function and clinical vestibular tests (gaze, convergence, saccades, smooth pursuit, optokinetic nystagmus, rotatory chair, head impulse test) combined with laboratory tests of vestibular function.

Conclusion: Our research shows that the combination of clinical information from a child's motor development and function and clinical vestibular tests shows a high correlation with laboratory tests of vestibular function, even in young children, and can be used to assess vestibular (dys)function both before and after cochlear implantation.

Use of a silastic block as a space-saver in two-staged surgery for chronic suppurative otitis media (CSOM) requiring cochlear implantation

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Objectives: Cochlear implantation in patients with a history of CSOM raises many concerns. Risk of infection, meningitis, device extrusion and the presence of residual or recurrent disease, including cholesteatoma are all to be avoided.

In those with pre-existing canal wall down mastoid cavities, efforts have been made to 'bury' the electrode lead by obliterating the cavity with various materials. Unwanted 'resurfacing' and electrode extrusion as these tissues settle is an added risk.

We describe a two-staged technique using a silastic block placed in the mastoid cavity as a space-saving obturator after radical first stage surgery. This includes a revision tympanomastoidectomy with eradication of all remaining disease and a blind sac closure using a robust "tragal swing", cartilage-reinforced technique.

The second stage at 3-6 months involves removal of the silastic spacer, assessment for residual disease, irrigation, debridement and implant insertion.

Method: We present a series of patients who have undergone this two-staged surgery.

Results: Our first case had a previous cochlear implant in the presence of a mastoid cavity that was partially obliterated. She subsequently had a device failure associated with settling of the obliterated cavity which began to drain. Our second and third cases involved cochlear implantation in patients with pre-existing canal wall down cavities and poor middle ear ventilation. All underwent first stage revision with blind sac closure and a space-saving obturator.

Conclusion: This two-staged technique has simplified our approach to these challenging cases.

The obturator removes the need for primary mastoid obliteration and allows a swift second-stage surgical approach as all the preparatory work has been done.

Cosmesis is good, healing quick and aftercare minimal as there is no risk of the electrode reappearing from beneath obliterated tissues and no mastoid cavity to care for.

Proximal fixation of straight cochlear implant electrode may decrease the risk of array migration

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Objectives: We asked if proximal fixation of straight cochlear implant electrodes reduces the risk of array extrusion or migration.

Study Design: Retrospective Review

Methods: Records of 278 children implanted with a straight electrode at a tertiary pediatric hospital from 1990-2017 were reviewed. Demographics, operative reports, electrode type, radiologic and audiologic assessments, including impedance and stimulation parameters were collected. A Significant abnormality was defined as a greater than 75% change in impedance compared to baseline, 1 month post-implant, impedance values.

Results: During this period, straight electrodes were chosen infrequently (298/1781 devices implanted (16.73%) in 278 children). They were used in the pre-curved electrode period (153/298) and subsequently in hearing preservation (32/298) and anomalous cochleae (48/298). Most recently they were used in a comparative study of children receiving one perimodiolar and one straight array (65/298). All straight electrodes were proximally fixed with a suture around the incus buttress (Nedzelski's knot). None of the 298 electrodes required repositioning. Comparative radiographs after long duration implant use were available in 72 of 278 children (25.9%) with none revealing changes in electrode position. Significant impedance changes (>75%), indicative of open circuits, were noted in 6/278 children (2.16%); ≤2 electrodes at various array positions were affected in each child. In one case, repositioning of the receiver/stimulator may have damaged the electrodes as they exited the device body but no changes in electrode position were evident on the post-repositioning radiograph.

Conclusions: Extrusion of straight electrodes is a known complication of cochlear implant surgery but was not observed in our cohort with proximal electrode fixation.

Outcomes of minimal invasive surgery for cochlear implantation in children

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Objective: The authors present series of 154 patients operated via both minimal invasive surgery and round window approach and their results.

Materials and methods: Primary surgery was performed on group of 154 children with pre- or perilingual deafness (mostly inherited in origin) aged from 17 months to 12 years. We had 9 children with cochelovestibular anomalies. Modified transcanal technique was used in 97 patients and all the rest were operated via posterior tympanotomy - round window approach. Preoperative radiological assessment both with CT and MRI scans was performed in all cases.

Results: We had 10 perioperative complications occurred in this series (hematoma, perforation of the tympanic membrane). There have been three cases of revision surgery due to device failure, and we had one case of postoperative meningitis. In eight cases deafness was due to bacterial meningitis with incomplete ossification of the cochlea.

Conclusions: We found both techniques feasible for cochlear implantation both in children and adults. Comparative advantages are minimal drilling of the bone and preservation of mastoid structure in modified transcanal technique, which is extremely important in children. These techniques enable safer access and better angle in performing cochleostomy in cases with normal anatomy as well as cochlear malformations.

Minimization of postoperative risks after cochlear implantation in children

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Objectives: The goal of the surgeon performing CI in child is complete exception of possible postoperative complications with reliable and approved techniques.

The novel CONCERTO PIN device is the first implant for reliable minimally invasive surgery, which is especially useful in children where the drilling of a bed and holes for sutures can cause rare but life-threatening complications such as epidural hematomas. This method allows reduced surgery duration and minimizes the impact of anaesthesia on the patient, which is of particular importance when very young children receive a CI.

Material and Method.: Since October 2013 till December 2016, 186 children (7 months - 16 years) old were consecutively implanted unilaterally with the CONCERTO PIN device. The surgical technique used the classic mastoidectomy/posterior tympanotomy approach was performed. In 92.5 % of CIs the electrode array was inserted through the round window membrane as it is proved that it reduces insertional trauma. In all cases no bony bed was drilled and holes for pins only were created in the cortical layer of the flat bone just behind the squamous suture. The mean time of surgery with the CONCERTO PIN was 30 ± 7.3 min.

Result and Conclusion: The follow-up period was 1 year. No major complications have occurred after CI. The implants are stable and securely fixed in every patient. No evidence of device migration or rotation was observed. Minor complications occurred in less than 3 % cases and included hematomas and one case of acute otitis media in the implanted ear.

The outcome of hearing rehabilitation with the COCERTO PIN seems similar to that with devices implanted using other techniques.

Cochlear implant and tympanomastoidectomy simultaneously

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Introduce: Cochlear Implant (CI) on Chronic Otitis Media (COM) could be performed. Canal wall Up (CWU) and Canal Wall Down (CWD) Tympanomastoidectomy(TM) may be could be choice on management of COM

Objective : To introduce how to prepare CI on patient suffering COM, how to decided what kind surgery and CI device be choice. To described the surgery technique of CWU and Closed Technique CWD

Method and material : During 2010-2016 among 261 ear from 180 patient which CI have been done , on the Out reach CI Programme in Indonesia

Four CI and Closed technique CWD TM were performed, 3 cases had been done CWU TM . Special technique that is reconstruction Posterior canal wall by using periosteum flap on CWD TM will be discussed on this presentation. Some variation of Med El CI electrode have been used in this project

Result: all cases be good result, no infection, and other complications

Conclusion: CI and CWU or CWD TM can be done simultaneously, which it need special surgery technique specially on CWD closed technique

Impact of room acoustic parameters on speech and music perception among participants with cochlear implants

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Objectives: Besides numerous other factors, listening experience with cochlear implants is substantially impaired by room acoustics. For CI users, complex listening environments are usually associated with heavy losses (Iglehart 2016; Roy et al. 2015). The aim of the present study is to determine room acoustic criteria that particularly influence audability for CI users.

Materials and Methods: Speech material of the Oldenburg Sentence Test as well as basic music material (major and minor triads) were auralized. The constructed rooms for speech stimuli were based on the German binding standard DIN 18041:2016-03 about acoustic quality in rooms, including specifications for inclusive applications in schools. For the music perception tests, two typical concert halls of different sizes were modeled.

The auralized test stimuli were unilaterally presented to 10 CI users via their auxiliary input as well as to 18 participants with typical hearing via headphones.

Evaluations were performed using modified MUSHRA tests (acoustic quality) and paired comparison tests (chord discriminiability).

Results: A strong preference of small source-to-listener-distances by CI users was found, but

no significant preference of room acoustic attenuation exceeding the recommendation for inclusive applications. The analyses of the energy-time-structures suggest that a dense concentration of early reflections makes a beneficial impact on CI listeners pleasantness ratings. Music materials were distinguished more consistently without any room acoustic impact, while no significant difference was observed between different room sizes and chord positions.

Conclusions: These results suggest, that for pleasantness of speech, source-to-listener-distance is the more influential parameter than room acoustic attenuation beyond German standard recommendation in CI users. Profitable reflections happen earlier than in NH. Future studies on chord discriminability concerning room acoustics are needed.

Bacterial colonization patterns of percutaneous abutment surfaces in relation to skin integration

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Objective: Peri-abutment dermatitis is thought to relate to bacterial infection of pockets around the patient's abutment. It is yet unknown how bacteria colonize the abutment surface. Molecular microbiology techniques allow for selective microbiota profiling to approximate bacterial migration patterns. Bacteria are in direct competition with the host's ability to control the abutment surface ("race for the surface" Gristina 1987). Upon integration of the host to the abutment, competitive bacteria are hypothesized to be prevented from colonizing it. Evidence for skin integration has been shown before for hydroxyapatite(HA)-abutments, but without elucidating the attachment mechanisms behind it. Therefore the objective of two investigations was to study the relationships between the microbiota on and around the titanium abutment and to investigate skin-integration on HA-coated abutments.

Study design: Observational case series featuring 3D imaging and molecular microbiology.

Patients: Sixteen subjects with and without peri-abutment dermatitis were included for the microbiology case-control study. Four subjects with a HA-coated and one subject with a titanium abutment were included for an ex vivo cell investigation of skin integration.

Methods: Molecular bacterial profiling was performed using IS-pro (IS-Diagnostics LtD) on the retrieved abutment of a subject, the skin surrounding it, and the contra-lateral side (control). Scanning electron microscopy was performed for biofilm assessment. Two-photon microscopy was performed on retrieved HA-coated abutments using fluorescent labeling of adhesion proteins, nuclei, and dermal collagen.

Results: The microbiota on and around the titanium abutment is diverse and distinct from the contralateral control skin, in health and disease. A multitude of different microbes including yeast and bacterial (sub)species belonging to different phyla on and around the BCHI titanium

abutment were found in planktonic form or biofilm, in subjects with and without inflammation. The HA-coated abutments without infection show evidence of integration by means of hemidesmosomes, basal keratinocytes, and/or the presence of vascularization.

Conclusion: The differences in the three microbiota per individual for subjects with and without inflammation suggests that the composition and complex interplay (i.e mutualism, parasitism, commensalism and/or coaggregation) of those microbiota might be a determinant for the difference between health and disease. Previously hypothesized skin integration markers were found on the HA-coated abutment.

FS 51: Intra-operative Measurements in CI

What is the significance of intra-operative cochlear implant re-insertion on measured impedences?

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Objectives: Intra-operative re-insertionof the array is sometimes necessary due to in-complete insertion, electrode failure, and during the teaching process. Throughout the development of cochlear implantation there has been an evolution in devices including the concept of 're-insertion' of electrode arrays. The aim of our study is to assess the sequalae of intra-operative re-insertion of the array as a proxy measure for fibrosis.

Methods: Analysis of the Sydney Cochlear Implant Centre database from 1994 – 7th January 2016 was carried out. All included cases were attempted surgeries where an electrode fault (short circuit or open circuit cases) necessitated immediate explantation and re-implantation within the same operative procedure. Cases were removed from analysis in cases of known preceding meningitis or labyrinthis ossificans; intra-operative electrode array buckling; or incomplete 'final' insertion by the senior surgeon. All controls were normal insertions which were age matched and had received the same electrode array inserted by the same operating surgeon. Impedence values, in common ground mode, measured at 'switch on', three months and one year were recorded.

Results: In total, there were 31 cases identified within our database. This was made up of 14 CI 24(RE) ST arrays; 6 CI 422 arrays and 11 CI 512 arrays. Controls Statistical analysis with Anova testing was performed, comparing mean common ground impedence for each electrode between each patient with its matched control. Although statistically significant distinctions were seen between the control and re-insertion groups, and also between arrays, none remained discernable by one year.

Conclusions: Our study shows that there is no prolonged alteration in impedance values following intra-operative re-insertion. This has importance in consideration of intra-cochlear drug delivery systems and indeed cochlear implant surgical training.

Intraoperative monitoring using cochlear microphonics in cochlear implant patients with residual hearing

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In the last decades, the cochlear implant (CI) indications have been expanded including patients with residual hearing. In particular, a group of patients has a slope audiogram, with very good residual hearing at low frequency while moderate up to severe hearing loos at high frequency. In this group of patients the preservation of the inner ear structure during electrode insertion on the CI surgery is critical in order to achieve hearing and structure preservation.

Intracochlear Electrocochleography (Ecochg), such as cochlear microphonic (CM), recorded via CI during electrode insertion has been shown to provide an objective monitor of the outer hair cells (OHC) function during CI electrode insertion, giving useful information and feedback to the surgeon about the electrode insertion trauma and the residual hearing on the long term.

In our center we included 5 patients with residual hearing having a slope audiogram. They were implanted with MED-EL Synchrony 28 mm or 24 mm. Intra-operatively, Ecochg recording was performed during electrode insertion via the clinical software Maestro 7 at different insertion steps, stimulating acoustically at the frequencies corresponding to the best residual hearing of the patient. Further, at the fitting sessions post-operatively, the Ecochg was recorded to monitor the residual hearing over time.

Electrocochleograpic changes during cochlear implantation associated with hearing loss

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A sudden decrease in the cochlear microphonic amplitude, recorded from the apical electrode during implantation has been associated with poor preservation of residual hearing. Here we describe changes in characteristics of the cochlear microphone (CM) during these events and explore the potential mechanism(s) of post-operative hearing loss.

Intra-operative electrocochleography was recorded from the apical electrode during implantation in 88 recipients of Cochlear's lateral wall electrode (CI522). During implantation, ECochG was recorded in response to a 0.5-kHz stimulus tone presented with alternating polarity at 100- or 110-dB HL. Audiometric outcomes were collected pre-operatively and at 3-months post-operatively. Here we describe when the CM dropped during surgery, and changes in the latency and frequency response of the CM during these events.

A drop of CM amplitude was observed during 59 surgeries. While it could occur early during insertion (18), it was seen most often at >20 mm insertion depth (27). Other associations were with placement of the electrode lead into the mastoid (4) or placement of fascia onto the round window (10). A CM drop led to significantly poorer audiometric thresholds at 3-months.

When the CM dropped, the latency (from stimulus onset to the start of the response) decreased in 17 cases and remained constant or increased in 26 cases. The peak amplitude of the Fast Fourier Transfer function shifted away from 0.5 kHz to a higher frequency in 15 cases, and a lower frequency in 9.

These findings suggest a change in the resonance of the system, which could mean either a shift in the stiffness of the BM or a change in the fluid dynamic by the presence of the electrode in the scala. The stiffness of the BM might be changed by direct contact. The fluid dynamics could be changed, particularly in an apical region where the scalar diameter is smaller and for low frequency stimulation where energy is propagated via deep water wave motion.

Electrode impedance fluctuations coincide with post-operative hearing loss and vertigo in cochlear implant recipients

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Fluctuations in cochlear implant impedance are associated with inner ear pathology after implantation. The current research explores whether these fluctuations coincide with episodes of hearing loss and/or vertigo, with a comparison between lateral wall and peri-modiolar electrode arrays.

Seven-hundred and seventy recipients of Cochlear's slim-straight, lateral wall electrode (CI422) or peri-modiolar (CI512) electrode were investigated for impedance fluctuations. Impedance fluctuations were defined as a median rise of ≥ 4 kΩ across all intra-cochlear electrodes from baseline measurements taken two weeks after switch-on. Medical records were analysed from 193 of the 770 patients selected so that a comparable number would have impedance fluctuations as did not, for both electrode types.

The slim straight, lateral wall electrode was found to fluctuate in impedance at a small, but significantly higher rate than the peri-modiolar array (17% vs 12% respectively). Impedance fluctuations were found to significantly correlate with medical events (either hearing loss, vertigo, or tinnitus). Overall, in the "fluctuation" group, 42 out of 75 patients (56%) demonstrated a clinical event during the impedance fluctuation, whereas 26 out of 118 patients (22%) of the "non-fluctuation" group had a clinical event. This significant difference existed with both implant type. The Positive Predictive Value (PPV) of the impedance fluctuation being associated with a clinical event is 0.56, and the Negative Predictive Value (NPV) is 0.78. There were no significant differences in the demographics of those who had an impedance fluctuation compared with those who did not.

These results support the relationship between fluctuations in cochlear implant impedances and post-operative clinical events, including the loss of residual hearing and vertigo. Monitoring cochlear implant impedance may be a method for early detection, and so the prevention, of these events in the future.

Intra-cochlear electrocochleography during CI electrode insertion is predictive of final scalar location

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Background & objectives: Conventional cochlear implant (CI) surgery is performed without a method of actively monitoring for potential damage to intracochlear structures. Intracochlear electrocochleography (ECochG) obtained directly through the CI may provide feedback facilitating better structural preservation and improved hearing outcomes. The objective of this study was to quantify the degree to which intracochlear ECochG can predict the CI electrode's scalar location. We hypothesized that ECochG patterns observed during electrode insertion provide information predictive of scala tympani vs. scala vestibuli location.

Methods: Intracochlear ECochG was performed in 32 patients across 3 different implant centers. During electrode insertion, a 50-ms tone burst acoustic stimulus was delivered with a frequency of 500Hz at 110dB SPL. The ECochG response was monitored from the apical-most CI electrode. The amplitude and phase changes for the first harmonic were categorized to understand the scalar electrode location and used in an algorithm to predict scalar location (scala tympani versus translocation/interaction

with the basilar membrane). Scalar location was verified using post-operative computed tomography (CT) scans and image processing.

Results: CT analysis showed 25 subjects with scala tympani position and 7 subjects translocating from scala tympani to scala vestibuli. The ECochG algorithm correctly estimated CI electrode location in 26 out of 32 subjects with 6 subjects incorrectly identified as translocation, resulting in a specificity of 100%, sensitivity of 77%, false positive of 0%, and false negative rate of 23%. A non-significant difference in hearing preservation was observed between the translocations (36 ±15 dB loss) and scala tympani insertions (28 ±10 dB loss) (p>0.05).

Conclusion: Intracochlear ECochG may provide information about CI electrode location and hearing preservation.

FS 52: Hearing Preservation in children

Hearing preservation with standard length electrodes in paediatric cochlear implantation: the RNTNEH experience

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Objective: Preserving low frequencies following cochlear implantation improves outcomes and allows patients to utilise a combination of electroacoustic stimulation. Advances in electrode design and surgical techniques have made preservation achievable. Full insertion of standard length electrodes may be advantageous over shortened electrodes because more electrodes can be activated over time if low frequency hearing loss progresses. There is need for further data regarding standard length electrodes in children, for clarity when counselling patients regarding likelihood and degree of hearing preservation achievable. We report our experience using standard length cochlear implant arrays for hearing preservation in children.

Material and Methods: Retrospective case series. Inclusion criteria: pre-operative hearing ≤85db at 250Hz and aged ≤18 years. Hearing preservation percentages calculated using the HEARRING group formula. S=[1-((PTApost-PTApre)/(PTAmax-PTApre))*100]% Preservation of > 75% was considered complete, 25-75 % partial, and 1-25% minimal. Patients were implanted with either MED-EL FLEX28 or Cochlear Nucleus CI522. Standardised operative technique including posterior tympanotomy and atraumatic round window insertion.

Results 52 implantations in 27 paediatric patients met inclusion criteria. Mean age at implantation: 9.8 years. Average follow-up audiogram: 8 months. Mean total pre- and post-operative pure tone averages were 82.8dB and 92.6dB. 17(33%) ears demonstrated complete hearing preservation, 22(42%) ears partial hearing preservation, 7(13%) minimal hearing preservation, and 6(12%) exhibited no acoustic hearing post-operatively. Mean hearing preservation was 55.5%.

Conclusion Hearing preservation is achievable to varying degrees in paediatric cochlear implantation using standard length electrodes. This study is amongst the largest additions to the knowledge base for hearing preservation in this patient population.

Hearing preservation using short and long flex electrodes in patients meeting EAS criteria

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Objectives: The benefits of preserving residual low-frequency hearing are well established. However, with greater understanding of the variance in initial outcomes and the likelihood of long-term maintenance of initially preserved hearing, a dichotomy is emerging between using short electrodes to deliver better hearing preservation (HP) and longer electrodes to provide better performance in the electrical stimulation-only (ES-only) condition should residual hearing be lost.

Results: Patients meeting the traditional audiological criteria for electric-acoustic stimulation (EAS) (thresholds of 65dBHL or better at 250 and 500Hz) were included in this study. The primary outcome was success of HP using the HEARRING group classification system and the secondary outcome was changes in thresholds at individual frequencies.

6 patients receiving Flex28 electrodes and 11 patients receiving Flex24 electrodes were identified for further analysis in this retrospective study. Using the HEARRING group classification system success rates for HP were similar between both groups, and there were no cases of minimal or complete loss of residual hearing.

Conclusion: Further study is needed to determine if comparable rates of HP can be achieved in EAS candidates between short electrodes specifically designed for HP surgery, and longer electrodes enabling Complete Cochlear Coverage (CCC). Should this be the case, then EAS patients may be better served by using longer electrodes for HP. Longer electrodes can be sequentially activated to match hearing deterioration over time in children, young people and younger adults, and would provide the benefits of CCC when residual hearing is no longer providing functional benefit. Additionally, work is needed to determine the long-term impact on quality of life and patient reported outcomes (PROs), between the outcomes of these 2 treatment strategies.

Hearing preservation using the cochlear CI422 and CI522 Nucleus implant

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Objectives: The benefits of preserving residual low frequency hearing during cochlear implantation (CI) are well established. There is agreement that the physical characteristics and design of the electrode array are a central factor influencing successful hearing preservation (HP). To date, lateral wall electrodes have demonstrated the best success rates and there remains significant variation in published results. This study evaluates the efficacy of the CI422/522 electrode in CI with attempted HP.

Method: Single centre observational study

Results: Although ongoing, the initial audiological results would suggest that the CI422/522 electrode array is a very effective electrode for CI with HP. Mean pre-op thresholds (n=14) at 125, 250, 500 & 1000 Hz were 45, 51, 68 & 80dBHL, respectively. Initial post-op thresholds (n=7) were 58, 68, 85 & 102dBHL and the latest post-op thresholds (n=9) were 49, 68, 82 & 95dBHL, respectively.

Conclusion: Initial experience of the CI422/522 electrode array suggests that success rates for hearing preservation are at least comparable to the most effective electrode arrays currently available. There is a clear need for electrode arrays that give consistent hearing preservation results. This requirement is emphasized as current candidacy criteria continue to be challenged internationally, with consideration being given to patients with increasing levels of potentially useable residual hearing.

Preliminary evaluation of objective electro-acoustic stimulation fitting using electrocochleography in children

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Recently, several pediatric cochlear implant (CI) recipients have aidable acoustic hearing in their implanted ear(s) for electro-acoustic stimulation (EAS). Reliable evaluation and efficacious programming in this complex population can be challenging. Use of objective measures like electrocochleography (ECochG) could make quick, easy and reliable measurement of acoustic thresholds feasible.

The objectives of this study are to (1) measure correlation between behavioral and ECochG thresholds and, (2) evaluate efficacy of programming acoustic component using ECochG thresholds in pediatric CI recipients. To date, 14 children (aged 12 months to 15 years, 17 ears) implanted with Advanced Bionics HiFocus Mid-Scala electrode array have been studied.

Behavioral thresholds were measured via routine audiometry (warble tones, insert ear phones). ECochG thresholds were recorded using CI electrode array in response to calibrated acoustic pure tones. To date, ECochG and behavioral thresholds are significantly correlated (n=17 ears, $r2 = 0.72$, $p < 0.01$).

A subset of children capable of providing subjective feedback and reliable speech testing were fit with an acoustic component using behavioral thresholds (n=8). Age and language appropriate speech outcomes and subjective feedback were obtained. Results indicate significant benefit when using EAS as compared to electric only. After successful use of this behavioral threshold fitting for at least 3 months, children were refit using ECochG thresholds. A comparison of outcomes across the two fitting methodologies shows equivalent speech understanding and subjective acceptance.

In conclusion, our data suggest that ECochG can be used to measure and monitor residual hearing in pediatric CI recipients and to reliably fit the acoustic component. This objective methodology has the potential to improve clinical measurement of very young children, where behavioral estimation of thresholds may be challenging.

Electric-acoustic stimulation outcomes in children

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Objectives: This study investigates outcomes in children fit with electric acoustic stimulation (EAS). Three main questions are addressed: 1) Are outcomes with EAS superior to outcomes with conventional electric only stimulation? 2) Do children with residual hearing benefit from EAS and/or conventional electric only stimulation when compared to the preoperative hearing aid condition? 3) Can children with residual hearing after cochlear implantation derive benefit from EAS after several years of listening with conventional electric only stimulation?

Materials and Methods: Sixteen pediatric cochlear implant (CI) recipients between 4 and 16 years of age with a low-frequency pure tone average (LFPTA) of 75 dB HL were included in 2 study arms. Arm 1 included new recipients and Arm 2 included children with at least 1 year of CI experience. Using a within-subject design, participants were evaluated with the CNC word list and the Baby Bio

at a +5 dB SNR using an EAS program and a conventional full electric program. Arm 1 participants' scores were also compared to preoperative scores.

Results: Speech perception outcomes were statistically higher for the EAS condition than the full electric CI condition. For new recipients, scores were significantly higher with EAS than preoperative hearing aid scores for both the CNC and Baby Bio in noise, however after 6 months of device use, results in the fully electric condition were not significantly better than preoperative scores. Long-term electric only CI users benefited from EAS over electric only programs based on CNC word scores.

Conclusions: Whether newly implanted or long-term CI users, children with residual hearing after cochlear implantation can benefit from EAS. Cochlear implantation with EAS fitting is a viable option for children with hearing aids who have residual hearing, but have insufficient access to high frequency sounds and poor speech perception.

Laboratory analysis and clinical results with the 532 perimodiolar electrode

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Objectives: To detail the laboratory findings with the 532 electrode. These analyses include fluoroscopic analysis, force measurements from the walls of the cochlea, intracochlear video analysis and histologic analysis. Additionally we will discuss the outcomes with over 300 patients with the 532 electrode including hearing preservation capacity.

Material and Methods: Real time fluoroscopic analysis was conducted on a number of temporal bones to both analyze the trajectory and functioning of the new 532 electrode as well as complication simulation. This was also captured on video from inside the cochlea. Force measurements were conducted using the Instron set up mentioned in prior studies. Histologic analysis of electrode position and trauma analysis was also conducted. Preventing tip rollover was also reviewed.

Outcomes on over 300 patients was also reviewed and hearing preservation results recorded.

Results: The 532 electrode is easy to insert and results in limited trauma to the temporal bone. Force measurements reveal little to no outerwall forces. The electrode is also easy to remove without trauma. Tip rollover prevention is discussed as we had 8 tip rollovers in the first 100 patients and none in the next 200 patients. Histologic analysis in temporal bones post implantation revealed little trauma to the cochlear structures. Outcomes were excellent in this patient cohort and hearing preservation is very possible, even in children with significant residual hearing.

Conclusion:The 532 electrode performs well in both temporal bone studies and in human implantation. Hearing preservation is very possible with this longer electrode with atraumatic insertion. We recommend this electrode over shorter electrodes in children with good residual low frequency hearing as they likely will lose residual hearing during their lifetime and a longer electrode prevents the need for re-implantation.

FS 53: Fully-implantable Active Middle Ear Implant: Clinical Outcome

The UK experience of the Cochlear Carina fully implantable hearing device – Bridging the gap in severe hearing loss

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Intro: The Carina is a fully implantable middle ear implant capable of amplifying up to 85dB SNHL. It can be attached to the incus or stapes and is suitable for pure SNHL or mixed hearing losses. We have found it useful to aid patients unsuitable for conventional or bone conduction hearing aids who have useful residual hearing.

Methods: 12 patients have been implanted in 4 centres in the UK, one patient receiving bilateral sequential Carina implants. The indications were moderate to severe SNHL and unable to benefit from hearing aids (air or bone conduction) but better than the UK NICE guidelines for cochlear implantation (>90dB at 2 & 4Khz). 11 of 12 surgeries used the intact ossicular chain for connection.

Results: Surgery was well tolerated with 6/12 being performed with same day discharge. Two complications occurred – (1) a seroma 5 days after surgery managed with aspiration (2) intraoperative displacement of the incus corrected during surgery. Average follow up is 13 months (2 – 27 months) and there has been no device failure. There has been improvement in hearing threshold, and significant improvement in speech intelligibility (Pre-op best aided AB word list presented at 70dB was 45±28%; Post-op 77±12%). There has been no deterioration in unaided thresholds confirming the device does not reduce natural hearing. Feedback has been an issue although this has reduced with altered surgical technique and improved feedback suppression within device software. No battery issues have occurred. Patients with severe loss often preferred to use an additional external microphone to improve clarity and reduce feedback. Glasgow hearing aid benefit showed reduction in disability from 60% to 6% with high patient satisfaction.

Conclusion: The Carina is an effective and safe implant for patients with moderate to severe hearing loss; it offers a totally implantable system which is audiologically and cosmetically acceptable. It also allows hearing restoration in patients with hard to aid mixed hearing loss.

First audiological results with the fully implantable active middle ear implant cochlear Carina™

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The Cochlear Carina™ system is a fully implantable active middle ear implant, consisting of a subcutaneously placed microphone, implant, rechargeable battery and an electromagnetic actuator. It is indicated in patients with middle- to severe sensorineural hearing loss or mixed hearing losses when there are contraindications for wearing conventional hearing aids e.g. chronic otitis externa, anatomical abnormalities or an active life style or working conditions are desired and are restrained by conventional hearing aids. This system is CE marked since 2013 by Cochlear and has been implanted for the first time in our clinic in summer 2017.

Between July 2017 and January 2018, several patients were recruited following the manufacturer's indication range, implanted and activated 6 to 8 weeks after implantation. Audiological examination pre-operatively and outcomes at initial activation and 1, 3, 6 month intervals were assessed. All patients were programmed using the Carina™ Fitting Software 4.0.

Speech perception tests including the Freiburg monosyllables at 50, 65 and 80 d SPL, and the Oldenburg Matrix Sentence Test (OLSA) was conducted at each interval.

Preliminary results revealed better speech perception in quiet and noise comparing unaided and aided at initial activation. Follow- up audiological results will be presented from the 1, 3, 6 months interval and outcomes pre-operatively with the best aided condition (e.g. conventional hearing aid) compared to the Carina™ aided results.

Preliminary data on quality of life and daily hearing function for Carina middle ear implant recipients

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Objective: Patient-reported outcomes and quality of life data are important for supporting efficacy claims and reimbursement for health technology solutions. To evaluate self-perceived benefits after hearing treatment with the Cochlear™ Carina, participation in an observational study (i.e. post-market follow-up, Cochlear-IROS) was undertaken. Preliminary longitudinal data will be summarized for 14 recipients.

Materials and Methods: Self-assessment of quality of life via the Health-Utilities-Index Mk3 (HUI3) and daily hearing function via the Speech Spatial Qualities (SSQ) scales was performed at preimplant and at 1 year in the post-implant representing the daily listening condition at each interval. Routinely measured air- and bone-conduction hearing threshold levels were also collected. Demographic, audiological and preliminary self-assessment data are reported.

Results: The majority of recipients presented with a sensorineural hearing loss, with hearing loss ranging from moderate to severe in the implanted ear. Longitudinal outcomes are available for n=14 recipients to date. At one year, a clinically important trend for improvement is observed for HUI3 multi-attribute scores (median 0.12, scale 0 -1.0) and for SSQ49 subcategory scores (~2.0 scale points, scale 0-10.0). Bone-conduction thresholds at one year post-implant are clinically similar to pre-operative levels.

Conclusions: These preliminary data suggest that Carina patients accrue a clinically significant improvement in health-related quality of life compared to their preimplant listening condition where increases in HUI3 scores were generally >0.03. Improvements in all three subcategories are also observed for the group. Sound quality was also improved using the Carina. The bone conduction thresholds were stable after 1 year of implant use.

The directional response of the Cochlear™ Carina® totally implantable microphone

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Objectives: One of the main elements of a fully implantable system is the totally implantable microphone (TIM). The Carina system uses a sub-cutaneous, omnidirectional microphone, which is surgically implanted on the mastoid bone behind the ear. The most frequently used TIM position is on the posterior inferior mastoid line, but due to anatomical reasons or surgeon's preference, it might also be positioned in other locations behind the ear. This may lead to variability in the directional response. Additionally, the retro-auricular microphone position does not seem ideal to pick up sounds from the front. The aim of this study was to investigate the directional response of the Carina TIM in various microphone positions on the mastoid to be able to make a judgement on which microphone position will be best for optimal speech discrimination.

Materials & Methods: The Carina TIM was positioned in four different positions on two different artificial heads (Cochlear Haddock and Cortex MK2) and a human cadaveric whole head. The heads were placed in the middle of a horizontal arch with loudspeakers having a distance

of 15° from each other. A broadband noise (MLS) with a duration of 1.5 s was played consecutively via the loudspeakers and recorded by the Carina TIM and a reference microphone.

Results and Conclusions: The directivity index (DI) and directivity vector (DV) will be calculated for each microphone position on all heads. The DI and DV for the broadband signal as well as for the octave bands will be analyzed and compared for the various microphone positions. Differences between the artificial heads and the cadaver head will be presented. Preliminary results show differences in the DI and DV for the various microphone positions for both, the cadaver head and the artificial heads, which suggests that there is an optimal position for the TIM and that the microphone position may have an influence on the hearing performance. Polar plots with the different directional responses will be shown and discussed.

Estimating the coupling efficiency of the fully implantable middle ear implant CARINA(R) via ABR

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The CARINA® from Cochlear is an active middle ear mplant, which is coupled to different structures to the middle ear depending on the type of hearing loss. Hearing outcomes correlate to the coupling efficiency of the actuator to the respective middle ear structure. Especially in patients with hearing losses close to the indication limits a sufficient coupling is essential to have enough gain to compensate the hearing loss.

Currently, the coupling between middle ear structure and the actuator is monitored indirectly via electrical impedance measurements. Nevertheless, it is still not possible to get an estimate about the ability of the implant system to stimulate the auditory pathway effectively. For this purpose auditory brainstem responses (ABRs) were measured intraoperatively after final positioning of the implant system and checking the electrical impedance of the actuator. The stimulation was performed using broadband chirp stimuli, which were presented starting from suprathreshold levels to below the registration threshold.

First intraoperative measurements revealed that it is possible to derive intraoperative ABR thresholds via the CARINA® middle ear implant.

Hearing with acoustic hearing implants, proposal multicenter study towards treatment options for patients with a contra indication for hearing aids

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There is a wide variety in treatment options of hearing impaired patients with a contra indication for hearing aids. When treatment with conventional hearing aids is not adequate or possible, alternative treatment options, depending on the type of hearing loss, are available: i) reconstructive surgery; ii) middle ear implant (Carina®, Vibrant Soundbridge®); iii) bone-conduction device. The decision to choose for a certain treatment is often hospital-specific and related to available funds or patient related factors (work, socioeconomic status) rather than empirical evidence-based clinical data. The aim of our consortium is to provide a roadmap with evidence-based clinical guidelines for the treatment of this hearing impaired population, to reduce the costs, and to avoid nonuse of expensive acoustic hearing implants. Secondarily, we will investigate the need and importance of bilateral implantation. In the proposed study we will compare existing health care interventions with internationally standardized methods in order to improve the efficiency and avoid that irrelevant features are tested and evaluated in more than one clinic. Currently, in case of conductive or mixed hearing loss even successful surgery often results in a remaining hearing loss with the need for amplification. Additionally, implanted patients are not always satisfied because aided thresholds and speech perception remain poor, and when patients are satisfied the hearing implant might not be supported anymore because it is rejected from the marked. The overall aim of the presented study is to compare existing health care interventions with international standardized methods in order to improve the efficiency and provide fundamental evidence for the best possible treatment.

FS 54: Evaluation of Vestibular Function

Vestibular preservation and motor function in pediatric cochlear implantation

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Objective: To evaluate perioperative change in vestibular function, balance, and motor development following cochlear implantation (CI) in children and adolescents.

Methods: This study was a retrospective analysis of vestibular testing, balance, and motor inventory scores both

before and after implantation of 16 ears in 13 patients. Vestibular tests included the rotary chair test (n=12), cervical (n=12) and ocular (n=3) vestibular evoked myogenic potential tests (VEMP), video head impulse test (n=6), and ice water caloric test (n=1). Balance and motor tests included the Peabody Motor Developmental Scale – 2nd edition (PMDS-2; n=5), Bruininks-Oseretsky Test – 2nd edition (BOT-2; n=5), and the clinical test of sensory integration of balance (CTSIB; n=5).

Results: A post-operative drop in baseline vestibular function was seen in four (25%) out of 16 implanted ears. An enlarged vestibular aqueduct (EVA) was present in three out of four implanted ears that demonstrated a post-operative drop in vestibular function, and three out of four patients with EVA demonstrated a post-operative drop in vestibular function. One patient with Usher syndrome and vestibular areflexia (pre and post-operative) demonstrated a drop in PMDS score post-operatively. All other patients that underwent both pre and post-operative functional balance/motor testing (PMDS-2, BOT-2, and/or CTSIB) demonstrated stable or improved scores post-operatively, regardless of change in vestibular function.

Conclusions: We found a higher rate of preservation of vestibular function following CI than has been reported in many prior studies. EVA appears to be a risk factor for a post-operative drop in vestibular function following CI. A unilateral post-operative drop in vestibular function did not have a significant impact on balance or motor development scores in any patients in our study.

Vestibular evaluation following cochlear implantation in patients with inner ear anomaly

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Introduction: several studies have been performed to assess the cochlear and surgical outcomes in cochlear implanted children with inner ear malformation. Auditory benefits from this intervention were significant, but the evaluation and management of vestibular system in those patients is a novel challenge to even the most clinician.

Objective: To evaluate the impact of inner ear anomaly on vestibular system in patients with bilateral severe to profound hearing loss whom undergone cochlear implantation.

Material and methods: In this retrospective review study, 43 patients with congenital profound hearing loss who underwent unilateral cochlear implantation from 2001 to 2016 were recruited. They were allocated into patients with and without inner ear malformations by temporal bone high-resolution computed tomography. Vestibular system was assessed with vestibular evoked myogenic potential (VEMP) and bi- Thermal caloric test. The effects of cochlear implant surgery on vestibular function were evaluated when contralateral ear was considered as control. Statistical analysis was conducted by using Binary Logistic Regression with SPSS and Fisher Exact test. The significance level was set at $p < 0.05$.

Results: Saccular dysfunction was detected in 60.7 % of abnormal ear that received cochlear implantation. There were significant differences in VEMP results between groups (p-value: 0.026) and 65% of patient with absent VEMP were in patient with abnormal inner ear anatomy. Patients with history of re-implantation in both ear had bilateral VEMP abnormalities (p-value: 0.012). Caloric- no response and weakness was detected in 77.7 % of patient with abnormal inner ear anatomy and 81.3 % of patient with normal anatomy had normal caloric test. There were no significant differences in caloric results and implanted ear (p- value: 0.66). Patients with history of re-implantation in both ear had bilateral caloric abnormalities (p-value: o.o3). Among patients with inner ear anomalies, those with abnormal internal auditory canal performed worse in vestibular function. Gender, age, duration of implantation, age of implantation, type of prosthesis and intra-op cerebrospinal fluid leak had no significant difference in both groups and did not affect clinical outcomes.

Conclusion: In patients with inner ear anomalies the incidence of vestibular dysfunction is predominant, especially in those with internal auditory canal narrowing. Therefore, surgeons should be aware of more labyrinth injury during cochlear implantation surgery especially in patients who need re-implantation and try to minimize the risk of injury.

Evaluation of balance function in patients with inner ear anomalies and cochlear implantation

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Introduction: Because of the importance of vestibular function in gross motor development, otologists and audiologists should recognize and understand the high incidence of vestibular dysfunction in hearing impaired patients and be prepared to undertake appropriate intervention. However, there have been no studies that investigated the entire vestibular function in patients with inner ear anomalies whom undergone cochlear implantation.

Objective: To identify vestibular dysfunction in patients with inner ear anomalies with severe to profound sensorineural hearing loss (SNHL) and cochlear implant surgery.

Material and methods: This is a retrospective case review study of patients with unilateral cochlear implantation from 2001 to 2016. 28 patients with congenital inner ear anomalies whom underwent cochlear implantation were selected, and were compared to 16 cochlear implanted patients with severe to profound hearing loss and normal inner ear anatomy. Inner ear anatomy was evaluated by temporal bone high resolution computed tomography (HRCT).Vestibular function was assessed by Computerized Dynamic Posturography (CDP) and Bruininks–Oseretsky test (BOT-2). Binary Logistic Regression with SPSS and Fisher Exact test were used for data analysis.

Results: In this study, patients with inner ear anomalies showed significantly worse performance in BOT-2 scores, 13 times more compared to normal group (p-value: 0.02). Data supported that as severity of abnormality increases, patients faced more vestibular dysfunction. Balance as measured by posturography, showed 5.91 times higher vestibular dysfunction (p-value: 0.012) in patients with inner ear anomalies in comparison with control group. Also, higher prevalence of vestibular dysfunction was found in patients with abnormal internal auditory canal. Gender, age, duration of implantation, age of implantation, re-implantation, type of prosthesis and intra-operative CSF gusher had no significant effects on vestibular function.

Conclusion: Vestibular disturbance is more identified in patients with inner ear anomalies. BOT-2 and posturography are simple, fast and efficient test to screen patients with vestibular dysfunction especially those with inner ear anomalies. Early identification and rehabilitation and appropriate intervention can minimize the risk of injury in these patients.

Assessement of the vibration-induced nystagmus test (Dumas' test) in deaf children: preliminary results

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Objectives: Vibration of the mastoid can induce a nystagmus termed skull vibration induced nystagmus (SVIN). This recent first-line indicator of asymmetrical vestibular function, quickly reveals a vestibular asymmetry in unilaterally vestibular lesioned patients and is used as a vestibular Weber Test. We aimed to assess the usefulness of the SVIN test (Dumas' test), a fast easy and low cost test, in children with moderate to profound sensorineural hearing loss.

Methods: A prospective monocentric study of children from 7 months to 14 years of age with middle to profound single-sided or bilateral deafness, was conducted from October 2017. The SVIN test was performed on each mastoid and vertex, first and double-blind by a senior and a fellow separately; then, Modified Clinical Test of Sensory Interaction in Balance (CTSIB-M), rotary chair, video Head Impulse Test (VHIT), cervical Vestibular Evoked Myogenic Potentials (cVEMP) were proceeded the same day, blinded from the SVIN test result. The parents' written consent was collected.

Results: A total of 13 children, aged 7 month to 14 years were included: 3 had single-sided deafness, 10 bilateral deafness. The main etiologies were genetic (4), CMV (2), pneumococcal meningitis (1), syndromic (1) , malformation (2), unknown (3).

Sensibility was 50%, specificity 100%, kappa coefficient of Cohen was 1. Negative predictive value was 81%, and Positive predictive value 100%. Clinical tolerance was excellent even in young children.

Conclusion: The skull vibration induced nystagmus test is fast and easy procedure to assess as a bedside examination a vestibular asymmetry in child.

Neuropsychological profiles of children with vestibular loss

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Objective: While previous research has shown that children with vestibular loss (VL) experience delayed motor development, it is not yet clear if vestibular loss also leads to delayed cognitive development. The impact of vestibular function on cognition is described in experimental animal and human studies, and adult patient studies with VL. These studies show links between uni and/or bilateral VL, and cognition impairments in working memory mental rotation and visual scanning. However, few studies have been conducted on children with VL. In this study, we will try to determine which cognitive abilities are impacted by VL in order to understand the impact of a vestibular loss on cognition from a developmental perspective.

Methods: A sample of 13 children with VL that consulted our department for vertigo/dizziness/clumsiness disorders (diagnosed with bithermal caloric irrigation, Video Head Impulse Test and Vestibular-Evoked Myogenic Potentials), and a group of 60 average-age matched controls performed neuropsychological assessment consisting of visuospatial working memory, selective visual attention, mental rotation and space orientation tasks.

Results: The results showed significant differences between the two groups for the cognitive measures of visuospatial working memory (both forward and backward span), mental rotation, and additional travelled distance in one

of the space orientation tasks (mazes). However, we found no differences on selective visual attention and the other space orientation task (Rey Complex Figure).

Conclusion: We discuss whether tasks characteristics could explain the child VL cognitive neuropsychological profile. We propose that visuospatial working memory, mental rotation and one of the space orientation tasks involves dynamic cognitive processes requiring high attentional load, causing impaired task performance in VL children. This is in contrast to static cognitive processes in selective visual attention and in the other space orientation task, requiring less attentional load, and no difference in performance relative to control participants.

Videonystagmographic signs of vestibular dysfunction before and after cochlear implantation

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Objective: To use videonystagmography (VNG) to reveal vestibulometric signs of vestibular dysfunction before cochlear implantation (CI) and investigate the possible influence of unilateral CI on vestibular function.

Material: 30 consecutive patients (19 women and 11 men) with bilateral chronic deafness received unilateral CI. All patients were examined preoperatively and postoperatively (in 1 week and 1 month after CI). Patients were aged 18-55 years.

Methods: The nystagmometric signs of possible peripheral / central / mixed vestibular dysfunction were assessed using computerised registration and automatic analysis of spontaneous, optokinetic and caloric nystagmus by means VNG.

Results: Preoperatively, 8/30 patients with bilateral chronic deafness suffered from bilateral chronic vestibulopathy with complaints of unsteadiness / oscillopsia / vertigo. The salient videonystagmographic signs were spontaneous nystagmus, abnormalities of optokinetic and caloric nystagmus, in particular their nontrivial asymmetry.

The videonystagmographic symptoms of peripheral vestibular dysfunction were revealed in 1 week after CI in 4/30 patients. The number with postoperative vestibular unsteadiness decreased to 2/30 at 1 month after CI. 2/30 patients experienced vestibular complaints with spontaneous nystagmus after the implant activation during program switch.

10/30 patients underwent medical therapy (glucocorticosteroids, benzodiazepines, non-loop diuretics, betahistines) after CI with positive effect; in so doing, possible unsteadiness in the early postoperative period was diminished and postoperative audiological performance did not deteriorate.

Conclusions: Deaf adult patients (75% of the cases) with central spontaneous nystagmus absence, regularity of symmetric optokinetic nystagmus presence and caloric responsiveness preservation had good prognosis for cochlear implantation in terms of vestibular function.

The presence of spontaneous nystagmus (33% of patients) was the proof of decompensation stage of vestibular dysfunction both before and after cochlear implantation.

Videonystagmographic evidence of vestibular dysfunction was rarely elicited after cochlear implantation: 13% of patients in the early postoperative period, 6% in the later postoperative period, and 6% during implant fitting.

FS 55: Complication Management in CI

Hypersensitivity reaction to cochlear implant, odd presentation

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Cochlear implantation is a worldwide accepted treatment for severe to profound sensorineural hearing loss. Many causes for device explantation have been reported. we are reporting two cases where devices had to be explanted due to hypersensitivity to the implant in the first case and to the electrode in the second. We discuss the underlying pathophysiology and the importance of high suspension in such cases.

Clinical management of long-term complications after pediatric cochlear implantation

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Objective: To summarize and analyze long-term postoperative complications in pediatric patients with cochlear implants, and to investigate the cause, clinical management and prognosis of the complications.

Methods: 259 children with complete follow-up data who received cochlear implants by the authors between March 2002 and November 2016 at Peking University Third Hospital were retrospectively reviewed.

Results: Among all the cases, long-term complications (occurred after 3 months following cochlear implant surgery) developed in 6 cases (2.3%). The complications occurred between 4 months and 5 years after cochlear implantation. 3 patients (1.2%) who suffered from otitis media complicated with peri-implant infection were all cured with antibiotics and symptomatic treatment. 2 patients (0.8%) who experienced device failure underwent device explantation and re-implantation. Flap infection and necrosis developed in 1 case (0.4%). Repeated attempts of

debridement and flap rotation and plasty could not control the infection. Finally the patient was cured after removing the device and implanting a new one on the other side. All 6 cases of long-term complications had satisfactory outcome after treatment.

Conclusions: Long-term complications following cochlear implantation in children are worth paying attention to even though the patients recover well after surgery. Timely discover and treatment can save and avoid further harmful consequence.

Skin flap complications in cochlear implant surgeryv

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Introduction: Skin flap problems are the most critical complications in cochlear implant (CI) surgery. According to this, the shape of the incision was changing from a large one to a minimal post-auricular incision. Lack of blood supply, infections and general problems could determine the integrity of the skin flap.

Aim: Determine the number, causes and resolution of these complications.

Results: A retrospective study about 329 cochlear implants surgeries was presented. The CI were during the last 10 (from 2008 to 2017), where a previous large incision was changed for a minimal retroauricular one. The rate of this major complication reached 1.8%, six patients suffered from partial necrosis of the flap between the first month up to 6 months after surgery.

In all the cases a new surgery was necessary to avoid the extrusion. A double flap was proposed to cover the partial extrusion with different designs (double racket, z-shape plasty and rotated flaps). 5 patients required a new surgery to remove the prosthesis, because the new flap failure. The bacterial infection in soft tissue leads usually this process, but the causes were in 2 cases the migration of the prosthesis, silicon allergy (unknown at the moment of the first surgery), anorexia (failures in the healing process) and the lack of postoperative controls with the presence of two major seromas leading to device migration.

Conclusion: According to our experience in the last 10 years, using double flap technique and minimal incision our rate of complications is decreasing in relation with the increment of number of surgeries.

Minor complication of cochlear implantation

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Objective: To evaluate the structure of minor complications after cochlear implantation.

Patients and methods: During the period 2014-2017 in 847 patients were conducted 967 CI. Implants of 4 world manufacturers were used. CI performed via classical approach. In the postoperative period, follow-up visits were every 3 months. The observation period was 2 years. Various variations of minor complications and the timing of their manifestation after CI were note.

Results: Minor complications in the form of a hematoma of the temporal area were note in 15 patients (12 children and 3 adult). In 2 children the hematoma of the temporal region developed as a delayed complication at 7 and 20 months after CI due to trauma in this area. In this case, the hematoma is eliminated by administration antibiotic therapy and topical application of troxevasin for 2 weeks. Vertigo after CI was noted in 8 adult patients immediately after CI. Vertigo was stop by administration of a 5-day course of hormone therapy. In the future, attacks of dizziness did not recur. One child immediately after implant connection, as an early complication, had a single seizure attack. Neurology examination and electrophysiological tests did not reveal the cause of the attack. An appropriate course of symptomatic therapy was prescribe. In the future, the seizure did not happen again. Acute otitis media is diagnosed in 2 children 6 and 8 months after CI, as a delayed complication. This complication was eliminate by appropriate conservative treatment.

Conclusion: The number of minor complications after CI is very low and does not always depend on the experience of the surgical team. In most cases, timely correction of minor complications of CI is the prevention of major complications

Reliability of cochlear implants: reporting in compliance with international standards by cochlear implant manufacturers

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The long-term reliability of cochlear implants is an important issue for patients and cochlear implant professionals, with the CSR (Cumulative Survival Rate) of different cochlear implant models considered by patients, clinicians and surgeons when choosing one cochlear implant manufacturer over another. Accurate and consistent reporting of

device reliability is also a crucial component in creating the Standard of Care for cochlear implantation. The implementation of the international consensus for classifying and quantifying reliability data has improved the compliance of reliability reporting, however comparing the CSR of different implant models or manufacturers can still be challenging and reliant on the reporting approach of individual manufacturers. The aim of this paper is to review reliability reporting requirements for cochlear implants, compare the methods used by manufacturers in their current reporting of device reliability per the existing international consensus, discuss the recently introduced ANSI/AAMI CI86:2017 standard (Cochlear implant systems: Requirements for safety, functional verification, labelling and reliability reporting) and assess the implications for patients and professionals.

Pain in cochlear implant – An under-reported long-term complication

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Objective: To describe the characteristics, management and outcome of pain over the CI receiver/stimulator (R/S) presenting months to years after implantation, with an update on previous reports.

Materials and methods: A follow-up on previously reported and new cases of unexplainable pain over the R/S, presenting through the years 2009-2017, with a follow-up of at least 6 months. The therapy regimen, outcomes and effect on hearing performance were reviewed.

Results: Thirty-six patients complained of 39 ears with pain over their R/S presenting months to years after their implantation, being 3% of 1225 primary implantations performed at the Sheba Medical Center as of 2017. The pain was unrelated to implant use, and without any local findings, apart from sensitivity in specific points around the R/S.

While 28 ears responded, at least temporarily, to conservative therapy, 11 ears required explantation and either primary or delayed revision surgery. At explantation no signs of infection, foreign body reaction or obvious device damage were found. Following re-implantation, the pain resolved in 8 ears. Only one explanted implant was found faulty in the analysis performed by the manufacturers.

The hearing performance at last follow-up did not significantly change compared to the performance at last evaluation before the presentation of pain. All-in-all, in 31 ears (80%) the pain has resolved, and the patients use their implant/s.

Conclusion: Delayed pain over the R/S, unrelated to use, is a serious consequence of cochlear implantation, and in some cases, those necessitating re-implantation or becoming non-users, should be considered a major complication.

Cochlear implant site infection and extrusion. How I manage it?

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Cochlear implant site infection and/or skin extrusion remain challenging issues in cochlear implant field. Staged procedures with implant removal is the standard treatment in most of cochlear implant centers. However, in many areas, this may be very difficult due to budget restrain. In this paper, I'm going to present our personal experiences in managing those cases without removal of the implant. We had total of 6 cases of either postoperative infection with skin breakdown or skin breakdown over the implant with infection. We could treat 5 cases without removal of the implant. The key steps are covering the implant with skin flap together with use of local antibiotic powders over the implant (in the 5 cases we used vancomycin powder). The failure case in which we had to remove the implant had vancomycin hypersensitivity. We believe that there is a chance with this technique to treat implant site infection and biofilm formation without removal of the implant with high success rate.

Reducing cochlear implant complications with the cochlear implant care protocol: A 5-year prospective audit

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Introduction: A retrospective audit determined that recorded rates of complications exceeded those reported in the literature. Through consultation with the department of Infectious Diseases, a Cochlear Implant Care Protocol was formulated, standardising care pre-, intra- and post-operatively, including guidelines for managing complications. The aim of this study was to determine the effect of this protocol.

Methods: After introduction of the Cochlear Implant Care Protocol in the first year, a prospective study was conducted. Data on all cochlear implants performed through our regional cochlear implant service was collected from 2013 to 2017 inclusive. Complications were defined as major or minor and prospectively audited for each consecutive year.

Results: Reductions were achieved in a minor complication rate of 53% in 2013 to 5.4% in 2017. The major complication rate was reduced from 10.6% in 2013 to 2.7% over the same time period.

Conclusions: The Cochlear Implant Care Protocol is described and its evidence base. The introduction of the

Cochlear Implant Protocol, based on multidisciplinary input, has successively improved outcomes in cochlear implantation by reducing complications.

FS 56: Topics in implantable bone conduction devices

Peri-abutment soft tissue outcomes following single-stage bone anchored hearing device implantation with tissue preservation at a tertiary referral centre

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Objectives: To investigate skin-related postoperative complications following a tissue preservation technique in percutaneous hydroxyapatite-coated concave bone anchored hearing aid (BAHA) implantation.

Methods: A retrospective review of adult patients who underwent single-stage osseointegrated hearing aids insertion between July 2013 and November 2017 was performed. One surgeon performed all procedures using a soft-tissue preservation technique described in Wilkie et al 2014. Patients were reviewed at 1 week, 4 weeks, 3 months, 6 months and annually post operatively and soft tissue reactions were graded by Holger's classification.

Results: 102 patients were included with a slight female preponderance (female:male 56:46). At 1 week post-implantation, 94 patients (92.2%) had a Holger 0. At 4 weeks, 15 patients (14.7%) scored ≤2 and 5 patients(4.9%) ≥3. At 3 months, 11 patients (10.7%) scored ≤2 and 3 patients (2.9%) ≥3. At 6 months, 11 patients (10.7%) scored ≤2 and 2 patients (1.9%) ≥3. 3 patients required removal of the BAHA abutment due to persistent soft tissue reaction on average 15.6 months post-implantation. 2 patients had the BAHA reimplanted due to traumatic dislodgement. The average follow-up period for our cohort was 8.5 months (SD 8.3 months).

Conclusion: In our experience the tissue preservation technique is the procedure of choice for bone anchored implant surgery. The preservation technique minimises patient morbidity, is possible with local anaesthesia and bear excellent soft tissue outcomes.

References:

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Intraoperative data overlay for navigated Bonebridge implantation

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Objectives: Bonebridge® implantation is usually a simple and safe procedure. In cases of malformation, prior surgery or a small petrous bone in can be tricky. Therefore, multiple software applications exist for preoperative planning. Translation of the virtual planning to the patient´s anatomy is difficult intraoperatively. The aim of this study was to translate the ideal preplanned position of the implant to the OR for a computer-guided surgery.

Methods: A Zeiss® Pintero microscope was connected to a Fiagon® navigation system to achieve intraocular visualization. Radiologic images and the boundaries of the segmented Bonebridge® model were overlayed in the microscopic view intraoperatively after the preoperative planning was transferred to the navigation system. The diagnostic CT scan was used for patient to image registration. The dynamic reference frame of the navigation system was screw mounted in the skull. The registration was done by a combination of pair-point and surface matching.

Results & Conclusions: The preoperative planned position of the implant was spatialised to the patient´s anatomy with high accuracy. Thus, the accurate realization of the preoperative planning minimized e.g. the needed compression of dura and /or sigmoid sinus intraoperatively.

Assessment of the effectiveness of Bonebridge implantation in children

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Objectives: In some cases of children with conductive or mixed hearing loss application of conventional hearing aids may be impossible or limited. In these case the most often recommended solution is the use of bone conduction devices. Selection of a specific solution is dependent on the degree of hearing loss, age and anatomical conditions. One of the solutions available for children older than 5 years is the Bonebridge implant. The aim of this study was the analysis of the effectiveness of application of this device in the population of Polish children.

Material and Methods: The study materials comprises a group of 11 children ages between 10 and 17 years (mean=14.3, SD=2.69), with uni- or bilateral, conductive or mixed hearing loss, implanted in one ear with the Bonebridge system in the Institute of Physiology and Pathology of Hearing in Kajetany near Warsaw in the years 2013-2016. Assessment of the effectiveness of this treatment was conducted using free field audiometry, word

audiometry in free field and APHAB questionnaire applied before and after implantation.

Results and Conclusions: The analysis of the results of free field tests shows statistically significant improvement of hearing sensitivity and speech discrimination rate. The results of the questionnaire assessment confirm the benefits observed in the auditory functioning of children in different acoustic conditions after a Bonebridge implantation. In a one-year follow-up period the Bonebridge system has been demonstrated to be a safe and effective tool for compensating for the conductive or mixed hearing impairment in children. If the anatomical conditions are adequate, the Bonebridge implant can be a safe alternative for other popular systems based on the bone conduction of sounds.

Vibrant Soundbridge in congenital external and middle ear deformation in patient with Goltz – Gorlin syndrome

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Objectives: The indications for Vibrant Soundbridge include sensorineural hearing loss with normal ossicles, mixed hearing loss in cases after radical modified operations with a presence of remnants of the ossicles, also in cases of chronic adhesive otitis media or even severe otosclerosis. Recently the middle ear implants have become the alternative in the treatment of hearing impairment in congenital deformations of external and middle ears in children. The objective of the study was to show the surgical technique used for VSB implantation in the patient with Goltz – Gorlin syndrome and analyze results obtained after surgical treatment.

Material and method: The child with Goltz – Gorlin syndrome was qualified to the VSB implantation. The patient presented with bilateral atresia of the external auditory canal and congenital deformation of the middle ears. Surgical technique included posterior atticotomy and facial nerve recess. We used the method of fixation of the FMT on the remnants of the ossicles without removing any of them.

Results and conclusions: The benefits of Vibrant Soundbridge use are significant. We did not observe any surgical complications. Short and long-term hearing results in this case of congenital deformation of the external and middle ears are very encouraging.

Transcutaneous bone conduction stimulation: a comparison of passive and active systems

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Objectives: Percutaneous, direct drive bone conduction implants (BCIs) remain the most common of BCIs. However, due to issues such poor osseointegration, skin reactions and aesthetics the uptake of transcutaneous BCI's has increased. Two transcutaneous BCI systems are implanted in Australia: the Bonebridge (Medel) and the Baha Attract (Cochlear Ltd). This retrospective study compares speech, quality of life, and discusses post-surgical complications experienced with both devices.

Method: Outcome data for 54 adult BCI recipients (23 Bonebridge, 31 Baha Attract) were analysed. Speech perception was assessed in quiet (CNC words) and Quality of life by the Abbreviated Profile of Hearing Aid Benefit (APHAB). Post-surgical complications were categorised ranging from no issues to significant medical complications.

Results: There was a significant improvement ($p<0.001$) in all APHAB scores except Aversion. Post-operatively APHAB (Total, Ease of Communication and Background Noise) scores were significantly better ($p<0.05$) for those with a Bonebridge than with a Baha Attract. Speech testing in quiet indicated an improvement in speech scores post-operatively for the Bonebridge recipients. There was no significant change in speech perception scores for Baha Attract recipients. In addition, substantially less post-surgical complications were noted with Bonebridge recipients than with Baha Attract recipients.

Conclusion: The Bonebridge offers better outcomes when compared to the Attract especially in aspects of communication. This is likely due to improved transmission of high frequency with the active BCI. Severe complications were not noted with the Bonebridge recipients, likely due to the reduced weight of the external processor. Careful consideration should be taken when counselling clients regarding selection of either the passive or active transcutaneous devices to ensure optimum outcomes, whilst taking into account medical limitations associated with each implant.

Comparative study in patients users of bilateral osseointegrated BAHA with BP100 processor and BAHA 5

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Introduction: The discussion about bilateral use of BAHA continue and benefits are widely debated. Due to this is a bone transmission system, the outcomes that can be obtained by a patient by using a BAHA system is the same that can receive by a bilateral fitting. A previous study developed at Clinica Rivas with adult patients users of bilateral BAHA showed greater benefit by using bilateral BAHA, mainly in the discrimination skills in background noise compared with the performance of the same group of patients by using unilateral BAHA. The new technology available (BAHA 5), can provide a greater benefit than the anterior technology (BP100) to users of bilateral BAHA.

Objective: To compare audiological and auditory performance outcomes between BAHA BP100 and BAHA 5 in users with conductive and mixed hearing loss that have been fitted bilaterally.

Method: Intra subject repeated measurements study. Each subject is his/her own control.

Outcomes measurements: Audiometry, speech discrimination in quiet environment, discrimination in adaptive noise (HINT phrases) without BAHA processors, with processor in the right side, in the left side and simultaneous use of two processors.

Surveys to measure quality of life (Glasgow Benefit Inventory –GBI), satisfaction with the device (Hearing Device Satisfaction Scale –HDSS), handicap self perception (Speech, Spatial and Qualities –SSQ) and subjective perception of sound quality –HISQUI.

Results: With 4 to 10 years of experience in using BAHA system, this study shows the auditory performance, satisfaction and quality of life of bilateral users of BP100 and BAHA 5, both have experienced benefits and limitations of technological changes through time, and this provide tools that justifies selection process, fitting and update to BAHA 5 processor.

Conclusion: Patients users of bilateral BAHA with BP100 and update to BAHA 5 obtain benefits in their auditory performance, and quality of life as well.

Congenital unilateral hearing impairment - BCD effect on speech-in-noise and localization

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Objectives: congenital unilateral hearing impairment (UHI) affects auditory performance in complex listening environments. Habilitation of UHI is a controversial aspect of contemporary audiology. Depending on diagnosis and severity of the hearing impairment, conductive UHI may be restored by conventional hearing aid, middle ear surgery with or without Active Middle Ear Implant (AMEI) placement, or bone conduction device (BCD), while Contralateral Routing of Signal hearing aid (CROS), BCD or Cochlear Implant (CI) may have a role for UHI in the range of Single Sided Deafness (SSD). There are issues in these indications, in that in conductive UHI both cochleae may be stimulated, while in SSD the CROS hearing aid and the BCD deliver the stimuli to the contralateral hearing ear, and the only chance to restore a true binaural hearing is a CI. To shed some light on this topic, a population of pediatric UHI patients wearing BCD has been evaluated.

Materials and Methods: prospective series of 37 pediatric patients affected by UHI (22 wearing BCD on softband, 15 implanted with transcutaneous or pecutaneous BCD) from a tertiary referral center. Head shadow effect, interaural attenuation, loudness summation, squelch on azimuth and elevation have been tested with and without BCD. QoL questionnaires and data logging have been taken into account.

Results and Conclusion: despite the different routing of signals of BCD in conductive UHI vs SSD, BCD improves speech-in-noise and some localization abilities in both cases ($p<0.001$), with no significant differences in outcomes ($p>0.05$). BCD is effective in restoring speech-in-noise and some localization abilities when hearing aids, middle ear surgery with or without AMEI placement or CI are not indicated for UHI. Binaural networks and monoaural processing of bilateral auditory inputs may contribute together to the development of advanced auditory skills.

Surgical and clinical outcomes of a transcutaneous active bone conduction implant in children

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Background: In children, concerns have been raised with percutaneous bone conduction devices in regards to cosmesis, risk of trauma, lifelong maintenance of the abutment, and soft tissue complications. The Bonebridge (BB) is an active transcutaneous bone conduction implant that received pediatric clinical approval from Health Canada in 2015.

Objective: This study describes the surgical and early clinical experiences with the BB in children.

Methods: A retrospective analysis of pediatric patients who received the BB at a tertiary academic center. Patient demographics, surgical indications, operative details, and immediate and longer term complications were documented. Audiometric outcomes recorded included thresholds, speech performance in quiet and noise as well as qualitative measures including the Speech, Spatial and Qualities of Hearing Scale (SSQ) for Parents of Children with Hearing Impairment. Patient comments related to hearing ability and device design were also recorded.

Results: Nineteen patients (4-14 years) with mixed or conductive hearing loss (11, including three with atresia), and SSD (8). Follow up was 6 months to 2 years. Seventeen patients had a preoperative CT scan. All had the device placed in the sinodural angle, and none required placement of a lift. No intraoperative or immediate perioperative complications were encountered. Two patients had erythema of the skin at the magnet site that resolved with a rest from device use. Speech perception and aided thresholds significantly improved postoperatively, showing statistical significance at all tested frequencies. Air conduction and bone conduction thresholds showed no significant changes. Patients reported significant subjective improvement as well as device acceptance.

Conclusion: Our findings indicate that the BB is safe in children and provides significant objective and subjective improvements in audiological outcomes. The device is associated with a high acceptance rate by patients.

Poster Sessions

Poster Session 5

Auditory and visual motion adaptation in congenitally deaf cochlear implant users: Evidence for typical crossmodal aftereffects

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The motion aftereffect refers to the observation that a prolonged exposure to a stimulus moving in a certain direction leads to an illusory percept of a stationary stimulus moving in the opposite direction. In healthy individuals auditory motion aftereffects have been repeatedly found after adaptation to both auditory motion (i.e., intensity changes) and visual motion (i.e., size changes), whereas visual motion aftereffects have been documented primarily after adaptation to visual motion. In individuals born with bilateral dense cataracts the influence of auditory motion adaptation on visual motion perception was shown to be higher after cataract surgery, suggesting persisting crossmodal changes affecting visual perception. In the present study, the influence of both visual and auditory motion adaptation on auditory and visual motion perception was investigated in eight experienced cochlear implant users with congenital and prolonged deafness (CD CI users) and 21 typically hearing controls to test whether visual adaptation elicits a stronger auditory motion aftereffect after a transient phase of congenital deafness. While the two groups were indistinguishable in both crossmodal motion aftereffects, the unimodal visual - that is, the visually induced visual - motion aftereffect was increased in the CD CI users as compared to the controls. These data suggest that the typically weak crossmodal link between the auditory and visual motion system was not permanently strengthened as a consequence of the transient phase of congenital deafness and typical visual-auditory aftereffects recovered.

Effectiveness of umbilical cord derived mesenchymal stem cell transplatation in cochlear implantation

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Introduction : Umbilical cord blood (UCB) & Wharton's jelly (WJ) in umbilical cord have mesenchymal stem cells that can differentiate into various tissue cells. This study was performed to confirm the effect of transplantation of human umbilical cord derived mesenchymal stem cells on functional & morphological regeneration spiral ganglion deaf animal model.

Methods: UCB & WJ were collected from pregnant women after obtaining consent, and mesenchymal stem cells were extracted. We transplanted UCB-MSC & WJ-MSC through the brachial vein of the deafened guinea pigs. Hearing test with auditory brainstem response (ABR) conducted at 1, 3, and 5 weeks, and the results were compared with cochlear pathological features.

Results: In deaf animal model, increased ABR threshold & decreased spiral ganglion neuronal cells were noted. After transplantation of UCB-MSC & WJ-MSC, a significant improvement in hearing threshold compared to control group. Examination of the cochlear morphological features demonstrated that the transplanted group showed a significantly increase in spiral ganglion neuron in deaf animal model.

Conclusion: Intravenous transplantation of Uumbilical cord derived MSCs can regenerate spiral ganglion neurons and restore hearing in deaf animal model. Therefore autologous umbilical cord derived MSC transplantation may improve functional result of CI.

Spectral complexity reduction of music signals for cochlear implant users - A validation with an interactive user interface

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Technical restrictions of cochlear implants like the limited number of electrodes and the spread of excitation lead to a considerable loss of information in the spectral, fine-temporal, and dynamic range representation of incoming signals. This makes music difficult to access for the majority of CI users. In earlier works we proposed a preprocessing scheme which uses Principal Component Analysis (PCA) to reduce the spectral complexity of music signals. We assume the leading or melody voice in a music piece to carry the predominant spectral portions that appear in the first principal components. Hence, by retaining only a reduced number of PCA basis vectors we obtain a generally more sparse spectral representation of the signal and a significant attenuation of the accompaniment which is easier to perceive for CI users. The scheme was then evaluated in blind two-alternative forced-choice listening experiments with 14 CI users who were asked to compare unprocessed recordings of high quality synthesized chamber music recordings with 2 spectrally simplified versions. These experiments yielded preference scores of up to 73.7%. In a new series of listening tests with 10

CI users and 8 consecutive sessions per subject we validated these results by means of an interactive user interface. The participants compared recordings of particular music pieces with a length of 10 seconds repeated in loop and were asked to choose their preferred version out of ten different complexity settings for each piece among which they could switch in real time using a jog dial. The previous results were clearly confirmed as the versions with low numbers of retained components were still significantly preferred. We also analyzed our data with respect to possible training effects. However, up to now such an effect neither towards higher nor towards lower spectral preferred complexity levels could be observed.

Middle and inner ear functional state before after cochlear implantation

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Purpose of the study: To evaluate middle and inner ear functional state in patients after cochlear implantation.

Materials and Methods: The study includes 49 patients after monolateral cochlear implantation with transmembrane electrode insertion technique. Audiological and vestibular tests performed preoperatively, at the first, seventh, and 30th days after CI.

Results. All patients before surgery had type "A" tympanogram. The greatest difference registered in static compliance, gradient, and middle ear pressure. All patients had type "B" at the first and seventh day after CI, while on the 30th day type "A" tympanogram was registered. The study showed a statistically significant deviations of gradient (0.48 (0.31-0.58) and middle ear pressure (-24.0) after CI comparing to gradient (0.57 (0.37-0.68) and middle ear pressure value (-26.5) ($p>0.05$) before CI. A significant change in static compliance (0.23 (0.13-0.46), before and after surgery (0.42 (0.3-0.73); ($p <0.01$) was obtained.

The results of posturography tests statistically different in patients before and after CI. The value of "eyes open" test was 35.5 (19.5-69.9), "eyes closed" test - 14.8 (5.9 -42.7) before surgery, while the value of these tests one week after CI was 34.6 (16.1-53.9) and 20.5 (11.1 -38.3) respectively ($p<0.05$). No difference has been obtained in these parameters in patients before and in one month after CI.

Conclusion. Both the audiology and vestibular tests showed statistically different parameters according to the period of investigation in patients before and after cochlear implantation. Vestibular system disorders observed during one week after CI in 16 patients (84.2%). A significant objective improvement in postural stability after CI registered in 11 patients (59.9%).

Comparison of acoustical and electrical perception of musical consonance in single-sided CI users

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Consonance of chords and their succession carry relevant musical information. Previous work showed deficits in the judgment on consonance in adult, postlingually deafened as well as juvenile, prelingually deafened CI listeners. The present study compares the electrical and the acoustical perception of chords and cadences in listeners with single-sided implantation.

Method: Listeners used a unilateral CI with near-to-normal hearing in the contralateral side. In experiment 1, major, minor, augmented, and diminished chords were presented pairwise. The task was to decide if the items were different. In experiment 2 standard authentic cadences ending on the major chord were interspersed with versions ending on an augmented chord or a diminished chord with the same root. Here the task was to decide if the sequence ended conclusive or asked for continuation. Both tasks were presented first to the normal-hearing side via headphones, and to the CI audio input afterwards. Discrimination was assessed with the sensitivity index.

Results: For most participants, a strong difference of the two hearing channels was found: Subjects could discriminate chords when presented acoustically but they were hardly able to do so when listening through the CI. A similar difference was found for the judgment on cadences.

Conclusion: The findings on cadences are consistent with those of postlingual and prelingual CI users: Whereas normal listeners have little difficulties to differentiate authentic and altered cadences, this is hardly possible through the CI. The discrimination of single chords is also much less solid through the CI than with acoustic listening. owever, in previous experiments, CI listeners judged the consonance of single chords similarly to normal-hearing pairs to some degree. This is in contrast to the findings of our previous studies, where CI listeners judged the consonance of single chords similarly to normal-hearing pairs, at least to certain degree.

Spatial advantage in bilateral cochlear implant recipients using a spatially-symmetric speech-on-speech masker paradigm

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Having access to the signals at the two ears is important for understanding speech in noisy conditions. One of the

contributing mechanisms is better-ear glimpsing (BEG), which takes advantage of the fluctuating signal-to-noise ratios (SNRs) across ears. Even though the spatial benefit provided by bilateral (over unilateral) implantation has been studied widely, the benefit provided by BEG is still poorly understood. Therefore, speech comprehension performance was measured in ten bilateral CI users in a spatially-symmetric masker paradigm. Helen-like questions recorded with a female native English speaker were presented from a loudspeaker in front of the subject (0o) while two female speech distractors were presented either from loudspeakers at ±90o or co-located with the target questions. The subjects' task was to answer the questions. The combined distractor level was kept constant at 60 dB-SPL and the level of the target questions was varied adaptively to obtain speech comprehension thresholds (SCTs), i.e., the SNR at which 50% of the questions were answered correctly. SCTs were measured unilaterally and bilaterally. The spatial benefit was calculated as the difference in SCTs between the spatially-separated and co-located condition for bilateral stimulation. The average benefit was 2 dB with individual results varying from -2 to 7 dB. The bilateral benefit was calculated as the difference in SCTs between bilateral and unilateral stimulation in the spatially-separated condition. The average bilateral benefit was 1.4 dB when compared to the better ear and 5.9 dB when compared to the worse ear. Individual results varied from -2.5 to 5 dB and 1.9 to 12.7 dB, respectively. Hence, bilateral CI users can benefit significantly from a second device in spatially-symmetric, fluctuating noise where neither of the ears receives a constant favorable SNR. Future research should further investigate the large inter-subject variability and further improve the observed benefits.

Application of the Bonebridge implant with simultaneous reconstruction of the posterior wall of the external auditory canal with autogenous material

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Objectives: Considering the size of the electromagnetic bone conduction floating mass transducer of Bonebridge implant, its implantation requires adequate anatomical conditions. In case of patients after radical ear surgeries placement of internal part in the typical position, which is in the sinodural angle, may be difficult due to bone defects. The aim of this paper is presentation of a novel technique of Bonebridge implantation with one-time reconstruction of the posterior wall of the external auditory canal (EAC) with autogenous material in a patient after a radical surgery. We present a case of a patient with bilateral mixed hearing loss of moderate degree who, based on the results of laryngological and audiological evaluation, underwent surgery for a Bonebridge implantation. In view of the post-radical ear surgery status of the ear selected for implantation it has been decided to perform at the same time reconstruction of the posterior EAC wall with autogenous bone dust.

Material and Methods: In this paper we present the surgical procedure of one-time implantation and reconstruction of the EAC wall as well as the assessment of the effects of the device application. At 12 months after surgery we have noted preserved and correct healing of the posterior EAC wall and hearing benefits involving improved hearing sensitivity and speech discrimination.

Results and Conclusions: In the presented case the surgical technique combining simultaneous reconstruction of the posterior EAC and implantation of a bone conduction device has enabled reducing the size of the postoperative cavity, thus facilitating its future debridement and, by covering the floating mass transducer has separated it from the external environment allowing its proper placement. Stable auditory results and local conditions after the posterior EAC wall reconstruction in our case suggest that this method may be an alternative for other bone conduction devices in patients with extensive bony defects.

A surgical technique using landmarks of the temporal bone for Bonebridge implantation

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Objectives: Bonebridge implantation is usually performed on a planned site of temporal bone with guidance of preoperative CT scan. However, planning of the exact site for BMT is difficult due to variations of anatomical structures. We present an implantation technique using common surgical landmarks of mastoid bones such as the tegmen mastoideum and the sigmoid sinus.

Methods: A small hole in the mastoid bone was made first in keeping with the planned position for the BMT using preoperative CT scan, then the tegmen mastoideum and the sigmoid sinus through the hole were identified. After two structure were identified and then the cortical bones over the structures were removed. If the tegmen mastoideum and the sigmoid sinus displaced inferior and anterior. The bone bed was widen inferior to the tegmen mastoideum and anterior to the sigmoid sinus.

Results: This technique allows exact positioning of the BMT by identifying the surgical landmarks first and minimizes the risk of complication.

Conclusions: A surgical technique using landmarks such as the tegmen mastoideum and the sigmoid sinus for Bonebridge implantation is useful and safe.

Feasibility of transmastoid implantation of the Bonebridge® according to different underlying pathologies in the adult temporal bone

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The most common indication for bone conduction devices (BCD) is conductive (CHL) or mixed hearing loss (MHL), or less frequently, single-sided deafness (SSD). Although chronic inflammatory diseases of the temporal bone with or without cholesteatoma are the underlying causes in the majority of CHL/MHL patients implanted with a Bonebridge device, a neuro-otologic disorder can be found in most SSD cases. This study aimed to evaluate the feasibility of transmastoid implantation with or without the addition of implant lifts in different pathologies, using a radiological simulation program. 240 temporal bones of 60 adult subjects with neuro-otologic diseases (NOD) and 60 subjects with chronic inflammatory diseases (CID) were enrolled. Complete implantation was possible in almost all cases with NOD as well as chronic otitis media without cholesteatoma (COM), requiring an implant lift in 50% of COM and 20% of NOD (p=0.025) cases. In contrast, in subjects with cholesteatoma, implantation required an additional tool in 95.5% of cases, leading to 59 % implantability rate in these temporal bones. Conclusion: Implant lifts increase the transmastoid implantability of the Bonebridge significantly in subjects with CID of the temporal bone. A preoperative radiological simulation to determine the ideal placement of the BC-FMT with regard to the position to the sigmoid sinus and the dura of the middle fossa is advisable in these cases.

A 29-year-old female with Neurofibromatosis type II who underwent auditory brainstem implantation

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Objectives: Auditory brainstem implants (ABI) are designed to be applied in patients with lesions occurring between the cochlear and cochlear nuclei. As ABI were not widely performed in Korea so far, here we report a case of ABI.

Material and Method: 29-year-old woman, diagnosed of neurofibromatosis type II(NF2), who previously took right acoustic schwannoma removal via retrosigmoid approach and thoracic spinal Schwannoma removal , had severe bilateral hearing loss. Right side was deaf and left side pure tone average was 75dB. On auditory brainstem response test, both sides showed no response.

Brain magnetic resonance imaging revealed 3cm , 3.5cm sized extra axial masses at bilateral cerebellopontine angle (Right, left consecutively). By tranlabyrinthine approach we co-operated with Neurosurgery department and removed the tumor on the left side and placed the electrode array near the lateral recess of 4th ventricle.

Results and conclusion : After the surgery, we are closely observing the patient with continuous mapping of the ABI.

Clinical experiences and outcomes in children with the Med-El Bonebridge

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Background and Objectives : Bone conduction devices have been used in the management of children with chronic and permanent conductive hearing losses and single sided deafness. Although these devices provided consistent and significant benefit, soft tissue complications as well as cosmetic considerations have inspired research for transcutaneous options. The BONEBRIDGE (BB)is an active transcutaneous bone conduction implant that received clinical approval from Health Canada for adults in 2013 and for children in 2015. The Saskatchewan Cochlear Implant Program began implantation in children soon after clinical approval. Limited clinical experience with the device exists in North America and this poster will describe two and a half years of clinical experience with children with the device.

Method: A retrospective analysis of surgical, audiological and clinical outcomes and experiences of 18 children who received the BB at a tertiary academic centre was conducted. Children ranged in age from 5 to 17 years; 13 children had conductive or mixed losses and 5 had SSD. Clinical variables included patient demographics, short and long term surgical complications, audiometric outcomes including aided and unaided thresholds, speech perception in quiet and noise and qualitative measures in the form of questionnaires were utilized. Patient and parental comments related to hearing ability and device design were also recorded.

Results and Conclusions: Four patients had erythema at the magnet site and this resolved with downgrading magnet strength. Audiometric outcomes showed improvement in all but one patient. The device was tolerated much better than Softbands. Our findings suggest that the BB is a viable option with a low surgical complication rate and that it provides significant auditory benefit in everyday situations.

Application of Bonebridge bone conduction implant in difficult anatomical conditions

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The Bonebridge bone conduction implant is used to compensate conductive and mixed hearing loss. It in dedicated for cases of chronic ear infections, conditions after repeated ear surgery with the removal of inflammatory lesions and congenital ear and / or external ear malformations. Changed anatomical conditions within the temporal bone affect the possibilities of implantation and positioning of the Bonebridge implant.

Objectives: Aim of this work is to present the technique of surgical implantation of Bonebridge bone conduction in cases of different anomalies within the mastoid.

Material and methods: Case reports contain implantation of the Bonebridge implant with the reconstruction of the posterior wall of the external auditory canal, implantation in the patient with anterior course of sigmoid sinus and positioning of the device in the congenital craniofacial malformation.

Results: The size of the post-operative cavity, its healing, hypoplasia of the mastoid process, the changed course of the sigmoid sinus are the most important factors affecting the positioning of the Bonebridge implant FMT(Floating mass transducer)

Conclusions: The use of a modified Bonebridge implant procedure, with one- or two-staged reconstruction of the posterior wall of the auditory canal, the use of lifts or ionomer glass allow for implantation of this device in the most difficult cases of extensive bone defects, significant hypoplasia of the mastoid or anterior course of sigmoid sinus, resulting in a full auditory effect.

Rehabilitation of telephone communication in cochlear-implanted adults

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Objectives: Using telephone is one of the most important expectations of the candidates for cochlear implantation, and is linked with the Quality of Life (QoL) after implantation. The objective of this work was to evaluate the benefit of a progressive and intensive auditory training comprising 18 sessions, conducted directly on the telephone, with cochlear-implanted adults.

Material and Methods: Nine cochlear-implanted adults underwent remote training that focused on the use of the telephone with a "Speech and Language Pathologist", and were evaluated before and after this auditory rehabilitation. The evaluation of the auditory perception involved monosyllabic words (Lafon) and sentences (MBAA) in several conditions: quiet at direct and recorded voice, over the phone, and for the sentences only, in noisy environment with a SNR5 cocktail-party noise. Patients also underwent a "note taking" task of a telephone message. The daily use of the telephone was evaluated by "ad hoc" surveys and statement of the number of calls made last week. The QoL and the quality of sound perception was measured by the Ersa and Aphab questionnaires.

Results: Before rehabilitation, repetition of monosyllabic words was significantly worse by telephone than at direct voice (26% ± 5.3 vs. 64% ± 5.7, $p < 0.05$). After the 6 weeks of auditory training by phone, the patients improved in an important way for the "note taking" task of a telephone message (50 ± 9 vs. 85 ± 3.7 out of 100, $p < 0.001$). Daily use of phone self-evaluated (29 ± 5.4 vs. 57 ± 4.3 out of 100, $p < 0.0001$) and the number of calls made the week before the assessment (0 ± 0 vs. 11 ± 3, $p < 0.0001$) have also increased.

Conclusions: A progressive and intensive rehabilitation program delivery over the telephone improved the use of the telephone in daily life of cochlear-implanted adults.

Are the BKB scores different when tested with male and female voices: results from adult cochlear implant candidates

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NICE defined the UK candidacy in 2009 as bilateral hearing loss at 90 dBHL or worse at 2 and 4 kHz together with a score of less than 50% on the BKB sentence listening task, when delivered in quiet at 70 dB SPL, in the best aided condition. However the NICE guidelines did not stipulate if the BKB task should be delivered with a male talker or a female talker. Clinical observation suggests that the female talker condition is more demanding and scores are often lower.

Objectives: The objectives of this study were (1) to determine the extent of the difference, if any, between the BKB sentence score delivered via male or female talker in quiet, when administered to adults undergoing cochlear implant (CI) assessment (n=78).

Method: Candidates for CI were tested on the BKB sentence task, presented with both a male and a female talker. Any candidate with BKB less than 50% in either condition

proceeded to cochlear implant. Outcomes of CI were followed up, especially in those candidates scoring above 50% on the BKB in the male talker condition, but below 50% in the female talker condition.

Results: For the CI candidates, the mean male talker BKB score was 53.1% while the mean for female talker BKB score was 39.9%. All of those proceeding to CI on the basis of female talker less than 50% on BKB achieved satisfactory outcomes with their CI.

Conclusion: Using the female talker BKB in-quiet condition could lead to a wider range of audiometric profiles being considered for implant. This small sample suggests there is clinical benefit to those candidates with BKB female talker condition scores lower than 50%, even if male talker BKB score is above 50%.

Datalogging and subjective evaluation of listening situations of cochlear implant (CI)-patients

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Introduction: Still few facts are known about the daily listening habits of retired CI-users above 60 years (retirees) compared to employed CI-users (employers) up to 60 years.

Methods: In this study 28 retirees and 29 employers were evaluated about their individual listening situations with a self-developed questionnaire at the earliest six months after initial fitting. Additionally, datalogging -an automatically identification of listening situations recording in the speech processor (CochlearTM, 2014)- was selected and compared with the results of the questionnaire.

Results: With the assistance of datalogging significant differences between employers and retirees were determined only in the length time of the listening situation "noise". In all other listening settings no significant differences were found. Furthermore it could be shown that employers as well as retirees wore their CI on average 13 hours per day. On contrast in their personal subjective rating there were significant differences between employers and retirees in the duration time wearing the CI per day and as well in the length time in the listening situation "speech in noise".

Conclusion: Using datalogging it could be shown that there is a discrepancy between subjective personal judgement and evaluation by datalogging. How far these results should be considered in technical fitting as well as in therapy should be investigated in further studies.

The study was supported by Cochlear GmbH.

Case study: follow-up of a candidate cochlear implant patient with a hearing aid

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Cochlear implant is a electronic device that can help to provide a sense of sound to a person who is profoundly deaf or severely hard-of-hearing. Inner ear malformations constitute about %20 of conjenital sensorineural hearing loss. Cochlear hypoplasia represents a group of cochlear malformations where external dimensions are less than those of a normal cochlea with various internal architecture deformities. In Cochlear Hypoplasia-II, the cochlea has smaller dimensions with defective modiolus and interscalar septa, but with normal external outline; The vestibular aqueduct may be enlarged and the vestibule may be dilated (Sennaroglu,2010).

A woman aged 33 was diagnosed with hearing loss at the age of 5. She has used hearing aid regularly in her right ear since she was 6 years old. She hasn't ever used hearing aid in her left ear. She applied to our clinic for cochlear implant operation.

According to her audiological assessment; right ear hearing thresholds were increasing towards high frequencies,the pure tone average of right ear thresholds was 62 dB HL; left ear hearing thresholds couldn't obtain (total hearing loss). Her free field thresholds average with heariNg aid was 30 dB HL. Also the previous audiological assessment results were similar with our assessment. In the sentence test, the auditory-visual score was %87, and the only auditory score was %56. The findings from MRI and CT screening were bilateral cochlear hypoplasia-II and dilated vestibule.

As a result; It was decided that the patient should be followed up with a hearing aid for a while;because she had benefited from the hearing aid and there was residual hearing in the right ear, especially at low frequencies. In addition; FM system was recommended to this patient to understand speech in noise.

Effect of hearing loss and age: speech in noise and cognitive skills

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Our auditory performance highly affecting our daily communication skills, depends on the integrity of peripheral hearing, auditory processing and cognitive processing systems. It's reported that auditory and cognitive functions are affected by aging and decreasing functional skills, affects communication skills negatively. In this study, it's aimed to evaluate the effects of sensorineural hearing loss and age in speech in noise, cognitive processing skills, and to examine the relationship between speech in noise and cognitive processing.

Individuals with hearing loss and normal hearing are divided into the 18-39 age group and the 40-60 age group, and the study consists of four groups. A total of 40 participants, including 10 participants in each group, were included in the study. To the all participants, Turkish Matrix Test and Consonant Identification test that evaluating speech in noise skills; The Visual Aural Digit Span Test and Auditory Verbal Learning Test that evaluating cognitive skills are applied and compared.

As a result of the study, in speech in noise tests, significant difference was found between the individuals with hearing loss and normal hearing individuals; young individuals with hearing loss and mid-aged individuals with hearing loss; normal hearing young individuals and normal hearing mid-aged individuals ($p<0,05$). While a significant difference was found between normal hearing young and mid-aged individuals in all cognitive tests ($p<0,05$), in some subtests a significant difference wasn't found between other groups. A correlation was found between the speech in noise tests and cognitive processing tests. In the results of this study, it is observed that not only hearing loss but also age significantly affects auditory performance, and so the need for a more holistic approach has been emphasized for finding out the problems and the exact evaluation of listening skills of the individuals with hearing loss and normal hearing individuals.

Limitation of high pitch sound perception in nontumor patients with auditory brainstem implantation

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Background and Objectives: Auditory brainstem implantation (ABI) is another option for hearing rehabilitation in non-neurofibromatosis type 2 patients who cannot undergo cochlear implantation (CI). However, the average performance of ABI is worse than that of CI. We analyzed the psycho-electrical parameters of each electrode and psycho-acoustic response to different frequency sounds in nontumor patients with ABI.

Subjects and Method: Sixteen patients with ABI from July 2008 to May 2013 were included in the study. They were followed up for 4 to 56 months. Among them, 12 were prelingual deaf with a narrow internal auditory canal or cochlear ossification. The remaining four were postlingual deaf adults with severely ossified cochleae. We analyzed the electrical parameters [impedance, threshold level (T level), and dynamic range] of each of the 12 electrodes. We also evaluated the sound field pure-tone threshold, Ling 6 sound detection-identification test (Ling 6 test), and pitch ranking data of these patients.

Results: The impedance, T level, and dynamic range did not significantly differ among electrodes. However, the pure-tone threshold to sound field stimulation was elevated in the high tone area, where more variables were found than in the low frequency area. Patients could not identify /S/ and /Sh/ sounds in the Ling 6 test. The mean T level and the dynamic range of the three highest pitch-perceiving electrodes in each patient was higher and narrower, respectively, than those of the three lowest pitch-perceiving electrodes.

Conclusion: The nontumor patients with ABI have difficulty perceiving high pitch sound. More sophisticated penetrating type electrodes and, if possible, bimodal stimulation with CI, could be considered.

Towards a novel task to assess listening effort: a pilot study in normal hearing

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Cognitive demand and listening effort (LE) are critical concepts in understanding the challenges people face in comprehending speech: listening effort is based on a limited-capacity resource model in which current ongoing cognitive operations engage a given percentage of total cognitive capacity1. The purpose of our project is to use behavioural measures and electroencephalography (EEG) to identify biomarkers of listening effort.

Seven normal hearing controls (6 female; mean age: 30.1 years) completed a modified version of a 1-back task. The stimuli consisted of a sequence of digits (1-9, excluding 7) randomly presented either aurally or visually. Participants were asked to make a button response to target events, i.e. everytime the digit matched the one previously presented, independent of the modality. The task was conducted in two different conditions, without (low LE) and with background noise (high LE).

Preliminary results show greater demands on the working memory system during the high LE condition ($F(1,6) = 51.5$, $p<0.001$). Post-hoc analysis shows longer response times (quiet: 573.45 ms, noise: 773.14 ms) and decreased accuracy (quiet: 87%, noise: 74%) for auditory targets. No such effect was observed for the visual targets. In addition to the behavioural analysis, we will report neurophysiological data and the effect the bimodal stimulus presentation and degraded speech has on typical biomarkers of working memory.

The ultimate goal of this research is to gain further insight into cognitive processing in CI recipients, and to be able to objectively assess listening effort and how different

programming parameters may be optimised to reduce listening effort in CI recipients.

1Sommers, M. S., & Phelps, D. (2016). Listening effort in younger and older adults: A comparison of auditory-only and auditory-visual presentations. Ear and hearing, 37(Suppl 1), 62S.

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The role of preoperative computerized tomography in a safe posterior tympanotomy for cochlear implant surgery

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Aposteriortympanostomy is a technique to proper access round window area to insert cochlear implant electrode into round window (RW) membrane or through cochleostomy.We aimed in this research to classify with evaluation the anatomical relations in between facial nerve (FN)(vertical part), chorda tympani nerve, facial recess (FR)pneumatization inanaxialtemporal bone computerized tomography (CT) to be safe when posterior tympanotomy will be operated. A retrospective analytic study was established of the petrous bone CT scans .51 patients who prepared to cochlear implantation (CI)with classical mastoidectomy with posterior tympanotomy were included in this cohort study.Preoperative diagnostic CT of the petrous bones for all cases from January 2014 to November 2015.Correlations in anatomical variations were classified by several parameters including FN protrusion into the mastoid antrum, FR pneumatization, and the facial canal integrity.Anatomical relationships between the vertical segment and posterior tympanotomy were classified into three types: type 1, the FN has no protrusion with a regular facial canal withpneumatized FR; type 2,theFNis protruded into the mastoid antrum within canal within regular manner and/or poorly pneumatized FR;andtype3,theFNhassclerotic mastoid with noFRpneumatization.These results enable preoperative evaluation of the FN's status and difficulty while performing posterior tympanotomy, providing basic knowledge to prevent injury of the FN while performing a posterior tympanotomy.

Computed tomography and magnetic resonance imaging evaluation in pediatric unilateral sensorineural hearing loss

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Objectives: Children with unilateral sensorineural hearing loss (USNHL) are not actively evaluated by physicians. The diagnostic tool for evaluation of USNHL is also controversial, and no strategy for diagnosing USNHL through imaging studies has been established. We examined the results of temporal bone computed tomography (TBCT) imaging and magnetic resonance imaging (MRI) studies on children with USNHL.

Subjects and Method: Eighty-nine patients with USNHL were reviewed. Of these patients, 21 underwent both TBCT and MRI, 51 underwent temporal MRI only, and 17 underwent TBCT only.

Results: The etiology of USNHL were determined through imaging studies in 20 patients. The most common abnormal finding (65%) was a narrow internal auditory canal identified on TBCT and cochlear nerve aplasia on temporal MRI. Incomplete partition (20%), common cavity (10%), and labyrinthitis ossificans (5%) were also observed in imaging studies. The hearing threshold was lower in USNHL patients with normal findings (76.1±28.7 dB) than in USNHL patients with abnormal findings on TBCT or temporal MRI (100.1±22.3 dB).

Conclusions: Cochlear and cochlear nerve abnormalities can be detected through imaging studies in approximately 25% of patients with USNHL. Therefore, we suggest that children should undergo TBCT when USNHL is confirmed through audiologic evaluation.

Development and validation of the Mandarin matrix sentence test in noise

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Objective: Development of the Mandarin Chinese matrix (CMNmatrix) sentence test for speech intelligibility measurements in noise according to the international standard procedure.

Design: A 50-word base matrix representing the distribution of phonemes and lexical tones of spoken Mandarin was established. The CMNmatrix consists of a corpus of phonologically balanced 50 words, with a construction of 10 names, 10 verbs, 10 numerals, 10 adjectives, and 10 nouns. 100 sentences capturing all the co-articulations of two consecutive words were recorded. Word-specific speech recognition functions, speech reception thresholds (SRT: signal-to-noise ratio, SNR, that provides 50% speech intelligibility), and slopes were obtained from measurements at fixed SNRs. The speech material was homogenized in intelligibility by applying level corrections up to ± 2 dB. Subsequently, the CMNmatrix test was evaluated: The comparability of test lists was measured at two fixed SNRs. To investigate the training effect and establish the reference data, speech recognition was measured adaptively.

Study sample: Overall, 80 normal-hearing native Mandarin-speaking listeners.

Results: Multi-center evaluation measurements confirmed that test lists are equivalent in intelligibility, with a mean SRT of -10.1 ± 0.1 dB SNR and a slope of 13.1 ± 0.9 %/dB. The reference SRT is -9.3 ± 0.8 and -11.2 ± 1.2 dB SNR for the open- and closed-set response format, respectively. Conclusions: The CMNmatrix test is suitable for accurate and internationally comparable speech recognition measurements in noise.

Poster Session 6

Elongated EABR wave latencies observed in patients with auditory neuropathy caused by OTOF mutation

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Objectives: Auditory neuropathy with OTOF mutation, which encodes otoferlin, is caused by a disrupted function of the ribbon synapses accompanying preserved cochlear hair cell activities and normal neural conductions. In this condition, cochlear implants(CI) are considered to be beneficial for patients because the electrode of CI could stimulate auditory nerves directory with bypassing impaired synapses. Indeed, some reports showed a usefulness of CI implantations for OTOF patients. However precise evaluations of post synaptic functions of this disease have not been made. Electrically evoked auditory brainstem responses (EABRs) could be available for evaluating cochlear nerves' neuronal activities.

Material and Method: For clarifying neuronal physiologies, we compared the EABRs responses of patients with CI implantations between those who have OTOF/GJB2/SLC26A4 mutations or CMV infections.

Result and Conclusion: We observed the distinct elongated EABR wave V latencies in patients with OTOF mutations which was not observed in others. (OTOF; 4.97 (n=6), GJB2; 4.24 (n=7), SLC26A4; 3.96 (n=4), CMV; 4.24 (n=4) (mSec)) Our results indicated that cochlear nerve synchronies were reduced in OTOF patient while primarily neuronal conduction would be preserved. It is known that the nerve synchronies are maturing as increasing electrical pre-synaptic stimulations. The disturbed synchronies observed in OTOF patients could to be caused by insufficient pre-synaptic stimulations and delay of pre- and post- synaptic neural network maturations. We unveiled a novel pathophysiology of auditory neuropathies caused by OTOF mutations and our results also showed the usefulness of EABRs for clarifying hereditary hearing loss pathophysiology.

Comparison of the auditory brainstem response *vs* the auditory steady-state response for the evaluation of adult deafness

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Objectives: To compare the auditory brainstem response (ABR) with the auditory steady-state response (ASSR) for the assessment of hearing disability in adults.

Method: One hundred sixty adult patients who underwent ASSR for the disability evaluation of hearing from 2010 to 2016 were enrolled to this study. Correlations between ABR, ASSR and pure tone audiometry (PTA) thresholds were analyzed.

Results: Both ABR and ABBR showed a positive linear correlation with the average hearing threshold of PTA, but the correlation between ASSR and PTA was significantly higher than that between ABR and ABR. The highest correlation between ASSR and PTA was observed at an average of 2 kHz; ABR and PTA at 4 kHz. The lowest correlation between ASSR and PTA was observed at an average of 4 kHz; ABR and PTA at 0.5 kHz.

Conclusion: Compared to ABR, ASSR showed greater correlation with PTA to assess the hearing disability in adults. ASSR can provide additional audiometric information for accurately predicting the hearing level.

Hemispheric asymmetry of auditory cortical activity elicited by temporal changes in adult cochlear implant users

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Objectives: Cochlear implant (CI) use changes the way that sound inputs are processed in the brain, possibly causing brain reorganization. Previous literature shows that children with long periods of unilateral CI showed a greater ipsilateral dominance to the stimulated ear. The current study investigated the hemispheric asymmetry of cortical activity and the relationship to speech perception abilities in adult CI users.

Methods: CAEPs were recorded from 64 scalp electrodes in 10 adult CI users and 10 normal-hearing controls. Speech stimuli were synthesized consonant-vowels from a 6-step voice onset time (VOT) / ba/-/pa/ continuum ranging from 0 to 50 ms VOT in 10-ms steps. During the recording, participants passively watched closed captioned movies. N1 dipole amplitudes, latencies, and locations were analyzed

as a function of VOT and the side of implantation. Various speech perception tasks were conducted both in quiet and noise conditions.

Results: For N1 dipole location, no consistent different location was seen across the VOTs. However, significant location differences between CI and NH groups were seen for 10 ms and 40 ms of VOTs in anterior-posterior direction (y). For hemispheric asymmetry, N1 dipole activities in good CI performers were higher in the auditory cortex contralateral to the stimulated ear, while poor CI performers showed greater ipsilateral activities for all VOT conditions. The lateralization index (LI) indicates that normal contralateral dominance of temporal processing was retained in good CI performers, but not in poor CI performers, although a group difference of the LI was not statistically significant (p=0.085). In addition, a LI at 20ms VOT which showed the greatest ambiguity to differentiate between /ba/ and /pa/ was correlated with consonant perception in noise (r=0.71).

Conclusions: These results suggest that hemispheric asymmetry of N1 dipole activity to VOT stimuli may help to estimate speech outcome of CI recipients.

Low stimulation artifact at eABR recording in cochlear implant users with unusual stimulator positions

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Introduction: In eABR a high stimulus artifact via the cochlear implant is normally every time to expect. Especially when a large pulse width is used you are often confronted with problems reproducing the waveforms. This issue affects wave forms the nearer they appear to the stimulation.

Material and Methods: Due to medical reasons in two patients who received a cochlear implant the subcutaneous neurostimulator wasn't placed in the usually selected area of the cranium. For patient 1 the stimulator had been placed a few centimeters below the standard positioning. The stimulator of patient 2 even has almost been put to the back of the head. For checking if the cochlear implant is working properly also with these unusual ground electrode positions an eABR and also an eALR measurement was performed postoperatively.

Results: In both patients the eABR and also the eALR could be recorded without any problems. In contrast to the eALR, a low stimulation artifact for the eABR was seen in patient 1. In patient 2 the artifact for the eABR was even lower. As the 2nd patient's eABR could be recorded so nicely, also the first millisecond is nearly without any interference via stimulation artifact.

Conclusions: These measurements of two special cochlear implant users lead to the hypothesis that a placement of the subcutaneous neurostimulator near the back of the head could in general reduce the stimulation artifact in cochlear implant users. This would make it easier to record eABR. Especially for patients with malformations the analysis of the auditory pathway could be done in more detail. Also when a high charge for evoking brain stem responses mainly influenced by the pulse width is needed this special stimulator placement could help EP specialists using this powerful and essential objective measurement, the eABR, in the near future for more patients than today.

Changes of cortical auditory evoked potential in early activation cochlear implant recipients

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Objective: Gordon et al. (2003) stated that behavioral thresholds in the sound field are higher in the first mapping session than the following sessions for cochlear implant receivers. With the adaptation and increased sensitivity of electrical stimulation, the behavioral thresholds of cochlear implant receivers usually tend to be stable after six months of the first mapping session. On the other hand, Brown CJ et al 2010 revealed little fluctuation of electrically evoked compound action potential (ECAP) thresholds over a period of five to six years after cochlear implantation (CI). Commencement of electrical stimulation within 24 hours after cochlear implantation has long been performed in our department on a routine basis. By means of a modification of the commonly adopted process for CI operation, initial activation within 24 hours was made possible. Previous research findings suggest that the cortical auditory evoked potential (CAEP) can be used as an objective tool to evaluate whether amplified speech sounds are audible in infants and children fitted with hearing aids (Gravel et al, 1989; Sharma et al, 2005;Golding et al, 2006).

The purpose of this study is to evaluate the changes of CI early mapping on the CAEP measured at neural activities in response to speech sound at the level of auditory cortex of cochlear implant receivers.

Method: Thirty prelingually deaf patients implanted with a MedEl and Cochlear system from May 2016 to August 2017 were included in the study. The subjects were defined as implant receivers who have basic communication ability and are able to differentiate the loudness of sounds. The subjects' ages during this study ranged from 2 to 17 years old with the mean age of 8.6 years.The CAEP stimuli (/m/,/g/,/s/) on both before CI insertion and initial activation within 24 hours were measured and the behavior amplified frequency-specific sound audibility were recorded. The CAEPs were compared in the pre/post CI insertion and the correlation of the CAEPs and the behavior response level was analyzed.

Results: 30 prelingually deaf patients in cochlear implant electrodes record a total of 130 CAEPs; We also calculated the correlation coefficient of three stimuli between pre/post CI insertion (F = 0.078, P> 0.05), was not statistically significant; pairs obtained 130 CAEPs and sound audibility threshold correlation analysis (r = 0.763, t = 0.001, P <0.05), there is a significant correlation. Compare with pre and post CI insertion were no significant differences (P >0.05)

Conclusion: The CAEP can be a useful tool to help evaluate difficult react little child's amplification efficiency of cochlear implant receivers.

Auditory system reorganization following cochlear implant in children with pre-lingual deafness

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Objective: To evaluate the auditory system reorganization following cochlear implant (CI) in pre-lingually deaf chil¬dren using cortical auditory evoked potentials (CAEPs).

Material and Methods: This is an open label prospective longitudinal study conducted on prelingually deaf Persian chil¬dren (n=20) who underwent CI in a CI center in Khuzestan, Iran during 2015 to 2016. The subjects (10 boys, 10 girls; mean age: 2.48 ±1.05 years) with profound pre-lingual hearing loss participated in this study. The CAEPs in response to speech stimuli (/m/, /g/, and /t/) were recorded using a HEARLab system. In all subjects the P1 latency of CAEPs was comparatively measured at three intervals: The baseline before CI and at two follow up points at 3- and 6- month post CI.

Results: The mean P1 values decreased with increasing time of implant use during the follow-up periods. The averaged P1 latency showed no significant difference between the different speech stimuli in all assessment intervals..

Conclusion: Our findings showed that CI influences the auditory system which can be measured in CAEPs.

Event-related potentials before and after HD tDCS in tinnitus patients: preliminary results

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Objective: There is currently a lack of objective measurements to evaluate the effects of therapeutic interventions in tinnitus patients. Previous studies have shown the underlying mechanism of maladaptive plastic changes and altered activity in the auditory and prefrontal cortex in tinnitus patients. Therefore, event-related potentials (ERPs) can provide substantial insight into processes in the brain, with the amplitude representing the extent to which neural resources are allocated to cognitive processes and the latency relating to the time course of these processes. The current study explores the value of ERPs in the evaluation of high-definition transcranial direct current stimulation (HD tDCS) in tinnitus patients.

Methods: This study compares ERPs before and after HD tDCS treatment on the right dorsolateral prefrontal cortex (DLPFC) in 22 tinnitus patients. The ERPs are recorded with a traditional- oddball paradigm. In addition to this objective measurement, the therapy effects are determined by use of tinnitus-related questionnaires.

Results: Preliminary results indicate a shortening of the N1, P2, N2 and P3 latencies after HD tDCS. However, the ERPs change is not significant correlated with the change in tinnitus questionnaires. Finally, P2 and N2 are more salient and show clear peaks after HD tDCS.

Conclusions: The current study uses ERPs as an auditory technology to investigate the sound processing in the brain. The shortening of ERP latencies after HD tDCS in tinnitus patients can reflect more effective sound processing due to a decreased tinnitus impact. Yet, these changes are not correlated with the subjective tinnitus perception. It may be that the tinnitus perception is not influenced by cortical changes. The more salient and clear P2 and N3 may be explained by much more cells in the auditory cortex which are recruited to analyzing sound and may imply a better synchronization in nerve cells firing.

Delayed sequential bilateral cochlear implant

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Objective:To assess speech perception skills in Open Set and the benefit acquired through the use of the second CI and Bilateral CI(BICI) that was sequentially delayed.

Material and Method: Evaluation of 25 patients who had received a Sequential CI with an interval of over 7yrs between both surgeries.

The speech recognition acquired through the use of CI1, CI2 and BICI benefit was carried out by applying two-syllable words in Open Set.

The perceptual subjective benefit obtained with the CI2 was made using Questionnaire of Anecdotal Report .

The evaluation was made after 12 month use of CI2.

Results: The results were analyzed in three different groups: 1) 1stCI made before the age 3 and with consistent use of

contralateral hearing aid(HA). 2) The same condition but without the use of HA and 3) 1stCI made in patients older than 3 yrs old.

G1: were included 9 children with an interval from 11 to 16yrs(10.7), all perform in Open Set with their CI2 , G2: 4 children with an interval from 7 to 15yrs(10.5), 50% perform in Open Set, G3 11 patients, interval from 8 to 15 yrs(10.4), 7 were users of contralateral HA , 55% perform in Open Set.

The average indicates that, there was an improvement of 18% benefit with the use of both CI.

Regarding the use of the CI2 throughout the whole day and the preference for the use of BICI, 92 % of the patients answered Yes. Regarding the fact of feeling comfortable with BICI, the 100% answered Yes. Regarding similar hearing in both ears, 44% answered that hearing was similar.

Conclusion: The best results in speech perception skills were in patients with contralateral residual hearing who used hearing aids consistently before CI2.

All the patients said that they felt subjetively better in the BICI condition.

The delayed sequential CI, in youth and young adults that were implanted at an early stage, provides an additional benefit in the general performance.

Performance of the second ear in sequential cochlear implantation

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Objective: The appropriate period of time from the first cochlear implantation (CI) till the second CI remains a matter of debate. Here, we aimed to investigate the performance of sequential CI at our institute according to inter-implant intervals.

Methods: A cohort of 33 children were followed-up for more than six months after a second CI. Patients who could perform a speech perception test were enrolled. Differences in Japanese phoneme recognition scores between the first and second implant were evaluated, and compared with the inter-implant interval.

Results: The mean age at the first implant was 32 ± 19 months, and the mean inter-implant interval was 38 ± 28 months. A total of 24 of 27 cases whose inter-implant interval was less than 5 years scored no less than 10% difference for the second implant compared to the first implant. The other 3 cases showed a difference between the first and second implant, but it was only 20%. By contrast, 3 of 6 cases whose inter-implant interval was greater than five years showed a marked difference in scores. Of these 3 cases, 2 cases with an inter-implant interval of 9 years had more than 60% differences, while the other case had an inter-implant interval of 6 years and 2 months and showed a 30% difference. The other 3 cases had identical scores for the second and first implants. Of these 3 cases, 2 previously had sufficiently good residual hearing to use a hearing aid, but finally decided to receive a second CI because of progressive hearing loss.

Conclusion: An inter-implant interval less than 5 years can achieve comparable performance for a second CI. If the interval exceeds 5 years, the performance can be variable. Some patients with residual hearing can score well, even with a long inter-implant interval.

MCLs in children after sequential bilateral CI implantation

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Objectives: In cochlear implant system (CI), the upper and lower limits of the stimulation current are typically described in terms of the threshold level (THR) and most comfortable loudness level (MCL). The study objective is to evaluate MCLs of children after bilateral sequential cochlear implantation (BICI)

Material and method: Nighty children (51 female and 39 male) were enrolled in the study. The mean age at first and second cochlear implant activation was 1 year 8 months and 4 years 8 months respectively. The mean intra implants delay was 3 years The group was stratified according to the intra implant delay more and less than 2 years. MCLs (in charge per phase - nC) were analyzed in both subgroups longitudinally (at the activation and 1month, 5, 9, 14 and 24 months after CI activation) across all channels (electrodes). The total MCL was calculated as the average MCL across all active electrodes. The comparison between MCLs in first and second implant has been made.

Results: In the short delay sub-group the first implant mean total MCLs at the consecutive time intervals were 12.5, 16, 18.6, 19.3, 20.3 and 20 nC respectively and the second implant mean total MCLs were 13.1, 18.5, 21.5, 23, 23.3 and 22.5 nC respectively. There was no significant difference between the first and the second implant. In the long delay sub-group the first implant mean total MCLs were 13.2, 16.3, 18.5, 19.2, 20.9 and 20.3 nC respectively and the second implant mean total MCLs were 14.2, 18.3, 22.5, 26.4, 29, and 30.2 nC respectively. The difference between the first and the second implant was significant.

Conclusions: In sequentially implanted children the short intra implant delay promotes symmetrical fitting.

The effect for children of bilateral cochlear implants with long interval between first and second surgery

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Objectives: Cochlear implants (CI) for children is better in lower age in terms of language acquisition. Moreover, bilateral CI is good enough to come into force simultaneously or with shorter interval. However, there are some cases in which the operation on the second side is performed with long interval after initial surgery for some reasons. Surgical adaptation of second CI is sometimes confused, especially in schoolchildren. We investigated the outcome in cases of bilateral CI, in which the second side operation was performed after school age.

Materials and Methods: The subjects were 20 children who underwent bilateral CI surgery in our hospital. The first operation age was 13 to 38 months, the second side operation age was 16 to 206 months, respectively. Four children, in whom the second CI were performed after school age were selected and divided into two groups depending on the interval between first and second surgery. Group 1 is less than 5 years, and group 2 is more than 5 years between each surgery. The details of the speech perception after first and second CI were examined in each case.

Results: The results in Group 1 showed a better speech perception than in Group 2. The data in Group 1 also showed a tendency to obtain the effect of second implant in a shorter period.

Conclusions: The effect of the second CI took a long time to reach comparable speech perception as the first CI. Second CI after school age, depends on the various needs of patients, should be determined surgical adaptation with adequate informed consent.

New approach in programming sequentially implanted children: effects of inter implant dynamic range differences on functional outcomes

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In children with bilateral severe-profound hearing loss, bilateral cochlear implants (CIs) offer functional benefits for spatial and speech-in-noise discriminations. Despite these functional advantages, getting long term unilateral users to adapt to a second implant can be challenging and requires some effort from both users and clinical teams.

It has been previously highlighted that imbalanced input levels from the two CIs can affect the ability to use inter-aural cues for speech-in-noise discrimination and sound localization (Gordon et al. Neuroreport, 2007). In a recent study conducted in our center we observed that sequentially implanted children with inter-implants delay (IID) longer than 7 years, had 25% smaller dynamic ranges (DR) in the second implant and showed no functional benefit of receiving a second implant (Simoes-Franklin et al., ESPCI 2017).

The main objective of this study is to assess if more balanced DRs in the two CIs leads to better outcomes on spatial localization and speech-in-noise discrimination.

The present ongoing longitudinal study focus on 20 children (mean age 13 years, IID 10.2 years) randomly assigned to two groups over a period of 15 months. Children assigned to the control group receive no changes to their pre-sequential CI1 map, while children in the study group receive changes to both implants' maps with the aim to balance the DRs in both sides allowing loudness growth. Speech discrimination will be assessed in unilateral and bilateral modes, at 9, 12 and 15 months appointments and spatial localization will be assessed using a portable tool that incorporates virtual reality and Head Related Transfer Functions to replicate a multi speaker array (Sechler et al., IEEE EMBS Neural Engineering Conference, 2017).

Intermediate results of this clinical trial will be presented and will help determine the effect of unbalanced DRs in functional outcomes and help clinicians set new guidelines in sequential programming.

Auditory speech perception and oral language in children with unilateral and simultaneous bilateral cochlear implant in the first year of use

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Objectives: The aim of this study is to analyze the auditory speech perception and oral language skills in deaf children users of simultaneous bilateral and unilateral cochlear implant (CI) in the first year of use. Methods: Retrospective longitudinal study. It was examined 20 children with severe and profound pre-lingual bilateral sensorineural hearing impairment, treated with CI. The mean age in the implant activation was 36.5 months. Participants were divided into two groups depending on whether implantation was unilateral or bilateral: G1, 10 children had simultaneous bilateral CIs, and G2, 10 children had unilateral CIs, without effective use of a contralateral hearing aid. The groups were matched according to chronological age, age at implant activation, brand and model of the internal and external component of the electronic device. Auditory perception and oral language skills were assessed over time by means of two questionnaires: Infant-Toddler Meaningful Auditory Integration Scale (IT-MAIS) and Meaningful Use of Speech Scales (MUSS). The evaluation was performed at three months, six months and twelve months

after implant activation. Results: The CI use allowed the development of auditory speech perception and oral language during the first year, with a gradual increase of IT-MAIS and MUSS scores, respectively, in the three evaluation moments in both groups, there was no significant difference (p> 0.05). Conclusion: In the first year of CI use, children using simultaneous bilateral and unilateral C

A multicentre review of electric-acoustic stimulation in children

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Objectives: During the CI assessment, children with partial hearing (PH) whose hearing thresholds are ≤65dBHL at low/mid frequencies are considered for electric-acoustic stimulation (EAS) fitting following CI surgery. Post-implantation hearing responses are recorded and the child is fitted with an acoustic component as appropriate. The reasons for not fitting an EAS device or changing to electrical stimulation over time are explored.

Methods: Since October 2014, our two centres have worked collaboratively to review of the outcomes of partially hearing children who have received CIs. Children with PH who received their CIs between 2008 and 2017 were included in the review. A comprehensive analysis of the data will be presented, including (1) overall rates of hearing preservation for the PH cohort, (2) numbers of children fitted with EAS, post-operatively, (3) numbers of children who are (a) continuing to use EAS and (b) who have changed to electrical stimulation only, (4) reasons for not using EAS or changing to electrical stimulation over time.

Results: This poster will illustrate the challenges involved in predicting, fitting and maintaining the optimal hearing device (EAS or electrical stimulation only). It will also illustrate the need for close monitoring of the child's hearing, their perceived preferences and issues with middle ear involvement.

Conclusion: Families should be carefully counselled on the possibility of CI and EAS. It is essential they are aware that hearing may not be preserved. It is equally important for them to understand that for a child receiving an implant at a young age, CIs outperform the child's hearing aids even where there is minimal preservation or complete loss of hearing.

I presented similar development of auditory speech perception and oral language.

Cochlear implantation in Refsum disease with facial nerve enlargement

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Objective: We would like to report the first case of cochlear implantation in a patient with Refsum disease and bilateral facial enlargement. The radiologic and surgical findings will be exposed, as the case represented a surgical challenge.

Results and Conclusion: During surgery, the posterior tympanotomy approach was limited by a large and dehiscent facial nerve; therefore, an extended facial recess approach was employed and the round window insertion procedure was uneventful. Intraoperative impedances, neural response telemetry, and postoperative transorbital radiography confirmed complete intracochlear placement of the electrode. Twelve months after activation and speech therapy, the patient showed a satisfactory pure-tone average and CNC word score in quiet.

The findings from this case suggest that cochlear implant surgery is safe and effective in patients with Refsum disease who exhibit severe SNHL and an enlarged facial nerve canal.

Interaction of tinnitus suppression and hearing ability after cochlear implantation

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Objectives: To study the postoperative impact of cochlear implants (CIs) on tinnitus, as well as the impact of tinnitus on speech recognition with CI switched on.

Methods: Fifty-two postlingual deafened CI recipients (21 males and 31 females) were assessed using an established Tinnitus Characteristics Questionnaire and Tinnitus Handicap Inventory (THI) before and after cochlear implantation. The tinnitus loudness was investigated when CI was switched on and off in CI recipients with persistent tinnitus. The relation between tinnitus loudness and recipients' satisfaction of cochlear implantation was analyzed by the visual analogue scale (VAS) score.

Results: With CI 'OFF', 42 CI recipients experienced tinnitus postimplant ipsilaterally and 44 contralaterally. Tinnitus was totally suppressed ipsilateral to the CI with CI 'ON' in 42.9%, partially suppressed in 42.9%, unchanged in 11.9% and aggravated in 2.4%. Tinnitus was totally suppressed contralaterally with CI 'ON' in 31.8% of CI recipients, partially suppressed in 47.7%, unchanged in 20.5%. Pearson correlation analysis showed that tinnitus loudness

and the results of cochlear implant patients satisfaction was negatively correlated (r ¼ .674, p < .001).

Conclusion: The study suggests six-month CI activation can be effective for suppressing tinnitus. The tinnitus loudness may affect patients' satisfaction with the use of CI.

The feasibility of endoscope-assisted approach for cochlear implant: a pilot study

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Objectives; The standard technique for cochlear implantation (CI) is transmastoid posterior tympanotomy approach, which includes cortical mastoidectomy and facial recess approach. Because this approach includes eliminating the mastoid air cell system inevitably, alternative approaches avoiding the mastoidectomy step have been developed. In addition, the direct line of view presented by the microscope through the posterior tympanotomy may not provide enough surgical exposure and sometimes it may be difficult to identify the round window in some cases.

The aim of this pilot study was to evaluate the feasibility of endoscope-assisted CI technique, in which the middle ear landmarks including the round window were identified through microscopic view through posterior tympanotomy or endoscopic view with elevating the tympanic annulus.

Material and methods; CT examinations and feasibility of endoscope-assisted approach to the round window region were analyzed in the cases of canal wall up tympanomastoidectomy. Postauricular skin incision was performed. Standard cortical mastoidectomy and posterior tympanotomy were accomplished using a microscope. The tympanomeatal skin flap and tympanic annulus were elevated and accessed to the middle ear. Rigid 0º and 30º endoscopes (2.7 and 4 mm in width) were used to view the round window region through the external ear canal, presuming that the endoscope was placed to the external ear canal and the electrode was transferred through posterior tympanotomy and inserted under endoscopic view. The size of posterior tympanotomy and the visibility of the round window region were compared through microscopic view through posterior tympanotomy or through endoscopic view with elevating the tympanic annulus.

Results and conclusion; The endoscope-assisted CI technique presents, without doubt, the improved visibility leading to a panoramic view of the round window region. However, this improved surgical view can be presented only by using an endoscopic view with elevating the tympanic annulus, but not by using an endoscopic view without elevating the tympanic annulus. The endoscopic view through the posterior tympanotomy without elevating the tympanic annulus was not good because the rigid endoscopes (0º and 30º, 2.7 and 4 mm in width) were too large to be passes through the posterior tympanotomy. Endoscope-assisted view with elevating the tympanic annulus can present clear and wide view of the round window region but included the elevation of the tympanic annulus in its procedures unnecessarily. This technique can be helpful to make the posterior tympanotomy not wide because the view of the round window region is guaranteed by the endoscope placed to the external ear canal and even small posterior tympanotomy is enough for the passage of the electrode. It should be kept in mind that the endoscope-assisted CI technique is still not a primary modality.

The effect of post-insertional cochlear implant movements in hearing preservation; are we negating our atraumatic insertion

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Aim: To investigate the traumatic effect of handling of the cochlear implant electrode post hearing preservation implantation on the cochlea.

Methodology: Using a similar In-Vitro model of the Scala Tympani previously reported in the literature for operative factors of Hearing Preservation Cochlear Implantation,(1) intra-cochlear pressure rise, variation and time were measured against different methods of handling the cochlear implant electrode after insertion.

The model was a 3D-printed cochlea model of the Scala Tympani, with a mechano-optical fibre optic pressure installed at the apex of the Cochlea that measured pressure changes along the fluid column.

Methods studied included pressure variation with an unsealed electrode, pressure variation with different methods of sealing the electrode, and pressure variation with a sealed electrode.

Post-Insertional pressure variation was measured and contrasted with insertional pressure variation to establish a functional relationship between the two phases of insertion.

Results: Similarly to previous findings, our experiments demonstrated that even slight movement of the implant electrode produced significant variations in intracochlear pressure.

Our study builds on these findings by comparing them with insertional pressure variation to determine their significance.

After successful implantation with minimal intra-cochlear pressure variation during insertion, uncontrolled movements and handling of the electrode were associated with significant intra-cochlear pressure variations.

Conclusion: Post-Insertional factors of Cochlear Implantation have a significant impact on intra-cochlear pressure variation and should be an important consideration in hearing preservation cochlear implantation

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and Their Effects on Intracochlear Pressure. BioMed Research International. 2016;2016.

Cochlear implantation under local anaesthetic – "How we do it"

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Introduction: Cochlear Implantation (CI) under Local Anaesthetic (LA) is an option for those patients who are deemed at a higher risk for a General Anaesthetic (GA). It is felt by some that GA in the elderly can affect cognitive function. Patient selection, counselling and planning is pivotal to ensure good outcome and experience.

Methods: With the selected patients particular attention is paid to communication during the surgery. Selection of the correct font for the custom-made cue cards enables appropriate interaction. Usual surgical preparation including facial nerve monitoring is performed. Local anaesthesia (Levobupivacaine 5mg/ml) is infiltrated into the appropriate neural pathways to ensure maximum effect. Lignocaine is used by infiltration/topically in the middle ear. Sedation is avoided but prophylactic antibiotics, Dexamethasone, anti–emetics and fluids are administered. One important feature is to ensure that any drill irrigation fluid is at body temperature to avoid caloric effects and to minimise suction. A simple questionnaire about the patients' experience is recorded.

Results: Fourteen patients with age range of 26 to 93 years (Mean 76.3) have successfully undergone CI under LA. Operative time is no different from GA and no procedure was abandoned nor complications noted. One patient was discharged the same day, the others the following day after completion of antibiotics. Implantation in one pregnant female was successfully achieved prior to delivery to enable early bonding. 100% of the patients indicated in the questionnaire that they were satisfied with the anaesthetic care and would have the same anaesthetic again.

Conclusions: CI surgery under LA is safe and well tolerated. Careful patient selection and counselling is required. Further comparative study to investigate cognitive impact of GA versus LA would be of future interest.

Influence of "hook" region anatomy on the approach to the spiral canal

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In patients with residual hearing it is crucially important not to alter the fine structures of the cochlea. In this study we analyzed the anatomic variations of the "hook" region on 35 cadaveric temporal bones and tried to find out the optimal electrode insertion rout.

Basing on the distance between the edges of oval and round windows all 35 cadaveric temporal bones were divided into two groups: "small" and "big" ones (on the ground of classification proposed by F. Atturo, M. Barbara, H. Rask-Andersen). It was revealed that this distance correlates with the position of the "hook" region structures: osseous spiral lamina, spiral ligament, basilar membrane, cochlear aqueduct and accessory aqueduct housing inferior cochlear vein.

In the experimental study we compared 4 types of electrode insertion: via round window, with the use of anterior cochleostomy, anterior-inferior cochleostomy and enlarged round window. It was proved that the most nontraumatic approach in both "small" and "big" cochleae is the electrode delivery via round window membrane. This approach in all cases enabled electrode insertion without altering "hook" region structures.

When anterior cochleostomy was performed in both "small" and "big" cochlea spiral ligament and lateral portion of the osseous spiral lamina were inevitably damaged in all the specimens. In 33% "big" cochlea cases basilar membrane was also altered. Whereas in temporal bones with anterior-inferior cochleostomy spiral ligament and osseous spiral lamina remained intact in 66% of "big" cochlea and in 50% of "small" cochlea and there was a significant risk especially in "small" bones (83 %) of damaging the cochlea aqueduct and accessory aqueduct. As for the enlarged round window approach we revealed alteration of cochlea aqueduct and its accessory canal in 75% cases ("small" cochlea) and 50% cases ("big" cochlea).

Round window niche area anatomy in terms of cochlear implantation

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The round window niche area is dramatically important in terms of cochlear implantation as its individual variations influences approach to the scala tympani of the cochlea.

Methods. The syntopy of round window niche area and adjacent regions was examined on 20 cadaveric temporal bones.

Results and discussion. Three types of free edge of the round window niche tegmen were distinguished. In 11 specimens out of 20 well-formed free edge of the tegmen was revealed and round window membrane was fully visualized. In 6 cases a well-formed free edge of the tegmen was detected but due to the angle of this anatomic structure the membrane was only partly observed. In 3 specimens free edge of the tegmen was hypertrophic and protruded

medially obscuring the membrane and the chamber of the round window niche.

In 16 cases in hypotympanum area we observed a tunnel between the finiculus and fustis. This tunnel connected tympanic cavity and petrous bone cells below the cochlea. Three degrees of expression of this structure were discerned: I - 11/20 bones presented wide tunnel; II – in 5/20 specimens only a small foramen was revealed under the finiculus; III – in 4/20 cases this tunnel was not visualized.

Learning outcome. A wide tunnel, which can be observed under the cochlea after the posterior tympanotomy, may mimic the round window niche. This can lead to the false electrode insertion. The potential risk of jugular bulb and carotid artery damage should be kept in mind as infracochlear pneumatization may serve as a pathway leading to these vessels.

Benefits of a new fitting formula for patiens using bimodal stimulation

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Objectives: This study aimed to investigate:

1) the benefits of the new Adaptive Phonak Digital (APD) bimodal fitting formula, and 2) the ease of use of QuickSync for patiens using bimodal stimulation.

Material and methods: 4 adults who use Advanced Bionics Naida Q70 CI sound procesors on one ear and hearing aid in opposite ear participated en this study. They all were experienced hearing aids users and had a minimum of 3 months using Cochlear Implant (CI).

The performance in speech perception was measured using CI alone and bimodal stimulation. In bimodal hearing 2 hearing aids where compared, the Phonak Naida V70 SP, fitted using NAL-NL1 formula; and the Phonak Naida Link, fitted using the APD formula.

Also, 4 measures where assessed through a rating scale: ease of use, general hearing, speech perception in noise and confort.

Results and conclusions: Due to the results observed, we believe that the new fitting formula added to the ease of use giving by the QuickSync, make the Phonak Naida Link hearing aid an effective solution for patiens using Naida Q70 CI sound procesors in the contralateral ear.

Binaural hearing rehabilitation in patients with postlingual asymmetric hearing loss

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Background: Binaural hearing is the fundamental property of the properly functioning hearing system. The advantages of binaural hearing have been repeatedly demonstrated in research on healthy human subjects. The benefits of binaural perception are sound localization ability, better speech intelligibility in both silence and noise, simplicity of oral-aural development and education processes, and improvement of the quality of life.

Methods The group consisted of 32 adults (n=32) with asymmetric hearing loss of different etiology. Each patient had been using hearing aids for some time before cochlear implantation.

Hearing ability was analyzed in 32 postlingual adults who received a cochlear implant (MED-EL; Innsbruck, Austria). The standard test procedure included pure tone audiometry in free field (using modulated tones) and speech audiometry in free field in both silence and noise (monosyllabic and polysyllabic Russian word lists).

Results: The thresholds of modulated tones were 60-80 dB with hearing aids but increased to 40-45 dB when patients used unilateral cochlear implant. The combination of a unilateral cochlear implant and an opposite non-implanted hearing aid recovered sound localization capacity.

The comparison of monosyllabic and polysyllabic words intelligibility before surgery and in 12 month post-surgery showed different degrees of increase in hearing ability. Before surgery the results were 4,8±1,72% % on the monosyllabic and 11,39±3,13% on the polysyllabic test, and 12 months post-surgery the results were 39,51±3,5% on the monosyllabic and 69,14±5,1% on the polysyllabic test. The combination of a cochlear implant and a hearing aid, however, revealed better results of speech intelligibility both (59,34 ± 4%) on the monosyllabic (59,34 ± 4%) and on the polysyllabic tests (85,7±7,4%), accordingly.

Conclusion: Cochlear implantation is the best choice for postlingual patients with asymmetric hearing loss without any hearing-aid effect. Unilateral cochlear implantation in combination with a traditional hearing aid on the opposite non-implanted ear or bilateral cochlear implantation (binaural hearing) improves speech intelligibility, recovers sound localization ability and other binaural effects, and, as a result, increases efficiency of patients' rehabilitation after cochlear implantation.

What did adult advanced bionics Q90 cochlear implant recipients think about the Phonak Naida link hearing aid? Results from a sound quality ratings questionnaire.

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Aims: to find out if this patient group reported any benefit from the Phonak Naida Link Bimodal hearing aid

Methods: a group of n adult unilateral Advanced Bionics Q90 recipients were fitted with the Naida Link bimodal hearing aid. Approximately 1 month following the fitting the client group were asked to complete a Naida Bimodal hearing

Solution Ratings Questionnaire which can be used to subjectively evaluate whether this hearing aid, compared to their previous situation, gave them any benefit. All patients within the group had been using their unilateral Advanced Bionics Q90 cochlear implant processor for at least 2 months.

Results: n questionnaires were returned. Data analysis is yet to be completed.

Conclusions: Data analysis has yet to be completed so no conclusions can yet be drawn. We expect to be able to show that the Naida Link hearing aid recipients report being able to follow conversation in quiet and in noise better; also to listen to music, TV and use the telephone better as well as not needing as much effort when listening and to better tell where sounds are coming from. Formal testing in these areas has not been within the remit of this study as a future study will focus on this.

Fitting cochlear implant processors in adults with preserved hearing – Development of a protocol

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We talk a lot about hearing preservation surgical techniques, but are we making the most of the preserved hearing when it is achieved?

In our department we do not have any guidelines or a protocol about when or how often to test unaided hearing thresholds, when to fit and re-programme a hybrid processor or what to do in cases of extreme ski slopes where low frequency hearing is entirely normal after CI surgery. The cochlear implant companies give advice about what levels to fit a hybrid processor to and how to programme them, but not about when to fit them and how to monitor outcomes and compare with non hybrid fits.

We sent out a questionnaire to other CI centres to ask if they had protocols and what they do with patients with preserved hearing. None of the centres who replied had a written protocol, but all were keen to standardise their practice and be involved in developing a protocol.

We are collating the responses about current practices as well as taking advice from manufacturers. We will present our findings and suggested protocol and ask for further feedback from centres in order to put together a standard national protocol that can be used to optimise listening in adults with preserved hearing.

Experiences in cochlear implant fitting – AutoART and applications

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Introduction: In optimal cases we cooperate with the patient through the soundprocessor fitting to be the most matching for the patient. To get this it is necessary to identify the Most Comfortable Level (MCL). In literature and in our clinical experiences to approximate MCL Auditory nerve Response Telemety is efficient.

Materials and methods: Auditory nerve Response Telemetry is integrated in the Maestro 7.0 software. In this program one can find the AutoART method, which helps in the parametrization of the measurement. We show this tool and our experiences with the ART fitting function in the case of 5 postlingual adult patients.

Results: The autoART measures the ECAP thresholds on every electrodes with a high speed (approx 2 min). The patients do not feel any discomfort or pain. We fitted the MCLs of the patients, than we performed an other MAP with ART fitting. We summed their observation.

Conclusion: With the information we got through these comparisions, we expect this method to be a base for the fittings with children. We can measure postoperative ART fast therefore the children stay patient in the meantime. Combining with intraoperative evoked stapedius reflex measurement the soundprocessor can be programmed easily in the case of not cooperative patients and children.

Impact of hearing rehabilitation on cognitive functions

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The association between cognition and hearing is well known. With regard to the growing number of older persons and the incidence of demential illness the question arises whether hearing rehabilitation might counteract cognitive decline in aging.

Since 2016 all patients aged 50 or more suffering of severe to profound hearing loss and scheduled for cochlear implantation at the Department of Otorhinolaryngology, Head and Neck Surgery, Ruhr University of Bochum (Germany) underwent a computer-based evaluation of neurocognitive functions prior to surgery. The multi modular computer-based test battery (ALAcog) composed of ten different subtests covered the most important cognitive

domains such as short- and long-term memory, processing speed, attention, working memory and inhibition.

So far 60 patients (median: 67.38 yrs) could be included. Out of these 33 patients aged 50 to 82 yrs were reassessed 6 months and 20 patients 12 months post implantation. After 6 months cognitive functions already increased significantly regarding attention ($p < .001$), delayed recall ($p = .03$), inhibition ($p = .04$) and working memory (2-back $p = .0041$; OSPAN-test $p = .0077$). The benefit of the executive functions was the most remarkable. Results remained mostly stable after 12 months. Only working memory measured by the OSPAN additionally enhanced after one year ($p < .001$). In contrast long-term memory did not improve earlier than after 12 months ($p = .021$). In general, improvement was statistically better for subjects with poor baseline results.

Cochlear implantation has a positive impact on cognitive abilities mostly on executive functions even in patients with lower preoperative performance. Further studies have to show whether hearing restoration through technical devices has a long-term effect on cognition and might even prevent demential illness.

Cochlear implantation in the octogenarian: speech perception outcomes and length of use

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Objectives: To evaluate the speech perception outcomes of cochlear implantation in elderly post-lingually deafened recipients implanted between 2000 and 2017 at the Emmeline Centre for Hearing Implants. To establish the number of years the CIs have been used in the group of deceased patients.

Methods: A total of 90 adults (mean age 84± 3.3years) with bilateral post-lingual severe to profound hearing loss were implanted with a unilateral multichannel cochlear implant. A retrospective cohort study of the patients' records was performed. Data on age at implantation, pre- and post-implantation scores for Auditory Speech Sound Evaluation (ASSE) test, Bench-Kowal-Bamford (BKB) sentence test in quiet and in noise were analysed. Length of use and a score of cumulative survival rate were calculated for deceased patients.

Results: The pre-implant average BKB test score for the study group was 13±3 %. The average progress in speech perception in quiet within the first 2 months post activation was 55% ± 27%. The recipients gained on average 18% for ten months scoring 78% ± 15% on average by the 12th month of usage. Phoneme discrimination has improved to 89%± 13% on average. The speech perception in noise was 59% ± 20%. The cohort included 23 deceased patients from 01/01/2000 until 10/10/2017. They have used their cochlear implants for 41 months ± 34 months on average. The cumulative survival rate for the cohort is 60.5%.

Conclusions: The cochlear implantation provided the elderly recipients with improvement in speech understanding and phoneme discrimination. On average the elderly recipients used their implants for 3 years ± 3 years which is corresponding to the average additional life expected for this age group. The improvement in their speech discrimination is more than 50% for the first 2 months of usage increasing to 78% by the first year.

Poster Session 7

Scala vestibular insertion of cochlear implant for labyrinthitis ossificans limited to scala tympani of basal turn of cochlea- Our experience

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Objectives: Planning scala vestibular approach of cochlear implant insertion in two children with labyrinthitis ossificans limited to scala tympani and evaluating their response following auditory verbal therapy.

Materials and Methods: The first child was 29 months old otherwise normal, who developed bilateral profound hearing loss and thus speech delay following meningitis at 7 months. Another 60 months old, non-syndromic child had history of recurrent meningitis followed by hearing loss for six months. HRCT temporal bone of the first child showed bilateral hyperdensity within the basal turn of the cochlea. Corresponding MR T2 drive sequence showed hypointensities in basal turn corresponding to scala tympani of the cochlea. The second child had similar findings on one side and cochleo-vestibular anomaly with perilymph leak on the other side. Identification of limited labyrinthitis ossificans by imaging helped to plan for scala vestibular insertion of cochlear implant.

Results: The first child underwent bilateral cochlear implant by cochleostomy, anterosuperior to round window and scala vestibular insertion of the electrode. The second child had unilateral scala vestibular insertion with closure of the leak on the other side. The electrode insertions in both the children were smooth and complete. On assessment after three months of auditory verbal therapy with Integrated Scales of Development, comprising of audition, reception, expression, speech, cognition and social communication; a good improvement was recorded in all the areas.

Conclusions: High-resolution CT temporal bone complimented by MRI images helped in precise location of limited labyrinthitis ossificans. Surgery was tailor made, according to the area affected. Literature supports superior results with scala vestibular insertion of electrode as compared to drill out of basal turn of cochlea in such cases.

The efficiency of subperiosteal suture fixation technique for cochlear implanation in young children

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Objectives: There are many studies showing that the earlier the cochlear implantation surgery, the better the hearing outcome. So children are receiving more surgery when they are younger nowadays. But in this age, skull is thin and it make hard to drill tie down hole. Our group has employed a technique in this age group which involves securing the receiver/stimulator with subperiosteal suture fixation technique without suturing over the device. We report our experience with 20 children aged 3 years or younger undergoing cochlear implantation with subperiosteal suture fixation technique.

Materials and Methods used: A retrospective case review was conducted. We reviewed charts for demographics, surgical time, and clinical outcomes. Outcome measures included postoperative complications, including evidence of device migration associated with interference with external device use or the need for revision surgery.

Results: 20 patients 48 months of age or younger underwent cochlear implantation over a three year period.

Simultaneous bilateral implantation was performed at 10 patients and unilateral implantation was performed in 10 patients, for a total of 30 implanted ears. The average age at time of implantation was 22.7 months. The average surgical time was 183 minutes in unilateral implantation and 227 minutes in simultaneous bilateral implantation. There were no postoperative complications. Also, no evidence of device migration were identified in any patient.

Conclusion: No wound complications or device migrations occurred in 30 cochlear implantations in 20 children aged 48 months or younger. Advantages of this technique include smaller incisions, and shorter surgical time. This method of fixation appears to allow for an efficient and minimally invasive approach without compromising patient safety or device performance.

Cochlear implantation in 3 Patients with CHARGE syndrome

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Objectives; CHARGE syndrome is a congenital disorder associated with multiple malformations resulting from abnormal embryonic organogenesis. Disorders of sense organs, such as vision and hearing impairments, are reportedly associated with significant developmental delay in patients with CHARGE syndrome. Therefore, congenital deafness is generally treated with cochlear implantation (CI). However, deafness is often diagnosed and managed after treatments for a wide variety of complications in patients with CHARGE syndrome. In addition, surgery for deafness is extremely difficult to perform due to the presence of various malformations in the ear region in these patients. We present our cases of performing CI in 3 patients with CHARGE syndrome.

Materials and Methods; All 3 patients were congenitally deaf and had cognitive abilities below average. The ages performed CI were from 47 months to 71 months, and in all cases hearing aids did not provide them with optimal hearing abilities. We demonstrated details of preoperative evaluation, surgical methods and postoperative course in each case.

Results and Conclusions; Both cases were able to perform surgery safely without complications. All cases have acquired responses to sounds, and it is necessary to follow up closely the hearing process in the future. Evaluation of detailed anatomical indicators and planning before surgery are important for safely performing CI.

Advantages of the use the endoscopy in cochlear implant

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Introduction: The goal of all surgery is the best results with the least possible damage to anatomical structures involved in the procedure. This premise has led in recent years to find methods that allow us to reduce the risks associated with surgery. In the case of cochlear implant surgery, in recent years many surgical techniques have been described. This paper presents our experience in cochlear implant surgery assisted with endoscopy.

Objective: To describe the usefulness of the endoscopy in the classical approach to cochlear implant surgery

Method: Retrospective study from September 2015 to January 2018 in the Sótero del Rio Hospital. During this period 49 surgeries were performed with this technique. All were evaluated previously with audiological and imaging studies. Surgery was performed with an anterior tympanomeatal flap, identifying the anatomy of the middle ear. Later mastoidectomy and posterior tympanotomy is made. One advantage of this technique is that the posterior tympanotomy is smaller. Once this process is completed, opening round window and inserting the electrode in the scala tympani is performed.

Result: Endoscopic Assisted Cochlear Implant had no complications, 100% of the inserts were by round window into the scala tympani. In one patient with inner ear malformation (incomplete partition), it allowed detailed visualization of the middle ear. The same occurs in a patient with a bilateral cochlear fracture. In 4 patients with advanced otosclerosis, there was no problem in the approach to the round window or the insertion of the electrodes. There were no problems with the tympanomeatal or infections.

Conclusion: The use of endoscopy seems a good tool with many advantages for cochlear implant surgery independent of alterations that may exist in both the middle ear and internal ear.

The effects of cochlear implantation on vestibular function in 1-4 years old children

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Objectives: Although cochlear implants offer an effective hearing restoration option in children with severe to profound hearing loss, concern continues to exist regarding the possible effects of cochlear implantation on the vestibular system and balance.

Methods: In a prospective cohort study, 27 children with bilateral profound hearing loss (all candidates for cochlear implantation) were evaluated for their vestibular function before and after cochlear implantation.

Vestibular evaluations consisted of Vestibular Evoked Myogenic Potentials, caloric testing and the Head-Impulse Test.

Results: Mean age at the time of cochlear implantationwas 27.19 months. Without considering vestibular evaluation results, one of the ears was selected for surgery. Vestibular tests after surgery were not indicative of any statistically significant change in vestibular system or balance.

Conclusion: This limited data shows that cochlear implantation did not impair the vestibular system of these patients. By the results of our study we may conclude that round window implantation does notnhave any disturbing impact on vestibular function in children. The generalization of this result needs further research.

Characteristics and pathogenesis of facial nerve stimulation after cochlear implant surgeries

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To analyze characteristics and propose mechanisms of FNS (Facial Nerve Stimulation) in cochlear implant surgeries. Thirty-two ears from 29 patients with FNS were evaluated from among 1151 ears which received a cochlear implant between April 1999 and July 2016. Locations of electrodes involved with FNS, presence and types of cochlear anomalies, presence of cochleo-facial dehiscence, and the current levels were analyzed. The current levels were compared to those of age- and sex-matched control group. Incidence of FNS was 2.8% (32/1151), and it was higher in ears with a cochlear anomaly (6.4%, 25/391) than in those without an anomaly (0.9%, 7/760). Patients without an anomaly showed two types of FNS: FNS at apical electrodes related to cochleo-facial dehiscence with low current levels, and FNS at basal electrodes with high current levels and partial insertion of electrodes. Patients with an anomaly showed a third type of FNS at most electrodes with high current levels, which was the most common type in patients with a common cavity or narrowing of the bony cochlear nerve canal. Facial nerve stimulation occurred at various current levels and locations of electrodes by different mechanisms related to incomplete insertion of electrodes, cochleo-facial dehiscence, and types of cochlear anomalies. Our findings might provide insight for preventing facial nerve stimulation when performing cochlear implant surgeries.

Impact of socioeconomic status on the occurrence of complications after cochlear implantation - A case study

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Introduction: Cochlear implantation has become an effective treatment for many profoundly deaf children. As with any surgical procedure cochlear implantation is relatively save procedure with low complication rate. The overall rate of complications among cochlear implant patients ranges from 6% do 20%. Major complications are those that are require surgery whereas minor complications are those that can be medically treated. One of the quite worrying and potentially devastating are the postoperative wound infections after cochlear implantation. Because of the risk of the implant infection in this cases, which can lead to device removal with loss of the implant function, every effort must be made to prevent this infections, or if they occur to be timely and appropriately treated which will enable salvage of the implant and its function.

Aim: To emphasize the importance of socioeconomic status as risk factors for the occurrence of postoperative wound infection after cochlear implantation.

Materials and Methods: We report the case of 4-year-old child with delayed postoperative surgical wound infection. The one appeared 14 days after the cochlear implantation (postoperative). Anamnestic data obtained from the mother indicates that after discharging from the hospital the child was repeatedly itchy the wound. On examination a half of the surgical wound was reddish with mild discharge and starting dehiscence at one point. The swab obtained from the wound was positive for Vancomycin resistant-Enterococcus faecium.

Results: An outpatient medical care with antiseptic dressing, topical and oral antibiotics was started immediately. Because of no response, even worsening of the local status, 7 days after a revision surgery was required. With the employment of timely and appropriate surgical wound debridement and re-suture the healthy edges without using a flap, the implant was salvaged.

Conclusions: As reported in the literature, in children from families with lower socioeconomic background incidence of complications is higher comparing to the children that come from families with higher income level. The reason for this can be poor hygienic conditions and habits, as well as negligent care of the parents. This indicates that a special approach in pre-operative preparation and postoperative care in the candidates for cochlear implantation with lower socio-economic back-ground is needed. Involvement of a motivated social workers in the care of the cochlear implant children is necessary for additional support and education of this group of parents and children, in order to prevent and reduce the negative impact of the socioeconomic background of the CI surgery outcomes.

Complications of cochlear implantation: a series of 300 patients and review of the literature

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Objectives: Cochlear implantation is the treatment of choice for bilateral severe to profound hearing loss. It is a safe technique with a relatively low complication rate. The purpose of this study is to present the complications of cochlear implantation found in our series, to prevent and treat them. These complications were classified in minor and major from simple skin irritation to explantation, and will be compared with the results of the literature.

Material and methods: This is a retrospective study of 300 patients from December 2007 to December 2017 (10 years) including 15 adolescents and adults and 285 children, ranging in age from 16 months to 6 years.

Results and conclusion: There were a total of 26 complications (8%). All the complications found were classified as minor and major. Minor complications,included local skin infections, facial paresis, temporo-parietal hematoma, keloid scar, posterior retraction pocket, acute otitis media, and vertiginous crises.

For major complications it is the failure of the implant either without apparent cause, or secondary to trauma, extrusion, and hyatrogenic cholesteatomatous otitis that required homolateral or contralateral explantation and reimplantation.

Cochlear implantation is a safe and reliable technique with a relatively low complication rate. The most common complications are of minor type, but serious complications may occur. Their knowledge is essential, helping clinicians to adopt specific preventive measures and adequate therapeutic management for the results to be successful.

Surgical complications and morbidity in cochlear implantation

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Introduction: Cochlear implantation (CI) has been established worldwide as the surgical AQ5 treatment for individuals with bilateral severe-to-profound hearing loss. This is a safe and standard procedure in the hands of experienced implant surgeons.

Complications due to surgery are minimal and are often encountered in cases of congenital anomalies of the temporal bone and inner ear.

Patients and methods: All patients receiving CI at our institution between 2014 and 2015 were included in the study.

Aim: The aim of this study was to report the frequency of surgical complications following 112 consecutive CIs in 102 children and 10 adults in the National Hearing and Speech Institute (HIS), Cairo, Egypt. The international consensus on the reporting of CI complications proposed by Hansen and colleagues was used and evaluated.

Results: In all, 112 implantations were performed in 102 pediatric and 10 adult patients. Overall, complications occurred in 21 (18.75%) patients, including major complications in nine (8.03%) and minor complications in 12 (10.71%) cases.

Complications were delayed in nine (8.03%) cases. No death was attributed to device implantation. Major complications occurred in 12 cases, which included misplaced electrodes in two cases, cerebrospinal fluid leak (gusher) in four cases, labyrinthitis ossificans in one patient, magnet displacement in one case (chronic suppurative otitis media), central perforation in one case, seroma and hematoma (severe cutaneous infections) in one case, wound infection in one case, and persistent pain/discomfort (migration) in one case.

Conclusion: Complications of CI are more common in children than in adults with trauma as a major factor. Inner ear malformations should prompt specific preventive management. CI in young children did not appear to be a risk factor in this study.

Contalateral side effects in auditory brainstem implantation: a case report

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Objectives: To report unusual contralateral side effects in the case with auditory brainstem implant (ABI).

Material and Methods: A 2-years-old girl was diagnosed with bilateral cochlear nerve aplasia and auditory brainstem hypoplasia. The family was reported left facial paralysis at the age of 5 months. She was implanted with auditory brainstem implant on the left side on 5th December 2017. The initial stimulation was done 1 months after the surgery under monitoring. After initial activation of ABI follow-up visits was scheduled as 1st month, 2nd month and 3rd month. Auditory perception abilities was evaluated with Ling sounds and MAIS scores.

Results and Conclusions: During the initial stimulation facial nerve stimulation was observed on the contralateral side on 9 electrodes. Only 3 electrodes could be activated. In first month follow up visit, all electrodes checked for side effects. None of the deactivated electrodes could be activated. In case of 3 activated electrodes, she wanted to use sound processor daily, can recognize the environmental sound. MAIS scores improved 3 months after ABI. Contralateral side effects can be seen after ABI in cases with brainstem hypoplasia. During the ABI programming, two experienced pediatric audiologist should observe the patient.

Cochear implant complications: electrode extrusion managment

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Objectives: We report in this study our experience in device failure management for patients who underwent CI revision due to device failure in our center and highlight the audiometric and surgical steps in the diagnosis and management of electrode failure.

Methods: A retrospective study of all patients implanted in our tertiary care center. Clinical databases were reviewed to identify all CI revision cases from 2012 to 2018. We included all children who were implanted and underwent revision CI in our center. In order to report the CI revisions, we identified subjects by complications according to the European Consensus Statement on Cochlear Implant Failures and Explanations: (1) cochlear re-implantation, (2) other revision surgery and (3) medical treatment. The audiological assessments were reviewed for all patients included in the study (ABR and OAEs pre-implantation, Aided thresholds and speech detection thresholds post-revision). We reviewed and reported the electrical compound action potentials pre and post – revision including the impedance measurements, a measure of the resistance to current flow. Intra operative X-rays are performed routinely to confirm the electrodes placement. Post revision, the parents of each patient have been contacted and handled a questionnaire of Categories of Auditory Performance (CAP) to compare the progress of their child post-revision.

Results: 89 patients were implanted in our center in the study period. Age of patient's ranges from between 6 months - 16 years old (8 females and 5 males). Total number of complications was reported in 13 patients, (1) two device failures, (2) ten revision surgeries and (3) one medical treatment. All patients were reimplanted / reinserted successfully. The aided audiometry post-revision showed normal to borderline hearing; average of ~20 to 25 dB in 3 patients, mild hearing range; average of ~ 30 to 40 dB in 6 patients and moderate hearing range; average of ~ 45 to 50 dB in 2 patients. CAP score questionnaire results revealed significant improvement in most of our cases 7 of the patients reached the highest score (7), which is using of telephone with known speaker.

Analysis of causes for cochlear implant explantations

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The aim of the study was to analyse the causes for cochlear implant explantations in our Cochlear Implant Program.

Material and methods: The cochlear implant program in our department started in 1994 and till now we have performed 1418 cochlear implantations. This group consists of 799 children and 619 adults. The medical charts of patients were retrospectively analysed to find the cases which required explantation.

Results and conclusions: Explantation was performed in 50 cases (3.5%). There were the following reasons of explantation found: 1) documented failure of the internal device (19 cases), 2) decreased performance over time (2 cases), 3) unsatisfactory placement of the electrode array (7 cases), 4) technological upgrade (1 case), 5) scalp flap complications (15 cases) and 6) intratemporal pathology (6 cases).

Managing extreme anxiety during cochlear implant assessment: a team approach

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Objectives: Anxiety in children surrounding hospital procedures can, if not managed well, have life-long and even trans-generational consequences. We describe our first case of a child - a 12 year old boy - who presented with extreme anxiety over any radiological or surgical procedure. We have never experienced such a case, despite operating on over 850 children and adolescents over the past 25 years.

Method: This child displayed more than 17 symptoms of anxiety. We also felt his mother had her own anxieties which were additionally impacting on the child. We therefore worked as a team across 4 internal departments including ourselves, specialist play services, clinical psychology and anaesthetics, and also closely with the local education service to support this child and his family through surgery.

Results: The child received four times as many appointments as would normally be required for a standard CI assessment for someone of the same age and time from referral to surgery took 9 months instead of 2 or 3 months. Appointments involved specialist play therapy, clinical psychology, cross-specialty joint appointments and a great deal of liaison. The hospital admission was adjusted from standard protocol to meet his needs. The child needed bilateral tympanoplasty and CI surgery. This would normally be staged over 3 surgeries over 6-12 months. Instead, we planned bilateral tympanoplasty and unilateral CI in one surgery as this might have been the only opportunity available.

Conclusion: With extremely detailed planning and preparation, allowing a lot more time than normal on the day of surgery, surgery went ahead as planned. The child is gaining significant benefit from his CI and, when he is calm, he is considering having the second stage surgery - a CI for his contralateral ear. However he still has significant underlying anxiety which resurfaces with any unexpected potential ear-related problem that could potentially result in a need for surgery.

Difficulties in cochlear implantation in children with Di George syndrome

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Di George syndrome is a rare congenital malformation. The syndrome is caused by the deletion of a segment of chromosome 22. The symptoms include hearing loss, congenital heart problems and usually multiple other associated conditions. The aim of the study was to show the surgical technique used for cochlear implantation in two patients with Di George syndrome and discuss the results obtained after surgical treatment.

Material and Methods: Two patients with Di George syndrome were qualified for CI treatment because of the bilateral sensorineural hearing loss and no effect with hearing aids. They presented complex inner ear malformations with cochlear dysplasia and congenital heart failure. In both cases the technique of cochlear implantation was facial recess.

Results and conclusions: The operations went without complications. We did not observe also late complications. After intensive rehabilitation we achieved satisfactory hearing results in both children.

The results of cochlear implant surgery in young patients with middle and inner ear malformation in Di George syndrome are good. In each case of this syndrome one should take care of associated conditions, including congenital heart failure. One should be also prepared for problems associated with complex anatomy during the operation.

Cochlear Implant in cochlear hypoplasia

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Objectives: To verify the effectiveness of the Cochlear Implantation in a patient with bilateral cochlear malformation with hypoplasia and dehiscence of superior semicircular canals.

Results: Male, 77 years old, attended to the Cochlear Implant Clinic with a progressive hearing loss 10 years ago that worsening on the last 3 years, without benefit with Hearing Aids. He presented bilateral profound sensorineural hearing loss with 112, 5 dBNA average to the right ear and 102,5dBNA to the left ear. Speech perception tests was 32% for trisyllables.

Cochlear Implant (CI) was performed on the right ear. The CT scan of the ears revealed bilateral cochlear hypoplasia and bilateral superior semicircular canal dehiscence.

Magnetic Resonance Imaging confirmed the cochlear hypoplasia with reduction of the apical part of the cochlea bilaterally. We choose the Med-el device with Form electrode to avoid the intraoperative gushing

After 3 months of surgery the patient already detects sounds and recognizes the sounds of the language and the audiometric average with CI is 45dBNA.

Conclusion: The field of cochlear implant surgery is growing fast, improving the Ci device quality, minimally invasive surgical techniques, staff training and electrodes to specific cochlear pathologies.

Cochlear malformation and dehiscence of semicircular superior canals does not contraindicate cochlear implant surgery and some specific electrode avoid intraoperative gushing.

The triphasic pulses in CI fitting for patients with facial nerve stimulation: a case study

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The subject is a 33-year-old female with bilateral sensorineural deafness due to fractures of the skull base, temporal bones, and facial bones when she was 19 years old (in 2003). In 2004 she was unilateral implanted with a MED-EL C40 cochlear implant. In 2013 she was reimplanted with a MED-EL CONCERTO cochlear implant.

The HDCIS strategy with standard biphasic pulses and pulse duration extended up to 100–120 ms, and Maplow compression = 2000 were initially used. Three channels (10, 11, and 12) were disabled due to high impedance. Two channels (3 and 9) were disabled due to the absence of auditory perception.

She reported the complaints about the low volume of the external sound, her own voice, and poor speech intelligibility. Increasing the MCL in the enabled channels was not possible due to facial nerve stimulation.

The application of triphasic pulse stimulation allowed for a significant increase in the pulse amplitude without stimulating the facial nerve, and as such, it was possible to reach loud subjective levels, activate channel 3, and achieve a satisfactory auditory sensation.

Increasing the interphase gap for triphasic pulses from the standard 2.1 ms to 10 or 20 ms led to a further increase in volume, but dramatically reduced the rate of stimulation. At a 30 ms interphase gap, she assessed the sound as indistinct and unclear.

Volume categorization, phoneme intelligibility, and disyllabic word intelligibility measurements were made across the following conditions: (i) biphasic stimulation: VC = very quiet, PI = 25%, DWI = 23%; (ii) triphasic stimulation with a 2.1 ms interphase gap: VC = medium-loud, PI = 27%, DWI = 30%; (iii) triphasic stimulation with a 10 ms interphase gap: VC = comfortably loud, PI = 30%, DWI = 33%; and (iv) triphasic stimulation with a 20 ms gap: VC = comfortably loud, PI = 30%, DWI = 28%.

During follow-up the patient chose the fitting with triphasic stimulation and a 10 ms interphase gap. Speech intelligibility increased slightly.

Triphasic pulse stimulation is an effective fitting method for increasing volume perception and improving speech intelligibility without stimulating the facial nerve.

Intracranial hemorrhage after venous sinus thrombosis in cochlear implantation: a case report

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Objectives: Cochlear implantation is a safe surgical procedure with low complication rates. In particular intracranial complications are rare.

Material and Methods: We present a case of a patient with difficult anatomical conditions during cochlear implantation, which led to an injury of the sigmoid sinus. Thrombosis and intracerebral haemorrhage followed.

Results and Conclusion: Diagnostic steps as well as treatment of these complications are explained in this case report.

The CT prevalence of cochlear-facial dehiscence: implication for cochlear implantation

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Objectives: The close anatomic relationship between the cochlea and the labyrinthine segment of the facial nerve represent both a potential hazard during cochlear implantation. The purpose of this study was to identify the prevalence of cochlear-facial dehiscence (CFD) in the CT scan.

Materials and methods: Retrospective analysis for temporal bone CT with the same collimation was performed in 57 patients to evaluate the relationship of the cochlea and the labyrinthine segment of facial nerve canal. The nearest distance between basal turn of cochlea and labyrinthine segment of fallopian canal for all of axial, coronal, Stenver, and Poschl planes were measured using Hounsfield unit value and electronic calipers.

Results: Total 10 of 90 ears (11.1%) were found to be a cochlear-facial dehiscence one of four planes: 3 (3.33%) for axial; 3 (3.33%) for coronal; 8 (8.89%) for Stenver; 2 (2.22%) for Poschl plane. None of the ears appeared to have dehiscence on all four planes. The length of CFD ranged from 0.1 to 0.6 mm (0.356 ± 0.15 mm).

Conclusion: The radiologic prevalence of CFD was 11.1%, which was much higher than the histologic prevalence of 0.6%, but it was similar to the rate of facial nerve stimulation following the cochlear implantation.

Facial nerve stimulation in narrow bony cochlear nerve canal after cochlear implantation

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Background: Facial nerve stimulation (FNS) is a well-known complication of cochlear implant (CI) restricting optimal use of the device. It was reported to be associated with various anomalies of cochlea or otosclerosis. In the same context, recently spotlighted narrow bony cochlear nerve canal (BCNC) could be a possible cause of FNS possibly by elevating the stimulating current level and finally result in leaking current to elicit FNS. The aim of this study was to evaluate the correlation between narrow BCNC and FNS after CI to predict the risk of FNS preoperatively and to see its underlying mechanisms.

Methods: A total of 64 cases who underwent CI in Seoul National University from 1998 to 2013 were included for this study. Only pediatric patients were included and all cases of inner ear anomaly or otosclerosis were excluded. Among them, 32 cases experienced facial nerve stimulation after CI and another 35 cases were selected from our total cohort of 817 pediatric cases by stratified random sampling for age and gender. The width of BCNC, T-levels, C-levels were compared between groups. Strategies for eliminating the FNS and their results including CAP scores were also analyzed.

Results: The FNS group had significantly narrow BCNC (1.06 ± 0.51 mm) over control group (2.00 ± 0.59 mm, $p<0.01$). The FNS group also recorded significantly higher T-level (168.5 ± 28.7 μA) and C-level (201.0 ± 26.9 μA) over control group (T-level: 141.7 ± 21.4 μA, $p<0.01$, C-level: 188.9 ± 21.7 μA, $p=0.043$). T-level showed significantly negative correlation with the width of BCNC ($R=-0.372$, $p=0.001$, Pearson's correlation test). If the cases were divided into normal BCNC (≥1.4 mm) and narrow BCNC (<1.4 mm) group by definition, cases with FNS had significantly narrower BCNC ($p<0.01$), higher T- ($p=0.007$) and C-level ($p=0.033$) only for normal BCNC group. The immediate onset group (0.74 mm, 42.9%, prior to the completion of initial mapping) had significantly narrow BCNC width over late onset group (0.91 mm, $p=0.134$). Adjustment of C-levels and/or pulse width, switching off offending electrodes was tried for eliminating FNS. Successful elimination was achieved in 71.4% of cases. FNS group showed significantly low CAP scores (3.00 ± 1.90) over control group (5.94 ± 1.41, $p<0.01$) after adjustment.

Conclusion: A narrow BCNC could be a cause of FNS after CI. Therefore, careful selection of the side for CI and programing strategies are required for reducing FNS.

Cochlear implantation in otosclerosis: usefulness of intraoperative NRT and EABR monitoring for programming to prevent facial nerve stimulation

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Facial nerve stimulation is one of well-known complications in surgery of cochlear implantation in advanced cochlear otosclerosis. Here we present a case where intraoperative NRT and EABR was useful for programming to prevent facial nerve stimulation. The patient, who was post-lingually deafened and diagnosed with advanced cochlear otosclerosis, received a cochlear implant in his left ear at the age of forty-five. Four years after the implantation he experienced facial nerve stimulation on his left face (implanted side) by use of the implant and he was not able to make full use of the electrode contacts due to facial spasm. As any modifications of programming did not help improving his word perception, he was referred to our Hospital at the age of sixty-seven. A preoperative computed tomography demonstrated otosclerosis involved the otic capsule and we diagnosed the right side with otosclerosis type 2c (double ring and narrowed basal turn) (Rotteveel et al., 2004). Pure tone audiogram showed he was totally deaf. After we obtained informed consent from the patient that cochlear implantation in otosclerosis would be technically demanding and would not be always satisfactory as it may elicit facial nerve stimulation, we implanted Cochlear® CI512 Contour Advance® electrode in his right ear. Facial nerve was stimulated by electrode contacts 10 – 15 in intraoperative neural response telemetry (NRT), and by electrode contacts 11 – 12 in intraoperative EABR monitoring. Two weeks after the operation we programmed his right cochlear implant by elevating current levels to the point where facial nerve would not be stimulated referring to the thresholds at which facial nerve was stimulated intraoperatively. He made full use of electrode contacts and his word recognition score increased from 15% preoperatively to 65% three months after implantation. In conclusion, intraoperative NRT and EABR monitoring was useful for mapping a cochlear implant to avoid potential facial nerve stimulation in advanced otosclerosis.

Benign paroxysmal positional vertigo secondary to cochlear implantation - how is different?

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Objective: Benign paroxysmal positional vertigo (BPPV) is the most common vestibular disorder and may account for up to one-third of vertigo presentations to dizziness clinics. The aim of this study is to compare and to emphasise the features of BPPV secondary to cochlear implant

(CI) surgery with those of BPPV secondary to other aetiologies and to review the literature.

Material and Methods: We present a retrospective study based on medical record review on a cohort of adults undergoing bilateral CI. The study included 33 consecutive patients who underwent vestibular evaluation before and after CI surgery (caloric test, head impulse test, cervical and ocular vestibular evoked myogenic potentials - cVEMP and oVEMP).

Results and Conclusions: BPPV occurred in 2 patients (on the cochleostomy side). The onset occurred before activation in one patient and 2 days after in the other one, but in 30 days frame from surgery in both cases. In the control group we did not find vestibular complains after the surgery, but we found, in most of the control cases, that cVEMP responses were absent. The absence of cVEMP responses was found also in both patients with BPPV. The repositioning manoeuvres were effective in both patients, with no recurrence so far. In each of our BPPV patients a mild feeling of imbalance persisted for several days after the repositioning manoeuvres, which can be considered secondary to trauma insertion of the electrode through cochleostomy. To consider the diagnosis of BPPV secondary to CI surgery, the onset of symptoms has to be in a frame of maximum 30 days after the surgery - after this period the otoliths being phagocytise by the dark cells - there will be no more particles left to trigger the BPPV. In patients with BPPV secondary to CI surgery the symptoms are slightly different from the classic presentation do to the superposition of the utricular damage (cVEMP absent) that appears to be secondary to electrode insertion through cochleostomy.

The effect of rehabilitation before cochlear implant on auditory and speech performance of children after cochlear implant

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Introduction: Cochlear implant is a continuous process in hearing impaired children, of which an important part is preoperative rehabilitation. The purpose of this study is to evaluate the importance of preoperative rehabilitation in acquiring post-operative hearing and speech skills.

Materials and Methods: A total of 47 children was evaluated from cochlear implant center at Loghman Hospital. Based on the parents' data from the history of rehabilitation, the children were divided into two groups with continuous (n= 30) and discontinuous (n= 17) rehabilitations. scores were assessed on the 5 scales of MAIS, MUSS, CAP, SIR, and APCEI at device delivery, 3, 6 and 9 month after Cochlear Implant. Data were analyzed by descriptive methods, repeated measurements, and visual analysis.

Results: The scores of both groups showed upward trends with statistically significant differences. Children with continuous and appropriate rehabilitation obtained higher mean scores than those with inadequate and discontinued rehabilitation. The difference between the mean scores of the two groups was not statistically significant.

Conclusion: This study showed that rehabilitation before Cochlear Implant can affect the performance of children. Accordingly, factors such as the type and extent of rehabilitation, assessment method and age of Cochlear Implant deserve further investigations. The results of this study can be effective in making decisions and drawing the attention of cochlear implant teams in both pre- and postoperative rehabilitations.

Efficacy of parent-child interaction therapy on anxiety symptoms in cochlear implanted deaf children

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Introduction: The aim of this study was to investigate the effectiveness of parent-child interaction therapy on the anxiety symptoms of cochlear implanted deaf children.

Materials and Methods: This is an experimental study designed as pretest-posttest with control group in the form of random assignment to two experimental and control groups. The statistical population of the present study included deaf children aged 7 to 11 years old with cochlear implants referring to Tehran cochlear implantation centers in 2017. Among these centers, the Pejvak auditory-verbal rehabilitation center was selected by cluster sampling. The subjects were sampled among the referents with required characteristics through a targeted method. The deaf children (n= 30) with implanted cochlea were randomly divided into two experimental (n= 15) and control (n = 15) groups. The parents of these children completed the Achenbach questionnaire/parent form (CBCL) and anxiety subscale. Data were analyzed by covariance test.

Results: Comparing the mean values of the experimental and control groups showed that average anxiety symptoms in the experimental group decreased significantly compared to the control group in the post-test.

Conclusion: Based on the results of this study, it can be concluded that parent-child interaction therapy has an effect on the anxiety symptoms of cochlear implanted deaf children.

Vestibular disorders in children with chronic suppurative otitits media

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Background: Study of vestibular function in children with chronic suppurative otitis media.

Material and methods: 139 children in age from 7 to 18 years suffering from different forms of chronic suppurative otitis media (CSOM). Examination methods include study of equilibrium function with simple and sensibilized Romberg's test; coordination finger-to-nose test and past-pointing test, and pneumatic (pressure) test; visual evaluation of spontaneous nystagmus (Frenzel goggles+20 diopters) ad with electronystagmographia (ENG); caloric test. ENG was performed at each study of vestibular function in a patient by early afternoon without administration of drugs during a day or longer.

Results: 81 children at stage of acute exacerbation of CSOM complained about "dizziness", but could provide clear definition, and follow-up questions help to clarify that it were sporadical staggering, slight instability, "light in the head", darkening of vision when the body position is changed. These signs where short-termed and disappeared without intervention. At stage of CSOM remission patients periodically reported about the same problems, which allowed diagnosing vegetative dystonia syndrome after vegetative nervous system study. Detailed vestibulogical study performed in 98 patients of elder age group didn't detect significant changes of vestibular function. All analyzed parameters of electronystagmogram were within limits of physiological dispersion of parameters that may vary within interval ±20%. We didn't register vestibular hypo- or hyperfunction in any case.

Conclusion: According to the study outcomes specificity of CSOM in children is in the fact that as distinct from adult patients children almost don't have systemic dizziness in cases without intracranial complications.

On-line service to support patients after cochlear implantation

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The main problem in providing quality and affordable rehabilitation in Russia are: the length of the country, the lack of rehabilitation centres and experts, their distance from each other and dispersed patients. One of the important techniques of quality improvement and optimization of rehabilitation after cochlear implantation is remote assistance and support.

At the present time in Russia developed and implemented in the rehabilitation process online service to communicate patient after cochlear implantation and specialist. The product allows you to remotely communicate with the patient and his entourage, including the report of the specialized information and multimedia materials, including rehabilitation programmes, complementing the real interaction with real people.

Online service for patients after cochlear implantation includes:
1. Access to information materials for the rehabilitation
2. Online appointment for consultation to a specialist
3. The lesson plan with the child after the CI for each day
4. Search for rehabilitation specialist in your area
5. Online video consultation with a specialist at CI
6. Testing hearing
7. Maintaining the vocabulary
8. Interactive games for the development of hearing and speech

We believe the results of the work online service for patients with CI in the framework of the remote support are as follows: the increase of rehabilitation potential users of cochlear implant systems; greater coverage, long-term and in-depth regions; provide technical service for remote support; development of new methods and techniques of remote online service: for patients and families for professionals.

Pre-school musical training in congenital hearing loss: cognitive and motor benefits

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Current evidence suggests that hearing-impaired (HI) children who receive hearing devices early in their life and are included in a high-quality training program can develop the necessary skills to access mainstream education. Nevertheless, HI children still appear to lag behind their normal-hearing peers in terms of linguistic, cognitive, and motor skills, while no consensus has been reached among scholars regarding the real advantage offered by habilitative programs available for CHL. Recent studies highlight that musical training can improve various cognitive ability in both typically developing and HI children, although neuro-cognitive and motor improvements in HI toddlers using hearing devices is still an under researched topic.

In order to explore the benefits of a well-structured musical training program on various neuropsychological domains, we conducted a pilot study involving three children (age: 35-44 months) with isolated CHL of moderate to severe degree. The musical training program included two training sessions, for a total of 20 lessons each, administered over a period of six months, with a two-month break in between. Musical activities involved listening, linguistic production, and music-making exercises, specifically designed to combine cognitive, motor, and linguistic skills.

Neuropsychological assessment was carried out before and after each session, and six months after the end of the program, to evaluate its effects over time. All three children showed neuropsychological improvements and consolidated acquisition, with highest scores achieved in motor sequence, memory for designs, and visual attention tests. Indirect evaluation of musical skills yielded similarly positive results.

Outcomes are discussed in terms of clinical and educational perspectives in the developmental trajectory of HI children.

Rehabilitation of patients with Mondini malformation and auditory neuropathy after cochlear implantation

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Objectives : The aim of this study is to analyze the features observed in the rehabilitation of participants with Mondini malformation (MM) and auditory neuropathy (AN) after cochlear implantation (CI).

Methods: In this study, 27 patients participated, from 2 to 6 years. In 10 participants AN was diagnosed, in 7 participants - MM, and the remaining 10 patients had sensorineural hearing loss (SH). All participants received CI in one ear. The EARS battery, LittleEARs questionnaire, phoneme recognition and articulatory tests were used to assess the auditory and speech progress of these participants. The participants were examined in three stages: the first fitting speech processor (SP) CI, 6 months after the first fitting, 12 months after the first fitting SP CI.

Results: In the first fitting SP 20% of participants with AN and 71% of participants with MM had a significantly higher level of electrical stimuli in the CI SP, compared to participants with SH.

Six months after connecting the speech processor, 20% of patients with AN also had higher levels of tonal thresholds in the free field. All participants developed the ability to recognize speech sounds.

Twelve months after the connection of the CI processor in 60% of participants with AH and 71% of participants with MM, the auditory development was consistent with the group of participants with SH. 40% of patients with AN and MM had problems with the discrimination of acoustically similar phonemes, mainly with speech sounds. They were also limited in their abilities to recognize speech by hearing and for poorer phoneme pronunciations.

Conclusion: It is important to recognize that the AH and MM CI users are not a homogeneous group. For effective rehabilitation of children with AN and MM, the interaction between the speech therapist and the audiologist is very important, especially when fitting SP CI and choosing the best approaches to speech therapy.

Poster Session 8

The survey of defect for extracorporeal cochlear implant

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Objectives: In JAPAN, basically CIs are used for both side of heavy sensorineural hearing loss, so the condition of CI devices is directly connected to hearing ability. Especially for the patients of stable map, we can regard hearing ability as device management. Now, we tried the survey of defect for extracorporeal CI which is influenced by usual life environment.

Material and Methods: In our hospital, we have 65 CI ears which include 11 one side operated ears and 27 both side operated ears. The CI manufactures are Advanced Bionics, Cochlear and Medel. About ages of operation, under 12 years old are 35 CI ears, under 70 years old are 15 CI years, and over 71 years old are 15 CI years.

We request the correspondence to the manufactures, when we find out malfunction of CI and we suspect the defect of CI.

The period is Jan 2011 to Apr 2017. In this term, we have 3000 CI devises month.1 month average are 40 CI devises per month.

Results and Conclusions: In the term, the number of malfunctions of CI are 202. It means 8 malfunctions are occurred per 10 CI devises per year. The season of malfunction are showed often on Aug ,and really May. It may be caused by Japanese humidity. There is no significant difference of the rate of malfunction between the ages. About the length of post-operation, the rate of malfunctions is increasing between 2000 to 2500 days after operation. It is 5 years and half to 7 year ,so we guess that service life of CI devise are concerned. The final correspondence of the manufactures is 50% of only inspection. And about 50% of contamination, foreign material and disconnection, manufactures change the CI devises newly of half of that. And they clean up CI of half of that.

The electrical stimulation of the ear in the USSR in early 1930's

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Objectives: To introduce electrical stimulation experiments of the ear from 1933 to 1935 in the USSR as the early part of the cochlear implant history.

Introduction: This retrospective study reviewed four available manuscripts regarding electrical stimulation of the ear previously published in Russian, in the USSR Physiology Journal, and never introduced in English literature. The first published work revealed the initiation of electrical stimulation experiments in healthy subjects using direct and alternative currents Leon Orbeli, a disciple of the most famous physiologist in the USSR, Ivan Pavlov. Based on the experiments conducted by physiologists, using direct and alternative currents, this study described the following assumptions: 1) There arose mechanical vibrations in the ear during the flow of the current; 2) Neuronal elements received direct stimulations of the auditory organ during the flow of the current; 3) Stimulation of other neuronal elements (i.e. touch, temperature) in the middle or the inner ear gave rise to hearing sensations; 4) The mechanical vibrations originating in some parts of alternative currents could stimulate the auditory organ.

Further experiments were performed by direct and alternative currents to test the above mention assumptions among three experimental groups: healthy subjects, patients with the affected middle ear and affected inner ear pathologies. These studies further confirmed that there were direct electrical stimulations of the inner ear neuronal elements.

Conclusion: When the USSR physiologists started their electrical stimulation experiments on healthy and deaf patients decades earlier, they were unaware of the implications of their research on those with hearing impairments, although they did indicate about the possibility of interest of their scientific contributions to the field of Otolaryngology.

Adults with cochlear implants – life quality and rehabilitation results after implantation

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Objectives: Cochlear implantation (CI) is a standard treatment method in case of severe to profound hearing loss in adult. The most important topics in cochlear implantation are surgery and other technical aspects, but more often the quality of life is discussed at an international level. Our goal was to find, how the implantation influenced the life of our patients.

Materials and methods: Until the end of 2017 in SPSKM clinics we had 73 adult patients with CI (Cochlear Ltd.). Each patient was implanted with one of the following implants: CI24R (CA), CI24R (ST), CI24RE (CA), CI24M, CI512 or CI522. In December 2017 we have sent the questionnaire prepared by ourselves to all patients from our database, to assess their activity and quality of life after surgery. The questionnaire contains questions concerning e.g.: demographic and epidemiological data, professional activity, hobby, social contacts, rehabilitation aspects and self - perception

Results: Among 73 patients, we have 29 male and 44 female patients. The average age was 48,7 (min 18, max 81). Patients are CI users from average 6,3 years (min 1 month, max 14 years). On the day of sending this abstract, we have 10 questionnaires received back. We expect a response rate near 50%. All 10 questionnaires present better self-assessment of patients after the implantation in comparison to situation before the surgery. We can also observe a strong benefits of CI relating to patient's relationship.

Conclusion: First collected data show that cochlear implantation has a big influence on patients' life quality and relationships. After collection of rest questionnaires we can provide more detailed data about patients' life, habits and daily barriers.

Cost-effectiveness of simultaneous cochlear implantation in South Korea

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Objectives: It is well established that profound deafness in childhood affects the development of auditory speech perception, speech production, and language skills. There are many studies showing that the earlier the cochlear implantation surgery, the better the hearing outcome. Purpose of this study is to compare the non-device-related costs of bilateral simultaneous cochlear implantation (BSiCI) vs, sequential cochlear implantation (SeqCI) in South Korea.

Materials and Methods used: This is a retrospective study of 19 patients who underwent bilateral cochlear implantations at a tertiary care facility. Ten patients with BSiCI and nine patients with SeqCI were included. We reviewed data for the total operation room time, surgical time, and direct costs associated with the operation and immediate in hospital post-operative period.

Results: The 1st, 2nd and cumulative total operation room time for the SeqCI group were 201, 175 and 376 minutes, respectively, on the average. The 1st, 2nd and cumulative surgical time for the SeqCI group were 171, 145 and 316 minutes, respectively. The 1st, 2nd and cumulative costs associated with operation and hospitalization were $2181, $2051 and $4233, respectively. For the BSiCI group, the total operation room time surgical time and direct costs were 223, 193 minutes and $2600, respectively. On the whole, the total operation room time, surgical time and direct costs of the BSiCI group were less than those of SeqCI group.

Conclusion: The total operation room time, surgical time and direct costs of BSiCI were less than those of SeqCI. Simultaneous cochlear implantation can lead to a potential saving of operation time and direct costs compared to sequential implantation in South Korea.

Management of cochlear implant patients requiring mri scanning: developing protocols to insure safety and effeciency

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MRI scans are widely utilized in medicine for the diagnosis of a broad range of disorders throughout the body. With the prevalence of MRI use, it is almost certain that cochlear implant patients will receive an MRI scan at some time during their life. Different implant companies have significantly different protocols for performing MRI scans on patients with cochlear implants. Options for some devices include magnet removal, wrapping the head over the implant tightly, and for newer generation MedEl devices, scanning the patient without any additional interventions. The variation in devices both by manufacturer and generation of cochlear implant make it difficult for radiology teams to determine the optimal protocol when scanning patients, especially in environments where the imaging center is not associated with an established implant center. This potentially leads to complications such as magnet displacement and pain during the MRI scan and additional costs due to rescheduled or incomplete imaging. Our cochlear implant clinic in partnership with radiologists have developed protocols to ensure patients' device is properly identified and prepared for safe MRI scans. These protocols also allow device identification and communication with remote radiology locations. Importantly, implant teams should discuss the current state of MRI compatibility with patients to ensure that these factors are taking into account when choosing a device. We will discuss work flows that we have developed to improve management of MRI scanning in patients with cochlear implants.

Problems of magnetic resonance imaging in patients with cochlea implants

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Introduction: Quality of life is closely linked to our physical health. Many studies have shown that hearing loss, whether uni- or bilateral, is often associated with loneliness and social isolation. Thus, in the field of hearing rehabilitation, cochlea implants (CI)have increasingly gained importance. However, not only rehabilitation but also prevention plays an important role in achieving best health standards. Magnetic resonance imaging (MRI) is increasingly used for medical investigations concerning physiological and pathological processes in both prevention and therapy of many diseases. The purpose of this study was to illustrate potential challenges in performing MRI scans on CI implanted patients.

Material and methods used: The data base of the division of otology and neurotology of the department of oto-rhino-laryngology at the university hospital of Heidelberg was scanned for patients that were implanted in our center and presented with medical condition of dislocation of the magnet. Our collective contained five patients that presented with that medical condition after going through MRI scan during a twelve month period.

Results: Of the five patients four were female and one was male. One was implanted on both sides whereas the others had unilateral implantation. All of them were implanted with devices from the "Cochlear" company. Two of them had MRI scan of the spinal colum and three got MRI scan of the neurocranium as part of neurologic diagnostic work-up of vertigo. Four out of five had a bandage wrapped around their head according to manufacturer's recommendations during the scan. These recommendations had been either supplied to the radiologists or have been given to them by the patients before the MRI scan. All five patients presented with headache, pain, sore skin and foreign body sensation in the area of the CI. Clinical examination and CT scans showed dislocation of the respective magnets in all five patients. All patients had to be taken to the OP for an open repositioning procedure.

Conclusion: We see a correlation between MRI scans and dislocation of the CI magnet. All of the five patients that presented in a twelve month period with a dislocation of the magnet have had recent MRI scans. Using the recommended wrapped head bandage did not prevent dislocation. CI and MRI seems to be a potential issue that remains to be solved suffic

Genetic predisposition of adult-onset and down-sloping sensorineural hearing loss

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Objective: Hereditary hearing loss is genetically very heterogeneous. Although congenital hearing loss is likely to be caused by genetic disposing factors, it is hard to distinguish inherited cases from non-inherited cases in sporadic hearing loss. Herein, we delineated the genetic inheritance in the cases of late-onset and down-sloping sensorineural hearing loss. Subjects and methods: Among the Korean adults (ranging from 20 to 60 years-old) with bilateral down-sloping non-syndromic sensorineural hearing loss (defined as patients with auditory thresholds at 1, 2, and 4 kHz more than 60dB HL and thresholds at 250 and 500 Hz less than 40 dB HL), subjects were enrolled if the onset of hearing loss was from 20 to 50 years-old-age. In temporal bone CT scan and MRI, there was no inner ear anomaly. Whole exome sequencing (WES) was performed to reveal the genetic variations associated with late-onset and down-sloping hearing loss. Results: Of the 18 unrelated families included in this study, genetic variations were identified in 5 probands. All subjects were negative of mutations in SLC26A4 and GJB2. According to the variation calling pipeline, we screened 182 known genes

causing inherited hearing loss including syndromic and/or non-syndromic patterns. As a result, missense mutations were identified in several candidate genes including MYH9, MYH14, and COL11A2. Conclusion: Genetic causes were identified in a relatively high proportion of patients showing adult-onset and progressive hearing loss with a down-sloping pattern which may be commonly ascribed to age-related or noise-induced hearing loss. Identification of the genetic cause of hearing loss in these patients may be used in counseling about the prognosis of cochlear implantation in those who progress to severe to profound hearing loss.

Cochlear implantation in patients suffering from Neurofibromatosis type 2

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Summary: From 2010 to 2017 12 patients suffering from Neurofibromatosis type 2 (NF2) underwent the resection of cerebelloangular schwannoma and the standard cochlear implantaion. These patients lost their hearing on the side of the surgery as the consequence of the tumor growth or following the surgery. In all cases the VIII nerve was preserved. Only two patients benefit from the cochlear implantation. In time the hearing results in these two patients are observed to drop down, undoubtedly as the consequence of the NF2 progression.

Material&Method: 12 patients (8 female, 4 male) suffering from NF2 lost their hearing previously or following the surgery of tumor resection. They were implanted with cochlear implant and were fitted in standard procedure. Patients were assessed using behavioral tests: by speech therapist and audiological tests – Free Field Tone and Speech Audiometry.

Outcomes: Only one female patient benefit from the cochlear system at the comparable level as other usual CI users. 1 patient achieved the level of sound detection and basic discrimination, 2 patients reported to hear something (reactions to the real sound hardly to observe), in 6 patients there are no effects of implantation.

Conclusions: Cochlear implantation in NF2 patients is not a standard procedure. It's hard to predict the results of the CI surgery in these patients. This disease has the progressive character and causes the deterioration of the patient's condition in general.

Hearing results in idiopathic sudden sensorineural hearing loss patients with combined intratympanic and systemic steroid therapy

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Background and Objectives : Idiopathic sudden sensorineural hearing loss(ISSNHR) is defined as a rapid decline in hearing for 3 days or less affecting 3 or more frequencies by 30dB or more without any identifiable causes. Hearing outcomes and prognostic factors of ISSNHL were investigated in patients who underwent com¬bined intratympanic and systemic steroid therapy.

Materials and Methods : This study was performed by retrospective chart review. Clinical outcomes and prognostic factors (age, sex, hearing threshold, type of audiogram, vertigo, tinnitus, social and medical history) were evaluated in 147 patients who received intratympanic steroid plus systemic steroid therapy.

Results : Complete hearing recovery was achieved in 36.7% (n=54) of the patients, partial recovery in 12.9% (n=19), slight recovery in 12.3% (n=18), and total recovery in 61.9% (n=91). Age was identified as an independent, negative prognostic factor for hearing recovery. The re¬covery rates of the down sloping and profound types were poorer than those of the up sloping type as determined by audiogram.

Conclusion : The results of this study suggest that the combined treatment of intratympanic and systemic steroids for ISSNHL results in high hearing recovery rates, and that the down-sloping and profound types of audiogram patterns and age are negative prognostic fac¬tors.

Osteogenesis imperfecta – analysis of the phenotypes and intraoperative changes observed during surgical procedures among patients treated at the Institute of Physiology and Pathology of Hearing

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Introduction: Osteogenesis imperfecta is a systemic connective tissue disease that affects many systems and organs. It results in a characteristic disease picture. Bone deformities, blue sclera, changes in the teeth may co-exist with hearing loss. Osteogenesis imperfecta affects the structures of the ear. In half of the patients, auditory ossicles are changed, and it is manifested by hearing loss. The most typical malformations relate to stapes. However, the degree of malformation within the middle ear is varied.

Objectives: The aim of the study is to characterise the phenotype and surgical findings among Osteogenesis imperfecta patients with hearing loss.

Material and methods: Retrospective analysis of 21 patients treated in Institute of Physiology and Pathology of Hearing due to hearing loss. 19 underwent surgeries of the ear. Phenotype and surgical findings were analysed.

Results: Type I was the most common Osteogenesis imperfecta type. All of the patients had blue sclrea, ½ had hypermobility of joints, 1/3 flexible skin and dentinogenesis. We noted 3 patients with III type- progresively deforming. The most frequent findings during surgery werefixation of stapes footplate, thickened plate up to 2-3mm, plate fragility, stapes footplate obliteration, fracture of the branches of stapes, heavy bleeding from the hypertrophied lining of the tympanic cavity.

Conclusions: The more severe type of Osteogenesis imperfecta, the greater the risk of significant malformation within the middle ear. These patients have a higher risk of reoperation and intraoperative complications such as abundant intraoperative bleeding.

Clinical and temporal characteristics of cochlear implant surgeries performed at a tertiary care center

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Cochlear implant surgery has emerged as a promise in rehabilitation of profound hearing loss, and since the first surgery in 1961 performed by William House in Los Angeles, thousands of patients have profited from this technology around the world.

The CDA (Hearing Impairement Center - Federal University of São Paulo) is a tertiary health care center for rehabilitation of patients with various degrees of hearing loss, also responsible for cochlear implant surgery, when indicated.

Objective: To identify the main clinical characteristics of the hearing loss among candidates for cochlear implantation, as well as the time between the first medical appointment and the surgery.

Methods: Patients that underwent cochlear implantation surgery between 2005 and 2017 had their data collected, regarding clinical features of hearing loss, date of first ENT medical appointment, date of surgery and age at surgical intervention.

Results: There were 186 cochlear implant surgeries performed in patients aged 1 to 66 years. The most frequent clinical features of profound sensorineural hearing loss were congenital, meningitis related loss, genetic, and progressive. Among the children, the congenital hearing loss appeared as main condition, and progressive loss was more prevalent among the adults. The mean time between the first appointment and the surgery was 25.6 months. When considered the group "children", this time fell to 19 months. Regarding meningitis, which requires agility in the decision by cochlear implant, the overall average time elapsed between the first care and the surgery was 26.6 months; among children 15.1 months and in the adults group 32.8 months.

Conclusion: The most frequent clinical features that led to cochlear implantation were congenital hearing loss, followed by hearing loss related to meningitis and genetic loss. The interval until cochlear implantation is still long, with an average of 25.6 months, however the priorities regarding the children were observed.

Saturday 30 June 2018

Keynote Lectures

New challenges for cochlear implant strategies

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Sound coding strategies represent the process of determining where and how electrical stimulation is provided in the cochlea in response to an input audio signal. Traditionally, they have been optimized for speech understanding in quiet environments with a single implant. Fortunately, speech information is highly redundant, allowing implant users to understand speech in quiet despite the distortions involved in a cochlear implant system. However, in more challenging situations such as understanding speech in the presence of background noise or listening to music, the redundancy of the information provided to an implant user may be reduced or eliminated. As a result, performance in these situations are much more difficult for cochlear implant users.

A relatively new development in cochlear implantation is that users are often not listening to the world with a single cochlear implant. Many are bilaterally implanted or have residual ipsilateral or contralateral hearing. Several studies have demonstrated the advantages of listening with a second implant or a combination of acoustic and electric hearing. Presumably much of this advantage comes from adding additional information from the additional inputs. However, in these situations, each of the inputs (implants, hearing aids, or even a normal ear) can provide conflicting information in terms of place of stimulation, spectral shape, and timing. It is therefore important to redesign strategies and fitting protocols to account for bilateral implantation and combinations of electric and acoustic hearing.

In the present talk, we will discuss some of the distortions provided by sound coding strategies in both the unilateral implant (without acoustic hearing) situation as well as the distortions provided by bilateral, bimodal, hybrid, and single sided deafened implantation situations. Additionally, we will discuss potential methods for addressing these problems.

Cochlear Implantation in Congenital SSD

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Cochlear Implantation is an accepted treatment modality in bilateral congenital and acquired deafness. Within the last ten years there is an increasing number of patients with unilateral deafness or single-sided deafness (SSD) that receive cochlear implants for auditory rehabilitation. Initially, Paul van de Heyning proposed cochlear implants as treatment for tinnitus in patients with SSD. As a side-effect he noticed a remarkable improvement of auditory abilities like localization and speech understanding in noise. And in fact, patients with SSD suffer from significant limitations in everyday situations although they have normal hearing on the other ear. These limitations in speech understanding in noise and reduced localization abilities increase the hearing effort and reduce quality of life. From a conventional point of view, hearing rehabilitation in SSD is possible with classic CROS solutions or bone-anchored hearing aids but these can only overcome the head-shadow effect. A true binaural hearing rehabilitation is only achieved by electrical stimulation of the deaf ear. Auditory rehabilitation in children with SSD is still under debate. Although first encouraging results show the same effects like in adults, especially the treatment of congenital unilateral deafness is still discussed. The optimal time course for cochlear implantation is still unclear and more results are necessary to fully understand the requirements of the developing auditory system. Nevertheless, studies of sequential bilateral cochlear implantation show that after a 1 year delay between first and second implant, the brainstem will not be able to catch up with the first implant. It seems safe to assume the same principles are true for children with a maximum of asymmetry. Therefore, early diagnostics and treatment will be the future key for successful auditory rehabilitation in congenital SSD children.

Main Sessions

MS 47: Bilateral Cochlear Implantation

A multicenter randomized controlled trial on simulateneous versus sequential bilateral cochlear implantation - Long term longitudinal analyses on objective and subjective outcome measures and complications

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Introduction: The primary aim of this study was to longitudinally compare the objective and subjective outcomes of simultaneous bilateral cochlear implantation (simBiCI) to sequential BiCI (seqBiCI) in adults with severe-to-profound postlingual SNHL.

Methods: This study is a multicenter randomized controlled trial with a 4-year follow-up period. Participants were allocated to receive bilateral cochlear implants (CIs) simultaneously (simBiCI group) or sequentially with an inter-implant interval of 2 years (UCI/seqBiCI group). The objective outcome measures were speech perception in noise from straight ahead, spatial speech perception in noise, localization and speech perception in silence. Subjective outcome measures encompassed questionnaires on quality of life (QoL), quality of hearing (QoH) and tinnitus.

Results: Nineteen participants were randomly allocated to the simBiCI group and 19 participants to the UCI/seqBiCI group. Three participants in the UCI/seqBiCI group decided not to proceed with their second implantation and were therefore unavailable for follow-up. The UCI/seqBiCI group performed significantly worse over time compared to the simBiCI group on spatial speech perception in noise in the best performing situation (8.70 dB [3.96 – 13.44], p<.001), and localization abilities (largest difference 60 degrees configuration:(-44.45% [-52.15 – -36.74], p<.0001). Furthermore, the UCI/seqBiCI group performed significantly worse over time on the TTO, all subdomains of the SSQ and the social interaction domain of the NCIQ. Yet, after receiving CI2, the UCI/seqBiCI group improved to the same level as the simBiCI participants on all of these outcomes.

Conclusion: After receiving CI2, the UCI/seqBiCI group improved to the level of the simBiCI group on all outcomes they performed worse on after UCI. Our results indicate that patients with one CI can benefit from binaural hearing provided by seqBiCI equally compared to patients who received two CIs simultaneously.

Predicting sequential bilateral cochlear implantation performance in postlingually deafened adults; a retrospective cohort study

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Objective: To identify which preoperative patient characteristics influence sequential bilateral cochlear implantation performance outcomes and to create a model that predicts benefit.

Methods: The data of 92 patients were included in a multicentre retrospective cohort study. All postlingually deafened adult patients who had undergone sequential cochlear implantations between January 1, 2000 and March 14, 2016 were included. Patients were excluded if the 12-month follow-up CNC phoneme score was missing.

We examined the effect of twenty preoperative factors on the maximum consonant-nucleus-consonant (CNC) phoneme score in quiet with the second cochlear implant (CI2) one year after implantation.

Results: Three factors were positively correlated to speech understanding with CI2: Wearing a hearing aid (HA) before receiving CI2 (r=0.45, p<0.00), the maximum CNC phoneme score with the first CI (CI1) (r=0.23, p=0.04) and the use of a HA before CI1 in the first implanted ear (r=0.25, p=0.02). Two factors were negatively correlated: The total duration of hearing loss before CI2 (r=-0.25, p=0.02) and preoperative pure tone audiometry (0.5, 1, 2kHz) before CI2 in the second implanted ear (r=-0.27,

p=0.01). The following model could be created: Predicted CNC phoneme score with CI2 (%) = 25 + (39 * hearing aid use before CI2 (yes)) – (0.25 * length of hearing loss before CI2 (yrs)) + (0.20 * maximum CNC phoneme score with CI1) (%)).

Conclusion: Using a hearing aid before receiving a second CI and a high level of speech understanding with the first CI predict a positive outcome for sequential cochlear implantation. A long duration of hearing loss before receiving a second CI predicts a negative outcome.

Assessing directional hearing in bilateral cochlear implant recipients using a two-talker localization task

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Auditory localization ability is commonly assessed in individual listeners by either asking them to identify the perceived direction of a stimulus or to discriminate the perceived direction of two stimuli presented successively. Here, a novel localization task is introduced that requires the subject to segregate as well as to localize two simultaneous talkers. This task is more challenging than common localization tasks and may address spatial auditory and cognitive processes that better reflect real world listening. Ten bilateral cochlear implant (CI) users were asked to localize short sentences spoken by either a single male or female talker or two simultaneously presented sentences spoken by a male and a female talker. The stimuli were presented randomly from 12 different directions at a sound pressure level of 60 dBSPL. Individual performance was measured for bilateral as well as for unilateral stimulation. Results revealed an average RMS localization error for unilateral stimulation of around 80 degees for both the single-talker and two-talker localization task, which basically reflected performance of guessing in all subjects. For bilateral stimulation, the average localization error reduced to 36 degrees for the single-talker localization task and to 55 degrees for the two-talker localization task. Bilateral results varied strongly across subjects, but showed a clear bilateral benefit for all subjects in the single-talker condition. The variation increased for the two-talker localization task, where some subjects showed similar performance as in the single-talker condition and others showed no bilateral benefit at all. The bilateral performance in the two-talker condition was significantly correlated with age, which may suggest that higher level processes are addressed such as spatial memory. Hence, the proposed two-talker localization task provides a promising method that may reflect spatial hearing outcomes with increased ecological relevance.

Sound localization in bilateral, unilateral and acutely-unilateral cochlear implant users

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Introduction: Cochlear implants (CIs) can partially restore hearing in patients with severe to profound hearing loss by providing direct electrical stimulation to the auditory nerve. There is increasing evidence of benefits on bilateral implantation over unilateral implantation in sound localization. Still, many of these studies define this benefit by comparing bilateral with unilateral fitting by switching off one of the two devices in the same bilaterally-implanted CI user. This approach creates an acute unilateral listening condition with which these CI users are unfamiliar. However, experienced unilateral CI users might have learned to exploit potential unilateral spatial cues to localize sounds. By comparing spatial hearing in long-term unilateral CI users and bilateral CI users, we aim to quantify and understand the real benefit between bilateral and unilateral implantation.

Method: We tested free-field sound localization in the horizontal plane (±90 deg) in 10 unilateral CI users, 10 bilateral CI users and 10 normal-hearing listeners. The target sound was a broadband noise of 150ms at 50, 60 and 70 dB.

Results: Sound localization performance was assessed by determining the Mean Absolute Error (MAE). The MAE of bilateral CI users was 25 deg in the bilateral listening condition and 70 deg in the unilateral acute condition. The MAE of experienced unilateral CI users was 45 deg.

Furthermore, the responses of the unilateral CI users, but not of the bilateral CI users, were correlated with sound level.

Conclusion: Long-term unilateral CI users are able to use a monaural cue when localizing sounds. This means that in the unilateral condition, the experienced unilateral CI users localize sounds better. Nevertheless, bilateral CI users perform best when they are allowed to use both implants.

Age-related variability in bilateral cochlear implant users

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Objectives: Cochlear implants undoubtedly provide significant benefits to those with severe-to-profound hearing loss; however, outcomes remain highly variable for these

patients. The inconsistencies in score may be due to the aging brain. This is further complicated by the high cost associated with cochlear implantation. While the cost-benefit analysis is clear for unilateral cochlear implantation, there remains a lack of evidence to demonstrate the same benefit for bilateral treatment. More empirical evidence is warranted to demonstrate cost-benefit for bilateral cochlear implantation. The purpose of our study was to investigate bilateral benefits of cochlear implantation on the notion that we will eliminate the inherent deficits of monaural listening in noise

Methods: Nineteen adults implanted bilaterally were included in the study, all of which had at least 6 months listening experience with the devices. The "better" ear was determined higher percentage on monosyllabic words. Sentences in noise were then presented to the better ear and in the bilateral condition. All subjects obtained a passing score on the Mini-Mental State Examination. Each subject also completed a subjective questionnaire.

Results: A significant correlation existed between age and percent correct in the bilateral noise condition; however, there were no significant differences in improvement from pre-operative and post-operative scores when divided between adults over 60 and older than 60 years. Furthermore, the subject questionnaire showed that the addition of the second implant not only reduced their perceived disability but also, subjects reported high satisfaction and increased benefit.

Conclusion: Current testing measures may not reflect real-life benefit. Due to the significant increase observed with unilateral implantation, it is difficult to demonstrate an objective improvement with a second implant; however, subjects are reporting an increased quality of life.

MS 49: Towards Totally Implantable Cochlear and Acoustic Implants

Effect of bone conduction on the intracochlear pressure and its relevance for CI microphones/acoustic hearing implants

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Towards totally implantable solutions

Objectives: Five transmission pathways are involved in bone conduction (BC) perception, of which the cochlea is the major contributor 1 . This contribution was confirmed by intracochlear pressure (ICP) measurements in chinchilla's and in one fresh-fresh frozen human temporal bone (TB) 2 , 3 .

The aim of this study is to evaluate an appropriate (reversible) fixation method to study BC transmission and to collect reference data to compute a standardized range. Results of intracochlear pressure measurements with BC stimulation on human temporal bones (TBs) are presented. Additionally relevant factors in relation to totally implantable systems such as CI will be discussed by the moderator.

Methods: Four fresh-frozen human TBs, compliant to ASTM-standards, are used for the ICP experiment after surgical preparations. Sound stimulation is conducted either through an insert phone via an artificial ear canal (air conduction, AC) or via bone conduction stimulator. After drilling the cochleostomies (Ø 350 m) under saline, two fiber-optic pressure sensors (FOP-M260, FISO Technologies Inc.) are inserted in scala vestibuli (SV) and scala tympani (ST) followed by sealing with alginate and dental cement. Different conditions are investigated during the experiment for both AC and BC: normal, stapes fixation , incudo-stapedial-joint cut. Differential pressure between SV and ST is measured.

Results & Conclusion: The use of alginate and dental cement and releasing the sensor from the micromanipulator was deemed the better fixation method, as sensor and promontory moved in phase and without relative motion. Relevance in relation to totally implantable systems will be presented during the session.

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An intracochlear acoustic receiver concept for a totally implantable cochlear implant system

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Background: The goal is to develop an intracochlear acoustic receiver (ICAR) for measurement of the sound pressure in the inner ear and in addition it is designed to be used as an implantable microphone for totally implantable cochlear implant systems. Critical ICAR specifications to be considered are the acoustical sensing performance, small dimensions, biocompatibility, hermeticity, reliability over time and low power consumption.

Methods: The presented ICAR concept consists of a MEMS condenser microphone (MEMS CMIC) with a passive protective diaphragm sealing the MEMS CMIC against the liquid medium (perilymph) and enabling insertion into the cochlea. Experiments were performed in human and sheep temporal bones and during acute experiments in sheep.

Results: The first ICAR prototypes have been used for intracochlear sound pressure measurements in human. The data thus obtained are in good agreement with the literature. A second ICAR prototype was further adapted for surgical insertion in the scala tympani in acute large animal experiments. A satisfactory agreement between sheep experiments in-vivo and in cadavers exist.

Conclusions: A MEMS CMIC-based ICAR concept was developed to fulfill the major requirements for intracochlear sound pressure measurements in human and sheep temporal bones and in acute experiments in sheep. We conclude that the presented MEMS CMIC-based ICAR concept can be used for measurement of intracochlear fluid pressure and that this concept has potential as an acoustic receiver in totally implantable cochlear implants.

Implantable microphones as an alternative to external microphones for cochlear implants

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Introduction: Totally implantable cochlear implants should be able to address many of the problems cochlear implant users have around cosmetic appearances, discomfort and restriction of activities. The major technological challenges to solve relate to implanted microphone performance. Microphones can be implanted under the skin or act as sensors in the middle ear. Surface contact and physiological noise are the main barrier to success in subcutaneous microphones. Evidence from totally implantable active middle ear implants suggest body and contact noise can be overcome by converting ossicular chain movements into digital signals. We discuss our own cadaveric series and clinical trial assessing a new fully implantable middle-ear microphone.

Methods: We carried out 40 temporal bone dissections and established the best method of coupling a new implantable microphone to the ossicular chain via objective sensitivity and body noise measurements. This informed a subsequent 6 patient clinical trial. Patients were implanted for 6 months and a series of audiological tests regularly carried out measuring microphone performance and patient satisfaction.

Results: Our cadaveric trial established the most robust position for microphone placement. Our presentation will discuss data from the clinical trial suggesting middle-ear microphone technology is a safe, functional and effective technology.

Conclusion: Potential benefits of a fully implantable cochlear implant are obvious, however, implantable microphones must also produce a sound quality that matches or exceeds external counterparts. To date, most commercial products are confined to subcutaneous devices and although most have equivalent hearing thresholds, surface contact or physiological noise are posible barriers to successful implantation. Positioning implantable microphones in the middle-ear avoids this and potentially takes advantage of directionality cues and amplification provided by the external ear.

Pilot study with an implantable subcutaneous microphone in cochlear implant

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Aim of the study: This study evaluates the feasibility of the subcutaneous microphone for potential use in future totally implantable cochlear implants (TICI).

Materials and methods: Ten post lingual native French speaking adult patients who had used and unilateral Nucleus cochlear implant for at least twelve months were selected.

The subjects received an implantable subcutaneous microphone at the contralateral side. The microphone lead was connected to percutaneous plug to bring out the microphone signal. Multiple adaptive sound cleaning algorithms were added to subcutaneous microphone firmware and fitting software. The processed signal of the microphone was fitted as additional accessory to avoid changes to the CI map.

The audiological performance with subcutaneous microphone was compared to that obtained with the external dual microphone. Hearing thresholds and speech recognition in quiet and noise were evaluated during 3 sessions on a 5 months period. Subjective sound quality (using comparative APHAB questionnaire and a study specific questionnaire) was investigated.

Results: The average hearing threshold was 34.5 dB HL.

The average word recognition score at 65 dB SPL was 84% and only 10% worse than dual external microphone configuration.

The hearing performance in noise as well as the sound quality ratings (word score) showed an important significant improvement over previous studies with TICI. Body generated sounds became totally acceptable.

Conclusions: A subcutaneous microphone is one readily available option for TICI and could meet the needs of patients for situations where the device will operate in invisible mode.

On the basis of this study, the subcutaneous microphone architecture is expected to meet those needs and significant progress compared to previous studies has been made.

Performance improvements can be mitigated by sophisticated pre-processing strategies, careful microphone fitting and optimise skin flap thickness.

Performance evaluation of a novel subcutaneous piezoelectric bone conduction hearing aid

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Objectives: Evaluation of the transfer function efficiency and acoustic feedback of a newly-developed subcutaneous bone conduction hearing aid (OSI).

Material and Methods: Experiments were conducted on five Thiel embalmed whole head cadaver specimens. A subcutaneous bone conduction hearing aid device (OSI) is sequentially implanted on three positions: 1) traditional BAHA position 5cm posterior of the tragus in the temporal line, 2) superior to the external auditory canal as close to the cochlea as possible, 3) a posterior position 7cm behind the tragus in the temporal line. For each stimulation location three types of measurements were performed: 1) acoustical feedback, from OSI to the modified sound processor, was measured; 2) motions of the cochlear promontory were measured on the ipsilateral and contralateral side, at a single point using a 1-dimensional laser Doppler vibrometer (LDV) system, and measurements were repeated after mastoidectomy on the ipsilateral side; 3) three-dimensional (3D) motions of the bone surrounding the OSI were quantified at 70-90 points, covering an area of approximately 8 × 8 cm2, using a single point 3D LDV system, supported on an automated robotic arm. All measurements at stimulation position 1 where done with both OSI (piezo-electric transducer) and BAHA Cordelle II (electro-magnetic transducer), sequentially, for comparison purposes.

Results: Surface wave patterns of the skull surface, for stimulation with OSI and BAHA Cordelle II, are comparable for both the magnitude and phase of motion. The magnitude of motion at the promontory, normalized by the driving voltage, is higher for stimulation with BAHA Cordelle II compared to OSI, at low frequencies (i.e. < 0.6 kHz), and vice-versa at mid and high frequencies (i.e., 1.5 – 10 kHz).

Conclusion: The sound transfer function efficacy and acoustic feedback of a novel subcutaneous bone conduction device have been quantified, and the influence of stimulation position and the state of the mastoid have been analyzed.

A synthetic tympanic membrane for middle ear acoustic sensor tests of a fully implantable cochlear prosthesis

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Vibration of human tympanic membrane (TM) has been used to produce electrical power IN piezoelectric acoustic sensors of fully implantable cochlear implants (FICI's). Besides, several TM driving electromagnetic transducers for middle ear implants have been developed as an alternative to conventional hearing aids.

Mass and design of these implants have a significant effect in hearing compensation performance. Therefore, to investigate these parameters in first steps of design, experiments on cadaveric human TM must be conducted. Having access to cadaveric TM and preparing for experiments are cumbersome. Moreover, obtaining non-reproducible dynamic response in different cadaveric TM due to different geometrical structures of middle ear in individuals, and limited experiment time due to soft tissue mechanical properties change are other disadvantages which prevent the precise comparison of sensors output.

In this study, for the first time, to the best knowledge of authors, we fabricated a physical model of TM as an easily accessible test platform which reproduces the basic vibrational characteristics of a human TM. Then, we measured its acoustically excited vibration by Scanning laser Doppler Vibrometer (SLDV). This PDMS based artificial membrane's first resonance frequency is found to be about ≈1 kHz similar to the TM. It's vibration magnitude is inside the allowed limits reported by the TM experimental results in literature, up to 8 kHz. Also we investigated the effect of mass on the membrane by attaching 32 mg and 57 mg weights and comparing the results with that of TM. This study shows promising results for further development of a future complete middle ear acoustic test platform which can be used to simulate the vibrational characteristics of middle ear sensors and eardrum driving transducers in primary steps of their design for minimizing the need for cadaveric TMs and animal's TM.

MS 50: Evaluating Vestibular Function before and after CI

Occurrences of dizziness after cochlear implant surgery

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Introduction: Reports of acute dizziness after cochlear implant (CI) surgery is not uncommon. Patients may react simply to the anaesthesia, or in particular, invasive surgery in the immediate vicinity of the vestibular organs. In order to better manage such incidents, a systematic investigation of dizziness before and after CI surgery was initiated.

Method: Starting from early October 2017, all patients undergoing CI surgery here at the SCIC were provided with a short questionnaire asking them about their history of dizziness prior to surgery as well as after their surgery.

Results: From a total of 166 implants, 13 patients who did not have dizziness prior to surgery reported slight to severe dizziness after surgery. In 3 cases the dizziness persisted until switch on (1-2 weeks post-surgery) and beyond. 1

of these patient whose array was subsequently identified to be in the vestibule was successfully reimplanted with a CI522 without any dizziness side-effects. The remaining 2 cases recovered after treatment whereupon the dizziness then disappeared.

The data collection is ongoing, and the latest results will be presented and discussed.

Conclusion: From a clinical and patient care perspective, it is important to keep track on the occurrence of dizziness after CI surgery. Generally, the patients can be expected to recover after treatment. Cases of persistent dizziness need to be taken seriously and reassessed in greater detail.

Objective assessment of vertigo causing perilymphatic fistula in cochlear implantees by cochlin-tomoprotein (CTP)

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Objective: A well-known and frequently reported complication after cochlear implantation is the appearance of postoperative vertigo symptoms. Perilymphatic fistula (PLF) is a known cause for hearing loss and vertigo. Cochlin-tomoprotein (CTP) is a cochlear specific protein acting as a marker for PLF. Aim of the present study was to observe, if the postoperatively new occurence of vertigo is caused by a perilymphatic fistula evidenced by CTP marker .

Methods: In a prospective analysis 12 cochlear implant patients with the postoperatively new occurence of vertigo underwent a transtympanally revison/resealing surgery. In all patients middle ear fluid was captured and analysed for CTP.

Results: In 5 out of 12 patients a positive CTP result was found indicating a PLF. Positive PLF finding did not correlate with the intraoperative visual assumption of a leak. The procedure solves in most of the cases the vertigo problem.

Conclusion: Our present finding demonstrates that objectively an insufficent sealing causing perilymphatic fistula occurs frequently in cases of newly postoperative vertigo after cochlea implantation.

Toards a clinically useful test for vestibular perception

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Objective: Clinical vestibular testing mainly consists of testing reflexes like the vestibulo-ocular reflex and the vestibulo-collic reflex. However, this type of testing does not always detect perceptual symptoms. The objective of this study was to propose a clinically useful test for vestibular perception, to investigate its age-related normative values and to compare these with the normative values of other known perceptual tests.

Methods: Fifty-five healthy subjects were included. Vestibular perceptual thresholds were measured using the MOTEK platform in the dark. The subject had to report the correct type and direction of the movements. The platform delivered twelve different movements: six translations (forward, backward, right, left, up and down) and six rotations/tilt (yaw left, yaw right, pitch forward, pitch backward, roll left and roll right). A staircase paradigm was used for threshold detection. This study had a shorter testing time and continuous communication between subject and researcher, compared to perception tests performed in previous studies.

Results: Age significantly increased perceptual thresholds for all movements. Gender did not have a significant influence. Within the translations, significantly different thresholds were found between forward-backward translations and the translations up-down. Within the rotations, significantly different thresholds were found between yaw-rotations left-right and both pitches forward-backward and roll left-right.

Conclusion: The results of this faster and more patient friendly test for vestibular perception showed comparable results to more research oriented tests regarding age-related influences. This opens up new perspectives in diagnosing vestibular perception in clinic.

Videonystagmographic signs of vestibular dysfunction before and after cochlear implantation

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Objective: To use videonystagmography (VNG) to reveal vestibulometric signs of vestibular dysfunction before cochlear implantation (CI) and investigate the possible influence of unilateral CI on vestibular function.

Material: 30 consecutive patients (19 women and 11 men) with bilateral chronic deafness received unilateral CI. All patients were examined preoperatively and postoperatively (in 1 week and 1 month after CI). Patients were aged 18-55 years.

Methods: The nystagmometric signs of possible peripheral / central / mixed vestibular dysfunction were assessed using computerised registration and automatic analysis of spontaneous, optokinetic and caloric nystagmus by means VNG.

Results: Preoperatively, 8/30 patients with bilateral chronic deafness suffered from bilateral chronic vestibulopathy with complaints of unsteadiness / oscillopsia / vertigo. The salient videonystagmographic signs were spontaneous nystagmus, abnormalities of optokinetic and caloric nystagmus, in particular their nontrivial asymmetry.

The videonystagmographic symptoms of peripheral vestibular dysfunction were revealed in 1 week after CI in 4/30 patients. The number with postoperative vestibular unsteadiness decreased to 2/30 at 1 month after CI. 2/30 patients experienced vestibular complaints with spontaneous nystagmus after the implant activation during program switch.

10/30 patients underwent medical therapy (glucocorticosteroids, benzodiazepines, non-loop diuretics, betahistines) after CI with positive effect; in so doing, possible unsteadiness in the early postoperative period was diminished and postoperative audiological performance did not deteriorate.

Conclusions: Deaf adult patients (75% of the cases) with central spontaneous nystagmus absence, regularity of symmetric optokinetic nystagmus presence and caloric responsiveness preservation had good prognosis for cochlear implantation in terms of vestibular function.

The presence of spontaneous nystagmus (33% of patients) was the proof of decompensation stage of vestibular dysfunction both before and after cochlear implantation.

Videonystagmographic evidence of vestibular dysfunction was rarely elicited after cochlear implantation: 13% of patients in the early postoperative period, 6% in the later postoperative period, and 6% during implant fitting.

Extensive exploration of symptoms of bilateral vestibulopathy

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Objective: To obtain a clear inside in the full spectrum of symptoms of bilateral vestibulopathy (BV).

Methods: Qualitative research was performed in 18 BV patients. All subjects had a reduced caloric response of summated slow phase mean peak velocity of less than 20°/s. An extensive individual interview was performed with open-ended questions. The interviews were transcribed, coded and analyzed by the first two authors. The descriptions of symptoms were organized in a mindmap and labeled by category. The symptoms were divided in physical symptoms, functional symptoms and emotions.

Results: Inner ear symptoms were reported such as oscillopsia, imbalance, vertigo, unsteadiness when walking or standing, and worsening of unsteadiness in darkness and/or on uneven ground. Moreover, symptoms beyond the inner ear were described by the BV patients, for example negative emotions (e.g. fear, agitation), cognitive/memory problems, reduced quality of life, and reduced spatial orientation.

Conclusion: BV symptomatology has a broader spectrum of symptoms than most literature currently focuses on. It reaches beyond symptoms of the inner ear. It is therefore important to take this into consideration during the development of outcome measures for therapeutic interventions such as the vestibular implant.

The importance of vestibular functioning testing prior to cochlear implantation

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Objectives; Patients undergoing cochlear implantation are at potential risk of vestibular disturbance post-implantation particularly if they have a pre-existing history of vestibular challenges pre-surgery or if the better functioning vestibular side is being considered for implantation. Therefore, objective pre-implant vestibular functioning testing is vital to ensure best clinical outcomes and to ensure patients are well informed and counselled on potential risks.

Material and Methods; All patients undergoing cochlear implantation at a tertiary centre, undergo vestibular testing as part of the candidature procedure. The testing protocol consists of videonystagmography, VHit (Video Head Impulse Testing), caloric and C-Vemp testing, multiband-tympanometry and quality of life questionnaires. The results of 45 patients undergoing vestibular testing and how these results have guided clinical and surgical decisions will be discussed. Post-implant outcomes will also be examined.

Results and Conclusions; Results indicate that vestibular testing pre-implantation is an integral part of the cochlear implant process. This is particularly important as the effects of a damaged vestibular system can be more debilitating for some individuals than a significant hearing loss.

MS 51: Neurosensorial Environment in the Cochlea

Influence of electrode array stiffness and diameter on hearing preservation in an animal model

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Objective : During cochlear implantation, electrode array translocation and trauma should be avoided to enhance preservation of inner ear structures. The aim of our study was to evaluate the effect of physical parameters of the array on residual hearing and cochlear structures after implantation.

Material and Methods : Three array prototypes with different stiffnesses or external diameters were implanted in normal hearing guinea pigs via a motorized insertion tool carried on a robot-based arm. Insertion forces were recorded with a 6-axis force sensor placed under the animal head. Array prototypes 0.4 and 0.4R had 0.4 mm external diameter and prototype 0.3 had 0.3 mm external diameter. The axial stiffness was set to 1 for the 0.4 prototype and the stiffnesses of the 0.4R and 0.3 prototypes were calculated from this as 6.8 and 0.8 (relative units), respectively. Hearing was assessed preoperatively by the auditory brainstem response (ABR), and then at day 7 and day 30 post-implantation. A study of the macroscopic anatomy was performed on cochleae harvested at day 30 to examine the scala location of the array and the presence of fibrosis.

Results : At day 7, guinea pigs implanted with the 0.4R array had significantly poorer hearing results than those implanted with the 0.3 array (26+/-17.7, 44+/-23.4, 33+/-20.5 dB, n=7, vs 5+/-8.7, 1+/-11.6, 12+/-11.5 dB, n=6, mean+/-SEM, respectively, at 8, 16 and 24 kHz, $p<0.01$) or those implanted with the 0.4 array (44+/-23.4 dB, n=7, vs 28+/-21.7 dB, n=7, at 16 kHz, $p<0.05$). Hearing remained stable from day 7 to day 30. The maximal peak of insertion force was higher with the 0.4R array than with the 0.3 array (56+/-23.8 mN, n=7, vs 26+/-8.7 mN, n=6). Observation of the cochleae showed that an incorrectly positioned electrode array or fibrosis were associated with hearing loss +/-40 dB (at 16 kHz).

Conclusion : In our model, hearing loss was either observed when a vestibular translocation or when fibrosis would contact the basilar membrane. An optimal position in the scala tympani with a flexible and thin array and prevention of fibrosis should be the primary objectives to preserve hearing during cochlear implantation.

Molecular pathways involved in fibrosis after cochlear implantation

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Rationale: Fibrosis is the final step of an inflammatory process caused by collagen secretion after fibrocyte proliferation. Wound healing consists of three phases: inflammation, granulation and tissue remodeling. During tissue remodeling, apoptosis removes myofibroblasts, and the deposited extracellular matrix (ECM) is remodeled to resemble the original tissue. Fibrosis occurs when inappropriate tissue remodeling results in excess ECM deposition due to inappropriate survival of cells or lack of ECM proteolytic degradation. The inflammation and enhanced TGFß signaling often present in fibrotic tissues causes cells to differentiate into fibroblasts via epithelial-to-mesenchymal transition (EMT). In the inner ear, the cells involved in the proliferative process are the mesothelial cells of the scala tympani and the scala vestibuli. Whereas, cellular and molecular mechanisms involved in fibrosis development are widely described for liver and lung, data about cochlear fibrosis are currently not available.

Methods: Adult female rats were anesthetized (Zoletil Rompun) and impmlanted with a rodent specific array (Cochlear Ltd.). Cochleae were harvested 1, 4, 7, 28 and 56 days after surgery and processed either for RNA extraction (TRIzol Ambion), cDNA construction (RT2 first strand cDNA kit - Qiagen) and qPCR (RT2 profiler -PARNZ-120, Qiagen and Roche Lightcycler 480), or immunohistochemistry after embedding in OCT and cutting using a microtome (Leica).

Results and conclusion Using a combination of qPCR arrays and immunohistochemistry in a rat model of cochlear implantation, we demonstrated that TGF-Smad, MAPK/ERK, and PI3K/Akt pathways are involved in fibrotic processes by stimulating EMT through matrix protein secretion and metalloproteases regulation. Analysis of inflammatory transcripts showed the overexpression of TNF, IL1β, and cytokines such as CCL2, 11 and 12. The implication of these findings in fibrosis prevention after cochlear implantation will be discussed.

Biodegradable piperacillin-tazobactam eluting nanofibrous mat against biofilm formation of cochlear implant

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Background & Objective: Biofilm-related infections caused by the colonization of bacteria on silicone medical devices are on the rise. The unexpected postoperative infection can be prevented sustained release of antibiotics in the surgical field. The purpose of this study was to evaluate the efficacy of sustained release of antibiotic by nanofibrous mat in preventing the formation of ciprofloxacin-resistant Pseudomonas aeruginosa (CRPA) biofilm on a silicone component of cochlear implant or postoperative infection.

Materials and Methods: We fabricated a biocompatible and biodegradable piperacillin-tazobactam (PT)-eluting electrospun poly(e-caprolactone) (PCL)-polyethylene oxide (PEO)-PT-PCL nanofibrous mat. The release of PT was assessed in vitro by spectrophotometry and the antibacterial effect was evaluated by inhibition zone test and biofilm formation test. Antibiofilm effect was assessed by scanning electron microscopic analysis and examinined of the dead/live stains with confocal microscopy.

Results: In the SEM image, the PCL fibers in the outer layer were homogenously uniform in diameter (2.5 ± 0.4 mm) with a highly porous mesh structure that is used in controlling drug release. The PT in the PEO fibrous mat was distributed consistently over the whole region of the fibrous mat. The diameter of the electrospun PEO/PT fibers was about 310 > 15 nm. The release profile of the PT in the multi-layered fibrous mat revealed that about 90% of the PT was rapidly released (initial burst) in less than 1 h from the PCL/PEO/PT/PCL nanofiber mat at 37>C. However, for the remaining 10% of PT, the release was slightly deterred over 7 days. A wide zone of inhibition (more than 3x 3 cm) was identified around the upper 3 round discs of the PCL/(PEO/PT)/PCL nanofiber mat.

We found that PT was released at a constant level for 7 days. PT-eluting nanofibrous mat prevented the formation of CRPA biofilm on the silicone surface, in vitro. . Colony counts of the controls were significantly higher than those from the silicone sheet with the PCL/PEO/PT/PCL nanofiber mat ($p < 0.0001$). Live and dead bacteria show green and red fluorescence, respectively. The control silicone sheet biofilm showed green fluorescence for live cell densities; in contrast, the study group silicone sheet showed a robust red fluorescence for dead cell densities. Scanning electron microscopy showed a robust CRPA biofilm in the control group. On the other hand, there was no CRPA biofilm formation in the silicone sheet with PCL/ PEO/PT/ PCL nanofiber mat group.

Conclusion: From these results, it can be concluded that the PT-eluting nanofiber mat may be a promising method for the prevention of CRPA biofilm formation and consequent infections.

Autologous cell transplantation to the inner ear

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Inflammation induced by insertion of cochlear implants may lead to short- and long-term sequeale. Thus, neuroprotective and anti-inflammatory treatment in cochlear implant recipients may mitigate these effects. Mononuclear cells are cells with unilobulated or rounded nuclei and consist of hematopoietic progenitor cells at different stages of maturation. Also, cells with multipotent capacity are among the mononuclear cells. In addition to the progenitor cells, lymphocytes, plasmatic cells, monocytes, and macrophages have been identified in the mononuclear fraction. They are able to exert neuroprotection, immunomodulation, neurorestoration, and neuro- genesis. Thus, mononuclear cells isolated from the bone marrow have been widely used in human studies as an immune modulator and source of protective growth factors. Autologous mononuclear cell transplantation presents therefor a promising approach for anti-inflammatory and neuroprotective treatment of the inner ear. In previous work, we have demonstrated an easy and effective method for the isolation of bone marrow-derived mononuclear cells during cochlear implantation. These cells can be transplanted autologously without the need of any in vitro expansion. However, the delivery mode of the cell transplantation may pose a challenge in clinical routine. Two different modes of application will be introduced: the coating the electrode array and the application via an intracochlear catheter. Experimental data as well as initial results from clinical application will be presented.

The effect of chronic electrical stimulation on functional and anatomical properties of the auditory nerve

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Degeneration of the auditory nerve associated with severe hair cell loss may deteriorate the ability to adequately respond to electrical stimulation required for hearing with a cochlear implant (CI). Animal studies are vital to study this degeneration process both at the functional and anatomical level. However, a crucial difference between the human situation and animal models is that the CI user's auditory nerve is subjected to chronic electrical stimulation. The effects of chronic electrical stimulation on the nerve are not clear, as both neuroprotective and neurotoxic mechanisms have been proposed. Previously, we found in deafened guinea pigs that loss of spiral ganglion cells (SGCs) is accompanied by changes in responsiveness to electrical stimulation, as measured with electrically evoked compound action potentials (eCAPs; Ramekers et al. 2014, J Assoc Res Otolaryngol 15: 187-202). Here we examine the effect of chronic electrical stimulation on responsiveness and anatomy of the auditory nerve.

Normal-hearing guinea pigs were implanted with an intracochlear electrode array. After 4 weeks the animals were ototoxically deafened. Chronic electrical stimulation, starting one week thereafter, consisted of 12 hours/day, 6 days/week stimulation on 3 intracochlear electrodes simultaneously with variable pulse rate (around 1 kHz). Using a MED-EL PULSAR CI, awake eCAP recordings were performed weekly during the period of implantation (up to 11 weeks). Cochleas were processed for histological analysis.

The basal region of the implanted and stimulated cochlea showed more SGC survival than the contralateral unimplanted cochlea. Chronic electrical stimulation did not influence the progressively changing eCAP characteristics after deafening such as a decrease of amplitude. We conclude that chronic electrical stimulation may have a modest positive effect on SGC survival without negative effects on responsiveness.

Deciphering hearing loss mechanisms using an innovative nanoproteomic approach

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Background: Molecular mechanisms underlying sensorineural hearing loss (SHL) are not clearly understood and the diagnosis relies mostly on clinical data. Given the confined anatomy of the inner ear, the pathological processes may be accurately reflected in the protein profile of perilymph.

Objective: Our aim was to investigate hearing loss long term molecular changes in perilymph using two different SHL rodent models.

Methods: We investigated the proteomic content of perilymph in rats exposed to different deafness protocols. To induce a toxic SHL model, 14 rats received combined injection of kanamycine and furosemide. For the noise-induced SHL model, 14 rats were exposed to a noise injury. The two groups were compared to a control group of 14 rats with normal hearing. SHL was confirmed using Auditory Brainstem Responses.

Perilymph samples were obtained during microsurgery and prepared for proteomic analysis. We used nano-interface strategies to enrich perilymph proteomic content before analyzing it with 2 mass spectrometry methods.

Results: Using nanoporous silicon chips prior to MALDI-ToF mass spectrometry and based on the protein profile, we were able to classify the samples according to the hearing loss mechanism involved. Using nanoparticles combined to nanoLC-MS/MS, we identified 836 different proteins in perilymph. Among them, we found 47 proteins whose abundance is significantly different in the 2 models of deafness compared to the control group. These potential molecular biomarkers of hearing loss mechanisms have to be further validated.

Conclusions: Perilymph proteomic analysis opens new perspectives in the understanding of SHL. Nano-technologies allow us to reach the deep proteome that would not be detected by conventional analysis. This approach could lead to new classification of SHL according to the hearing loss mechanisms, to the discovery of specific drug therapies, the potentiation of cochlear implant within its protein environment or to the development of audio protective strategies.

MS 52: Aspects of New Experimental Electrodes

A new hearing implant targeting the auditory midbrain: initial clinical trial results

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The cochlear implant is considered one of the most successful neural prostheses to date. However, patients without

a functional auditory nerve cannot benefit from a cochlear implant. A new central auditory prosthesis was developed that targets the inferior colliculus (auditory midbrain implant, AMI). The first AMI device consisted of a single-shank array with 20 electrodes and was implanted in five neurofibromatosis type II (NF2) patients during 2006-2008. The AMI achieved encouraging results in terms of safety and improvements in lip-reading capabilities and environmental awareness, but it has not yet provided sufficient speech perception comparable to cochlear implants. Additional animal and human studies were performed demonstrating that a two-shank AMI array can potentially improve hearing performance by targeting specific neurons of the inferior colliculus and minimizing suppressive effects induced by temporal stimulation patterns presented on individual electrodes. A new two-shank AMI device (11 electrodes along each shank) has been developed and is currently being investigated in a clinical trial performed in Germany that is funded by the National Institutes of Health in United States. Two NF2 patients have been recently implanted in the new AMI trial, in which each patient will be evaluated over a 2-year period. The device has shown to be safe and is providing useful hearing sensations to the patients. Activation properties, pitch percepts, temporal coding capabilities and speech perception performance in these patients will be presented and compared to hearing performance achieved with the previous AMI device and auditory brainstem implants. Overall, the initial results are encouraging in terms of safety and functionality, and hopefully hearing performance continues to improve in these AMI patients over time. Up to five NF2 patients will be implanted with the AMI in this clinical trial.

Parallel electrical stapedial reflex threshold and electrical evoked compound action potential recordings: focus on loudness of auditory percept for continuous stimulation intensity growth in children

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Objectives. To analyze the auditory percept measuring in children the electrically Evoked Compound Action Potential (eCAP) with the novel continuous intensity growth function („fine grain") at two rates of stimulation (40 and 80 Hz) versus the standard non-continuous stimuli recording paradigm on three representative electrodes in the apical / middle / basal region. In adults, a reduction in the loudest acceptable presentation level (LAPL) were observed between „fine-grain" and the standard paradigm. In particular, continuous stimulation growth function with larger charges steps at 44Hz gave smaller LAPL compared to 80Hz (~18qu versus ~21qu respectively)

Materials and methods. Recordings were performed on 12 CI pediatric cochlear implant recipients (15 CI) aged 6 to 10 years at the Audiology Dept. of the University of Milan in the Audiology Unit of the IRCCS Ospedale Maggiore Policlinico. Starting from 0 qu up to the loudest acceptable presentation level (LAPL), in „fine grain" paradigm, stimulation intensity was continuously increased with 1 qu per second (1 qu~nano Coulomb). During the delivery of the stimuli, the threshold of electrical elicitation of the stapedius reflex (eSRT) was monitored and ECAPs were recorded.

Results and conclusions, ECAP identification was found in > 90% of cases with an higher resolution of stimulation intensities with the novel paradigm. eSRT determination varied with respect according to the different differing LAPLs reached and those levels were not significantly different between the two paradigm. Our results support the use of objective measures such as eSRT, LAPLS and ECAP to assess the change in auditory percept. Besides these findings, our study confirmed the suitability of the fine-grain stimulation paradigm for a paediatric population.

Comparison of hearing outcomes obtained with intra-cochlea, auditory nerve or ponto-cerebellar angle electrical stimulation by an auditory implant

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Introduction: Poor cochlear implant (CI) functional outcomes obtained in a 7 year-old child presenting bilateral X-linked incomplete partition (IP-III) labyrinthine abnormalities were found to be associated with a CI Med-El array misplacement. 4 electrodes are located in the first cochlear turn, 4 in the internal auditory canal (IAC) and 4 in the ponto-cerebellar angle (PCA). This case constitutes a model of IAC or PCA auditory implantation.

Objective:To verify if it is possible to provide hearing perception by selective stimulation of only the IAC or PCA electrodes.

Results: Combined activation of all the electrodes gives HTA of 40dB and a speech discrimination of 88% (22/25) using disyllabic Olivaux lists in open set. Selective activation of only the 4 intracochlear electrodes provides HTA of 45dB and a speech discrimination score of 80%. Activation of only the 4 PCA electrodes shows HTA of 55dB and a speech score of 64%. No response was observed after electrical stimulation of only the 4 IAC electrodes.

Discussion: The functional results of CI or Auditory Brainstem Implant (ABI) are known in children with labyrinthine malformations. This case shows that limited activation of the first cochlear turn could provide functional results, whereas direct stimulation of cochlear nerve within the internal auditory meatus gives no auditory sensation. Surprisingly, the activation of the PCA electrodes provides a functional hearing comparable to ABI placed in

the Luschka space. The association of PCA and cochlear stimulation improves the studied hearing outcomes, but these audiometric results are not associated with a normal language development.

Conclusion: This clinical case represents a model of a combined cochlear and retrocochlear electrical stimulation and shows that electrical stimulation in the IAC may be not sufficient compared to PCA.

In vivo real-time remote cochlear impedance measurements: a glimpse into the implanted inner ear

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Objectives: to propose a remotely, real-time way to measure electrode electric impedances components (Ra, Cp and Rp) on cochlear implant recipients and to determine their standard values in the immediate postoperative period and one year after the implantation. We also propose a practical standardize colorimetric graph of the cochlea as a way to visualize results of these impedance parameters.

Material and Methods: We developed a software using NIC library, approved by the Ethics Committe, that allows the measurement of impedance in implanted patients, including monopolar, common ground, 3- and 4-point modes. The software is capable of remotely getting this information in real-time. The data is stored in a cloud, and further analyzed to get the voltage response.

Two patients who had received a cochlear implant at least one year ago and two patients who were implanted on the same day were studied using this tool, and standard values of the access resistance and polarization component of the impedance were calculated.

Results: With the employment of the aforementioned tool, we were able to calculate the access resistance and the polarization component in every specific electrode in different modes, thus in every specific region of the cochlea of implanted patient. The mean access resistance value in the one-year group was around 5.08 KΩ (SD = 1.4 KΩ) and the mean polarization component was 5.61 nF (SD = 1.62 nF). In the one-day group, the mean access resistance value was 3.32 KΩ (SD = 0.76 KΩ) and the mean polarization component was 6.04 nF (SD = 1.14 nF). Rp mean values per group was 6.99 KΩ (SD = 0,9 KΩ) and 6.21 KΩ (SD = 1.77 KΩ) respectively.

Conclusions: Routinary use of this tool may allow in-situ constant assessment of cochlear health and could be eventually used to monitor the effect of systemic and local drugs delivery in the inner ear. The methodology presented here provides an in-vivo „electrical view" of the inside of the cochlea.

Development and initial experience with a new thin lateral wall electrode in vitro and vivo

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Objective: Today's cochlear implant (CI) recipients commonly have some low-frequency residual hearing that can be combined with electrical stimulation to improve speech understanding and enhance sound quality. The objective was to test this with a new slim lateral wall electrode design in temporal bones followed by human implantations

Materials and Methods: Several iterations of the prototype lateral array design were tested in temporal bones using a 3-dimensional force measurement system, refining the prototype to a 23 mm length; targeting a 420 degree insertion depth. The final design was tested in a series of 10 fresh-frozen temporal bones. Round window (RW), extended RW and bony cochleostomy approaches were used, with the facial recess maintained to reflect a live surgical approach. Computed Tomography and histological analysis were conducted. Finally, 10 human implantations have been performed so far using a RW approach. To control insertion, ECochG was recorded intra-operatively.

Results and Conclusion: No trauma was observed for 9 of the 10 bones implanted with the lateral array design. In one case the basilar membrane was slightly elevated. A mean insertion depth of 432 (SD ±13) degrees was obtained: consistent with the 420 degree design intent. All live surgeries progressed smoothly. If ECochG dropped, insertion was halted, or the electrode withdrawn until the signal recovered. Following 10 ECochG was recorded on completing the insertion, indicating successful hearing preservation. In one case technical problems prevented a final ECochG measurement.

A rigorous design process appears to have resulted in a lateral lying electrode array with positive surgical handling properties that appears capable of high levels of hearing preservation. Experience shows that both electrode design and surgical technique are important for reliable hearing preservation, with ECochG bringing useful real-time surgical feedback during insertion.

MS 53: MRI Evaluation after CI and ABI: Pitfalls and Future Perspectives

Pain free 3 T MRI scans in cochlear implantees

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Objective: For cochlear implant recipients, undergoing MRI scans is associated with safety risks and potential

side effects. Even following safety guidelines, potential complications(e.g., pain, magnet dislocation, image artifacts) are possible during 1.5 TeslaMRI scans. The stronger static magnetic field of a 3.0 T scanner is associated with further risks of complication, including implant demagnetization. These complications led to the recent development of rotatable internal receiver magnets with a diametrical magnetization.

The aim of this study was to evaluate the potential occurrence of pain during 3.0 Tesla MRI scans for cochlear implant recipients with a rotatable, diametrically magnetized implant magnet.

Method: In the prospective case study an 3T MRI scan was performed on 25 implantees and the degree of pain was evaluated by a visual analog scale.

Results: In all patients, all MRI scans were performed without any pain, Demagnetization was clinically not observed.

Conclusion:3.0 T MRI scanning can be performed on cochlear implant recipients with a rotatable diametrically magnetized internal magnet without risk of the most frequent cochlear-implant-related MRI complication: pain. This finding enables the expansion of MRI scanning indications up to 3.0 T without complication. Limitations in terms of MRI artifact still persist.

3 T MRI-based estimation of scalar cochlear implant electrode position

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Introduction: Recent advances in the knowledge about handling MRI artefacts and the pain-free performance of MRI scans in cochlear implantees showed that an estimation of the intracochlear electrode position is possible at 1,5 T with perimodiolar or midmodiolar arrays. The aim of the study was to evaluate the assessment of the ipsilateral scalar position of the cochlear implant's lateral wall electrodes by MRI sequences at 3 T.

Methods: In a prospective study we evaluated 10 patients implanted with a diametrically bipolar implant magnet system with a lateral wall electrode in an axial and coronal position and a T2 weighted sequence at 3 T. We compared the evaluated intracochlear position with the routinely postoperative performed CBCT scan observed position.

Results: In all cases the MRT-estimated scalar position corresponded with the CBCT scan estimated position. In all cases a scala tympani position was assumed. While the position in the basal turn is reliably localisable, the first-turn visual assessment is difficult. A translocation as a visual couterpart is missing in our series.

Conclusion: An estimation of the intracochlear position of lateral wall cochlear implant electrodes by 3 T MRI is possible for the basal turn. The electrode design plays a major role for the visual assessment.

MRI-CT fusion: a novel approach to evaluating the intra-cochlear electrode position

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Background: Cone Beam Computed Tomography (CBCT) has proved to be a very useful tool for routine evaluation of the cochlear implant (CI) electrode position within the scala chambers, owing to lower radiation doses, high image resolutions and minimized artefacts. However, it still represents more a subjective rather than an objective assessment method due to the inability to delineate basilar membrane on CT/CBCT.

Aim: This study investigated if image processing and combination of preoperative MRI with postoperative CT/CBCT may be utilised to accurately evaluate the electrode position within the cochlea.

Method: This study included seven consecutive adult patients implanted with the new straight lateral wall electrode from Advanced Bionics (the HiFocus SlimJ). The electrode position was evaluated at four points along the basal turn using postoperative CT/CBCT, as previously described (1). Fusion of pre-operative MRI and postoperative CBCT imaging was conducted and compared to the CT/CBCT evaluation. Measurements of the electrode contact distance in relation to the overall scalar height were used to objectively assess the probable location of electrodes along the cochlea.

Results:In all cases fusion of the images with an accuracy of a voxel (0.2mm) was possible. The SlimJ electrode was consistently positioned within the scala tympani. There was a good correlation between the CT/CBCT grading and the MRI-CT fusion technique. The fusion technique was able to provide further information on the position of each electrode contact.

Conclusion: The HiFocus SlimJ electrode was consistently retained in the scala tympani, a pre-requisite for an electrode aimed at hearing preservation CI surgery. The new MRI-CT fusion technique promises to play an important role in evaluating new electrode designs.

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Magnetic resonance imaging assessment of superparamagnetic iron oxide nanoparticle contrast in the inner ear

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Objectives: Use of superparamagnetic iron oxide nanoparticles (SPIONs) as an effective contrast agent in magnetic resonance imaging of the inner ear.

Methods: Long Evans rats were injected with investigative SPIONs by surgical delivery into the left middle ear by a post-auricular approach to the bulla, and subsequent deposit of SPIONs onto the round window niche.

The animals were subjected to magnetic targeting in order to deliver the SPIONs into the inner ear and Magnetic Resonance Imaging was subsequently performed.

Regions of interest were drawn on coronal sections, at different cochlea turns. The signal intensity of the treated ear was calculated for each level relative to the same location in the untreated ear.

Hearing was evaluated using Auditory Brainstem Response (ABR); performed before and after magnetic delivery. Finally the cochleas were collected for hair cells and spiral ganglion neurons count.

Results: Decreased signal intensity was observed in the SPIONs treated cochlea of all rats compared to untreated ear. The signal decrease was seen in the perilymph leaving the endolymph in the scala media with bright signal.

In the rats treated with magnetic targeting, there was a further small Relative Signal Intensity (ROI) decrease at the apex of the cochlea (0.80±0.15), which was not observed in the group without magnetic targeting.

A significant signal decrease in the vestibule was also observed in all animals on the treated side only.

Hearing was confirmed normal before and after the procedure.

Discussion/Conclusion: Imaging of the inner ear remains a challenge due to its fluid-filled compartments and blood-labyrinth barrier. Different agents have been tested in the recent years and SPIONs appears as a potent T2 negative contrast agents in vivo, as seen in this study. Importantly, we were able to use magnetic targeting to improve the penetration of the contrast nanoparticles into the inner ear without compromising the cochlear hearing function.

Performing magnetic resonance imaging on cochlear implant and auditory brainstem implant recipients - 13 year review

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Objective: Review of safely in perform MRI scans on cochlear implant (CI) and auditory brainstem implants (ABI) over a 13 year period. The presence of the internal magnet located in the receiver stimulator can cause complications in performing MRIS scans on CI and ABI recipients. Outside the MRI scanner, the receiver stimulator magnet is subjected to a linear force pulling it into the MRI scanner. Inside the MRI scanner the magnet is subjected torque forces causing it to dislocate from its retainer in the receiver stimulator. The metal case and the magnet causes image voids and spatial distortion in MRI images of the head.

Methods: Initially in vitro test were performed on cochlear implants from 3 different manufacturers, Medel Pulsar ci100, Advanced Bionics HiRes90k and Cochlear CI24RE. Qualitative force tests and possible heating were performed on each of the three implants in the magnetic field of a 1.5T scanner.

Result :Over the past 13 years the MRI unit at Addenbrookes Hospital, from Sep 2004 to Aug 2017.

Total number of patients scanned 72, youngest 4 year and oldest 86 years.

29 recipients have more than one MRI sessions and 5 recipients have 20 MRI sessions or greater. Total MRI sessions 336 and 508 individual MRI procedures, resulting in a total of 2217 MRI sequences excluding localisers. Complications is 4.5% for CI recipients and 3.7% for ABI recipients, these are caused by dislocation of the receiver stimulator magnet or excessive pressure caused by the head bandage.

Conclusion: No implant failures occurred in this 13 year period where cochlear implant recipients received one or more MRI procedure. No problems encountered with demagnetisation of the internal receiver stimulator magnet.

CI and MRI Compatibility - Survey of Information and Patient management.

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Introduction: Cochlear implants have revolutionised the management of patients with severe to profound sensorineural losses. Preoperative investigations involve radiological assessment of the cochlear by MRI scan, CT imaging or both. For parents and patients one of the main focuses is understanding

and hopefully having surgery. In our unit patients have choice of devices. The reasons for varied are quite varied. Issues such as accessories and water compatibility appear to be significant factors to the patients and families. Clinically, it is clearly understood that the magnetic components, and to a certain degree the internal electronics, have a compatibility issue with MRI scanning. Some devices require removal of magnets. Others, are conditional to 1.5 Tesla. No matter what system is used significant voids and distortions are produced by the magnet when imaging the brain. There is a high chance that a child would require an MRI during his/her lifetime. Information from Germany indicates 114 MRI / 1000 inhabitants with head scans using CT / MRI being fairly equal (55% v 45%). Spine and extremities have higher proportion of MRI. The aim of this paper is to investigate what information is given pre implant to ensure informed consent is given. How issues are managed in the acute and non-acute situation will be reviewed.

Methods: A survey was sent to all UK implant centres asking them about the giving of information, formal surgical consent, their experience of dealing with patients potentially needing and actually having MRI scans. Final questions focused on any subsequent issues that arose. Results were used to compare our practice and subsequent management.

Results: 22 centres were approached and 18 replied. - Is departmental information given about MRI scanning? 69% No - Which/how is MRI related information is given? - Verbal 38%, - BCIG safety guidelines 35%, - Manufactures literature 23%, - No specific advice 4%. - Specifically mentioned at surgical consent? Yes 46% - In the past 12 months; median (range) - What external request for advice has been received? - 3 (1 - 25) - What number of actual known MRI scans have your patients had? - 2 (1 - 10) several centres did not know.- What reported issues have been reported? - demagnetised; displacement; pain.

Conclusion: MRI scanning can be performed without side effects. However, there does seem to be a range of patient experiences and varied outcomes.

As a result of our own experience we have developed a mould to cover the implant and offer local anaesthetic before firm head bandaging. From the survey reasons behind the need for an MRI scan should always be investigated. Would other imaging such a s CT +/- contrast be more appropriate? Also, clearly we need to pay more attention to consenting with future MRI scanning.

MS 54: Final Comments on Active middle Ear Implants

Powerstapedectomy with Vibrant Sound Bridge SP coupler

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The therapeutic options in otosclerosis are limited to medications (acute disease/active symptoms) as well as the rehabilitation of the hearing loss (HL).Rehabilitation can be with hearing aids (HA),stapedectomy,middle ear devices,osseointegrated implants and even with cochlear implants,depending on the HL degree. Conventional HA stimulates the hearing acoustically, with sound amplification,so there are feedback limitations,distortions,limited auditory gain,eczema of the external auditory canal,and other disadvantages. HA advantages remains on aesthetic aspects (intracanal/retroauricular, small dimensions),it does not require any surgical approach,which less morbidity. In MHL,the ideal is to combine technologies to achieve a complete improvement of hearing.Therefore, the option of middle ear/osseointegrated implants is a great solution, already well established in the world medical literature as one of the gold standard treatments for the correction of mixed/moderate hearing loss.Such devices achieve great auditory benefits in cases of MHL of mild/moderate degree,because of the power of a mechanical auditory stimulation technology.This allows them to provide a great auditory gain without sound distortion and with great sound quality.Their disadvantages lies in not being as aesthetic compared to HA,and the need for the patient to undergo surgery, which implies obvious risks. The therapeutic options in your health and health, as well as the rehabilitation of your hearing. The patient can be rehabilitated only with hearing aids, stapedectomy surgery, middle ear or osseointegrated implants and even with cochlear implants, one dependent on the degree of deafness and involvement of his hearing. It is worth mentioning that conventional hearing aids stimulate hearing in an acoustic way, with an amplification of the children, on the other with limitations of feedback, distortions, difficulty in obtaining adequate auditory gain, eczema of the external auditory canal, within other limitations. Its advantages are more aesthetic (it can be intracanal, retroauricular) and does not require any surgical surgery, which greatly reduces the risks for the patientThe therapeutic options in otosclerosis are limited to medications (when the disease is in its acute stage, with active symptoms) as well as the rehabilitation of its hearing. Materials and Methods used: To evaluate the Surgical and clinical outcomes of the Treatment for MHL in Otosclerosis with Stapedectomy & VSB.All patients receive a SP(short process) coupler of VSB/Medel and a stepedectomy (teflon prostheses/0.4 mm).

Results: Five patients underwent to surgery (stapedectomy with VSB SP) for treating MHL in Otosclerosis.All patients get closed the air-bone gap wiht the stapedectomy and get

normal pure tone thresholds after activation of the VSB. Excellent vocal and speech outcomes. There were no surgical or audiological complications untill now.The follow up time is 16 months. Conclusion: Stapedectomy & VSB is a good option for surgical rehabilitantion for treating MHL in Otosclerosis.

Audiologic gain of incus short process vibroplasty with conventional incus long process vibroplasty: a retrospective analysis of 36 patients

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Objectives: To compare the audiological and non-audiological benefits of incus short process (SP) vibroplasty with those of conventional incus long process (LP) vibroplasty.

Methods: Retrospective chart reviews were performed. Thirty-six patients with sensorineural hearing loss were treated with a middle ear implant (Vibrant Soundbridge®). Of these, 22 were treated with conventional LP vibroplasty, and 14 were treated with SP vibroplasty using SP couplers. All surgical procedures were performed by a single surgeon. Patients underwent pure-tone/free-field audiography and word recognition tests before and 3 months after the surgery. Operation time and duration of hospital stay were obtained through chart reviews, and a questionnaire was used to assess postoperative complications. The results of these tests were compared.

Results: The improvement in hearing gain was comparable between SP vibroplasty and conventional LP vibroplasty, except at 8 kHz ($P < 0.05$). Patients undergoing SP vibroplasty had shorter operation time ($P < 0.01$) and duration of hospital stay ($P < 0.01$). While four patients who underwent incus LP vibroplasty experienced taste changes, none who underwent incus SP vibroplasty experienced any complications.

Conclusions: SP vibroplasty with the newly invented SP coupler could be a good alternative to conventional LP vibroplasty for treating patients with sensorineural hearing loss. Although both SP vibroplasty and LP vibroplasty produce good results, the former is associated with a shorter operation time and duration of hospital stay as well as fewer complications.

Round window soft coupler for Vibrant Soundbridge® implant

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Objectives: To compare surgical feasibility and auditory performance with VSB traditional system versus the new RWC for the VSB implant.

Methods and materials: Thirty two patients treated with VSB systems indicated for conductive and mixed hearing loss patients, are included at the moment with a FMT in the RW. Eleven patients implanted with VSB Coupler versus 21 patients with no-Coupler VSB.

Mean pure tone thresholds before and after implantation are obtained for VSB Coupler group and no-coupler VSB group. Besides, functional gain and discrimination of disyllabic words at 65 dB in quiet is analyzed.

Results: Surgeon subjective perception is that RWC simplify the surgical process, allow a more stable coupling and minimize the risks of post-surgical FMT movement as well. For conductive-mixed hearing loss patients, mean hearing thresholds for the air conduction before and after the surgery were 84.75 dB and 40 dB respectively for the no-Coupler VSB group, opposite to 85 dB and 30.75 dB for the VSB-Coupler group; and mean functional gain and disyllabic word recognition was 47.5dB and 70% for the no-Coupler VSB group, opposite to 53 dB and 96% for the VSB-Coupler group. Conclusions:

Surgical procedure is simpler for coupler VSB for both indications (SNHL and conductive and mixed hearing loss). A greater tendency to improve auditory outcomes is described for RW Coupler group vs no-Coupler RW group.

Maximum speech perception with a direct acoustic cochlear implant compared to conventional hearing aids

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Objectives: The maximum monosyllabic word recognition score for phonemically balanced words (PBmax) is used as an indicator for a patient's auditory potential for speech recognition. Patients aided with hearing aids (HA) often do not achieve the potential maximum speech perception as predicted by the PBmax. The discrepancy between PBmax and aided speech perception is referred to as speech perception gap (SPG). The objective of this study was to evaluate the aided speech perception in quiet and the SPG of direct acoustic cochlea implant (DACI) patients in comparison to hearing aid users.

Material and Methods: In a retrospective data analysis, the aided speech perception at 65 dB SPL and the speech perception gap (calculated as the difference between PBmax and aided speech perception) of 59 DACI implanted ears was determined and divided into four different BC hearing loss groups (group 1: > 35 to ≤ 45 dB HL, group 2: > 45 to ≤ 55 dB HL, … group 4: > 65 to ≤ 75 dB HL). The speech performance of the DACI patients was compared to the published literature data of 208 ears aided with a conventional HA (Hoppe et al. 2015).

Results: DACI patients with a hearing loss between 45 and 65 dB HL have a significant higher mean speech recognition score compared to patients with conventional HAs. An overall speech perception gap of 10.8% points for the DACI system and 21.3% points for conventional HAs was

determined. Further, 28.8% of the DACI users and only 14.4% of the HA users achieved a speech perception that equaled or exceeded the PBmax.

Conclusion: For moderate-to-severe inner ear hearing losses, patients aided with a DACI obtain on average higher speech scores in quiet and a speech performance closer to the maximally possibly score PBmax compared to patients aided with a conventional hearing aid.

MS 55: Towards a Consensus in Single Sided Deafness in Children?

Quality of life in children with unilateral hearing loss

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Introduction and Objectives: Children with significant unilateral hearing loss (UHL) traditionally have limited options for intervention and face unique listening challenges. An ongoing clinical trial is evaluating quality of life (QOL) among young children with UHL who receive cochlear implants (CIs). The present report will review pre- and post-operative QOL data obtained from subjects and their parents.

Methods: Participants were children ranging from 3.5-6.5 years at the time of implantation. All had at least a moderate to profound UHL. The test battery included the Pediatric Quality of Life Multidimensional Fatigue Scale (PedsQL), the Speech, Spatial, and Qualities of Hearing Scale (SSQ) for Children with Impaired hearing, and the Bern Benefit in Single-Sided Deafness Questionnaire (BBSS) that had been modified for pediatric use. The data were obtained pre-operatively and at regular intervals following activation.

Results: Subjects consistently reported greater fatigue than their parents reported perceiving. Improvements in QOL were demonstrated as early as 3 months post-activation, with particular enhancement reported in spatial hearing and ease of listening.

Conclusion: Children with UHL tend to perceive greater difficulty with fatigue than their parents' rankings would suggest. Cochlear implantation can bring improvements in QOL to children with UHL, even within the early months of device use.

Cochlear implantation for pediatric unilateral hearing loss: early auditory development in the implanted ear

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Introduction and Objectives: Treatment for children with profound unilateral hearing loss (UHL) has historically been limited to rerouting of signals to the better hearing ear. Cochlear implantation allows for stimulation of the auditory pathway of the deafened ear itself. This report will present localization, speech perception, and early listening skills data from an ongoing clinical trial of cochlear implantation in pediatric unilateral hearing loss.

Methods: Children between 3.5-6.5 years with moderate to profound UHL were enrolled. Localization measures were obtained with and without the cochlear implant (CI). Open and closed set speech perception was assessed pre-operatively with a hearing aid and post-operatively with a CI. Auditory skills were measured in a therapeutic setting both pre-operatively with the normal hearing ear and post-operatively with the CI. Speech perception and auditory skills were assessed while the speech processor was directly connected to a laptop. All measures were obtained at regular intervals following stimulation.

Results: Participants had little to no aided auditory skills in the deafened ear prior to implantation. Following activation, most subjects reached ceiling levels on closed set tasks by 3-months and had developed significant real-world auditory skills in the implanted ear (e.g. Identifying environmental sounds, answering common questions, identifying songs). All subjects had achieved some open set understanding by 3-months that continued to improve over time. Localization was improved with the device.

Conclusion: Even within early months of device use, cochlear implantation can provide opportunities for speech understanding in the deafened ear of children with UHL. Auditory skills are improved in the implanted ear and localization is enhanced with the device.

Toddlers with single sided deafness and a cochlear implant

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Every year, neonatal hearing screening services in Flanders (Belgium) detect single sided hearing loss in approximately 60 neonates, of whom about 20 have a profound sensorineural hearing loss, also called single sided deafness (SSD). As these children have no binaural hearing, they often will experience difficulties with localization of sounds and with speech intelligibility in noisy situations.

As in many other countries, there is no standard care for these children in Belgium, while an increasing body of research suggests that single sided hearing loss is a risk factor for speech-language delays. A cochlear implant (CI) on the deaf side has the potential to restore binaural hearing. It is likely that early implantation is critical for bilateral auditory development.

In our ongoing multicenter study (Leuven, Antwerp, Gent), so far eight infants with SSD have received their CI between the ages of 0;8 and 2;2 (yr;mo) and are tested with age-appropriate materials at regular intervals. We compare data of these children to those of matched normal hearing peers and matched children with SSD without a CI. The children are tested with regard to their receptive and expressive language skills, their cognitive abilities and from four years of age onwards their ability to localize sounds and their speech in noise understanding. Furthermore, language environment is studied with the LENA system and parents are asked to complete questionnaires on auditory behavior, language development and social-emotional and adaptive behavior. Results of the first testing sessions, 2 months pre implantation and 4(/10/16/22/28/34) months post implantation, will be presented at the conference.

Congenital unilateral hearing loss involves multi-modal neuropsychological processing

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Children with congenital unilateral hearing loss (CUHL), although they can hear and learn through the normal hearing side, cannot benefit from binaural advantages and may encounter difficulties in accessing relevant acoustic information in adverse listening environments. Literature has shown that children with CUHL also experience greater difficulties than their normal hearing peers in a variety of domains. Nevertheless, individual performance is highly variable, with some children showing developmental delay and other seemingly demonstrating normal performance and development. Similarly, while recent neuroimaging research information shows effects of CUHL on auditory but also non-auditory brain regions, little is known about specific consequences on clinical neuropsychological domains.

In order to highlight if CUHL affects cognitive disabilities that go beyond auditory system, particularly those connected with Executive Attention, we evaluated 15 children affected by CUHL (age 8-11yrs) with average scores on general cognitive abilities compared to control group (15 children). The assessment battery included tests examining several abilities (Executive attention, visuo-spatial short term memory, visual and motor search, complex visual constructive skills, word and non-word reading), following the rationale that Executive Attention is the basis of several complex abilities. The clinical sample shows significant differences with the control group. We found impairments that go beyond auditory problems and our results support the information derived from functional neuroimaging studies, showing effects of CUHL on auditory but also on non-auditory brain regions and suggesting that CUHL can represent the source of a functional connectivity alteration. Even though CUHL represents a modality specific deficit, it may well involve complex neuropsychological development and multi-modal processing.

Cochlear implantation in children with single sided deafness: congenital cytomegalovirus is the strongest determinant of candidacy

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Objectives: We asked what were the characteristics of children with single sided deafness (SSD) who become candidates for unilateral cochlear implantation (uCI). Study Design: Retrospective review. Methods: Records of 73 children with short duration (< 4years) SSD presenting for uCI candidacy assessment to a tertiary pediatric children's hospital from 2013-2017 were reviewed. Demographics, radiological studies, audiological data, hearing loss etiology and parental decision to proceed with implantation were examined. Results: 73 children with SSD were reviewed. 64 children had completed and 9 were in the progress of candidacy assessment at the time of review. Many (20/64, 31%) did not meet candidacy criteria for implantation, most because of cochlear nerve aplasia/hypoplasia (17/49, 34%) and because 21/64, 32% of families elected not to go forward with implantation. The most common etiologies of SSD in the 23/64 (36%) children who both met candidacy and consented to implantation were congenital cytomegalovirus (cCMV) (10/22, 45%), trauma (4/22, 18%) and cochleovestibular anomaly (3/22, 14%). Conclusions: Many children with unilateral deafness who present for implant candidacy assessment do not ultimately receive uCI. Major factors contributing to non-candidacy are cochlear nerve aplasia and parental decision. Of the proportion of children with SSD (~50%) who are candidates for implantation, most have hearing loss associated that is sudden in onset or carries risk of progressive deterioration in the better hearing ear. These findings provide important insight into this new population of cochlear implant users and the emerging acceptance of this intervention.

MS 56: Preoperative and Postoperative CT and CBCT in Cochlear Implantation

Improved Wrapping Factor (WFi), the importance of the scala diameter. Radiological and histological analysis between standard and improved WF

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Introduction: Radiological analysis after cochlear implantation predicts audiological outcomes of CI recipients. Wrapping Factor (WF) is an extended measurement that evaluates how tight is an electrode to the modiolus. The main problem of WF is that it does not have into account the diameter of the scala in the calculations; so same wrapping factor could means different electrode to modiolo distance. An improved WF (WFi) that takes in consideration the modiolar wall corrects the ambiguity of WF.

Objective: To calculate and compare on temporal bone, histological and Cone Beam Computer Tomography (CBCT) images, the WF and WFi scores and evaluate performance of the masurement

Material and Methods: Three temporal bones were implanted with a CI532. One case has a perfect implantation, the second has been a bit over-inserted and the last case is completed over-inserted. Each measurement, WF and WFi, was done ten times by ten experts with a total of 600 measurements (100 for each data, 3 CBCT and 3 histology). A statistical analysis was performed to compare the measurements between CBCT and histology and between the WF and WFi.

Results: WF does not sort the cases, from the better to the worst, correctly. On the other hand WFi scores each case and are correctly sorted and are clearly differentiated ($p<0.001$ between different insertions). A Gage Repeatability and Reproducibility was performed to evaluate the measurement method treating the histology as the gold standard and analysing the usefulness of the CBCT as a gauge to distinguish between the three insertion cases. The percentage of Gage R&R of total variations in case WF was 48,96% and 24,55% for WFi.

Conclusions: WFi improve the standard WF measurement avoiding the ambiguity that produces the unknown value of the scala diameter. This result in a better sorting of the cases, the lower the value the better perimodiolar position and also, the measurements technique have a lower PRR.

Intraoperative Conebeam CT for assessment of intracochlear positioning of electrode arrays in adult recipients of cochlear implants

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Background and Purpose: Intraoperative cone beam CT (CBCT) has been introduced into the operating room, and provides quick radiological feedback. This study aimed to investigate its utility in the assessment of positioning of the electrode array after cochlear implantation.

Materials and Methods: This was a retrospective study of 51 patients (65 ears) with intraoperative imaging by CBCT (O-arm®) after cochlear implantation between 2013 and 2017. Correct placement into the cochlea was immediately identified. Positioning assessments were later analyzed with OsiriX software.

Results: Intraoperative imaging was quickly performed in all cases. No misplacement into the vestibule or semicircular canals was found. A fold-over of the implanted array was identified in one patient. Secondary analysis by two raters showed excellent agreement on insertion depth angle (intraclass correlation (ICC) = 0.96, $p<0.001$), and length of insertion of the electrode array (ICC = 0.93, $p=0.04$) measurements. The evaluation of number of extracochlear electrodes was identical between the two raters in 78% of cases (Cohen's Kappa = 0.55, $p<0.001$). The scalar position was inconsistent between raters. Comparing O-arm® and high resolution CT images in 14 cases, the agreement was excellent for insertion depth angle (ICC = 0.97, $p<0.001$) and insertion length (ICC = 0.98, $p<0.001$), good for the number of extracochlear electrodes (Cohen's Kappa = 0.63, $p = 0.01$), but moderate for the scalar position (Cohen's Kappa = 0.59, $p = 0.02$).

Conclusion: Intraoperative CBCT using O-arm® is a safe, rapid, easy and reliable procedure to immediately identify a misplacement or fold-over of an electrode array. The insertion depth angle, insertion length, and number of electrodes inserted can be accurately assessed.

Intra-operative evaluation of the cochlear implant electrodes using intra-operative mobile Cone-beam CT

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Objective: To evaluate the electrode status during cochlear implantation (CI) using mobile cone-beam CT (mCBCT)

Study design: Retrospective case review

Setting: Tertiary referral hospital

Patients: Fifty-seven patients (seven bilateral surgeries, sixty-four ears) who underwent cochlear implantation (CI) and took the intra-operative mCBCT images. Twenty-nine patients were less than 10 years old (mean age: 2.9 years old).

Intervention: Cochlear implantation and CBCT during surgery

Main outcome measure: The electrode location and angular insertion depth (AID) determined by intra-operative mCBCT images.

Results: Seven were cochlear malformation cases where intra-operative mCBCT was useful to confirm the electrode location. Among 58 ears with normal cochlear morphology, perimodiolar, slim straight and mid-scalar electrodes were used in 30 (cochleostomy, 14 advance off-stylet technique cases), 27 (26 round window (RW) and one extended round window (ERW) insertion), and 1 (RW insertion) cases, respectively. Complete scala-tympani (ST) insertion was achieved in 35 cases (fourteen cochleostomy and 21 RW or ERW cases). The complete ST-insertion rate was significantly higher in the RW or ERW insertion than cochleostomy insertion ($p=0.03$). The AID values (average ± standard deviation) for perimodiolar electrodes (354.4 ± 29.44 degrees) were significantly smaller than those for Flex24 (464.8 ± 43.09 degrees) and Flex28 (518.2 ± 61.91 degrees) electrodes ($p<0.05$).

Conclusions: Evaluation results of the CI electrodes by intra-operative mCBCT were comparative to those utilizing fan-beam CT or C-arm based CBCT. Considering the low radiation dose of mCBCT and its availability in any operation room, mCBCT is the better selection as a modality to evaluate CI electrodes.

Automated three-dimensional cochlear surface from clinical computed tomography scans

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Background Better knowledge of the cochlear morphology of individual patients may improve the outcomes of cochlear implantation. Extracting the 3D surface of the cochlea from clinical CT (computed tomography) scans in a manual fashion would be an error-prone, cumbersome and time-consuming process. Hence, we propose a new automated segmentation algorithm for the cochlea from clinical CT scans to obtain 3D surfaces of the individual cochlear anatomy.

Methods The clinical CT scans are reoriented and resliced in order to obtain midmodiolar slices. Next, the cross-section of the cochlear tube, i.e., the cochlear contour, is segmented on every slice, following the spiral shape of the cochlea. In order to determine the cochlear contour, we extract the pixel intensities of the midmodiolar CT image along rays that project outwards from the center of the cochlear contour. The profiles that contain these pixel intensities are then searched for troughs and peaks and we ultimately derive the cochlear contour as a function of these troughs and peaks. Finally, by connecting all cochlear contours, we reconstruct the 3D cochlear surface.

Results We obtained 3D surfaces for the first 1.5 turns of 648 cochleas. Validation of our algorithm against 8 manually segmented ground truths from micro CT showed good agreement with 90% area overlap and a 0.11mm average distance between our result and the ground truth.

Conclusion We designed an algorithm to obtain sub-resolution segmentations of the cochlea from clinical CT scans. With this algorithm, we are planning a detailed analysis of individual cochlear morphology in the context of cochlear implantation. Our method will allow investigation of the size and shape variability for a large dataset of human cochleas and it might enable a personalised selection of implant design as well as insertion planning guided by the patients individual morphology.

Evaluation of intracochlear trauma using Cone-beam CT (CBCT) in pediatric CI

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Introduction: Cone beam CT (CBCT) is a valuable tool for evaluation and quality control of the cochlear implant electrode position postoperatively. It provides a chance to demonstrate the delicate cochlear structures with high resolution quality, with a rapid scan time and lower radiation dose to be used in the pediatric population. Objectives: We set up a prospective study to evaluate the value

of CBCT in evaluation of insertion of cohlear implant electrode and any intracochlear trauma Patients and methods: Children who underwent cochlear implantation for bilateral profound sensorineural hearing loss in Ain Shams University hospitals in the period from January 2017 till June 2017 were included. Different types of electrodes were used from all known manufacturers. Patients underwent CBCT 3-6 months following implantation. Basic films in the axial plane were taken then reconstruction was done in different planes, and the following parameters were measured: major cochlear diameter, the electrode-modiolar distance (EMD) and the angular depth of insertion of the array. Evaluation of position of electrode, whether in scala tympani or scala vestibuli, was done, noting the complete or incomplete insertion. Cochlear trauma was recorded and graded, on a scale from 0-4, according to Eshraghi et al, 2003. Results: In a total of 36 cases, the mean major cochlear diameter was 8.9 x 6.4mm; the EMD for the first electrode was 4.8mm.The mean depth of insertion was 368°. There were 4 cases with grade 1 trauma, 2 cases with grade 3 trauma and 2 cases with grade 4 trauma. Incomplete insertion was found in 6 cases. Conclusion: CBCT was very informative in evaluation of intracochlear trauma by visualization of the electrode position in relation to the osseous spiral lamina. It can also evaluate the incomplete insertion, kink of the electrode and exact location of the different electrodes inside the cochlea.

A data driven concept to choose the optimal CI electrode array

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Background: A Cochlear Implantat (CI) is a successful therapy in the treatment of total or severe hearing loss. Various electrodes from different manufacturers exist and often the patients choose the manufacturer in advance. The surgeons decide, based on their subjective experience, which electrode type and length to implant. It is known that the cochlea anatomy varies in length and shape among the population. There is a large range in the hearing outcomes for CI patients that is not yet sufficiently well understood and we don't have a theoretical model for the optimal electrode position.

Methods: Therefore, we suggest a data driven approach: In an ongoing retrospective investigation of more than 670 patients with MED-EL FLEX electrodes, we manually evaluate the pre- and postoperative radiological images in terms of the individual cochlea anatomy (cochlear duct length, lateral wall helix) and the exact post-op location of all inserted electrode contacts. Moreover, speech understanding, residual hearing, medical background and individual history of hearing loss were taken into account. After considerable efforts to normalize, clean, and link all the mentioned information, we can apply and compare different supervised machine learning methods like decision trees, Gaussian processes, neural networks, or logistic regression in order to predict the post-operative speech performance and the residual hearing.

For the learning of these models, the different post-op hearing and speech tests have to be combined into a single number to compare the success of implantations. Furthermore, all the pre-operative data have to be mapped to define "similar" patients.

Conclusion: Now, it is possible to tap the hidden knowledge of a large patient database: Suggesting the optimal electrode and insertion depth that retrospectively led to the best hearing outcome for patients with similar anatomy and residual hearing. We present the conceptual benefits and limitations of such a system.

Instructional Courses & Tutorials

Tutorial: The Swiss Robotic Experience

Feasibility of pediatric robotic cochlear implantation in phantoms

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Objective: To demonstrate the feasibility of robotic cochlear implant surgery, in phantoms, by anatomical study and drilling experimentation. Study design: Pilot study. Materials and Methods: Computed tomographic preoperative encrypted data of twelve pediatric patients (total of 24 sides), between eight months and six years of age, who undewent cochlear implant surgery, were studied, eight were used to create 3D printed phantom models, followed by drilling with the Hearo robot system. Results: Eight temporal bones phantoms created from data of previously implanted CI children between eight months and six years old were successfully drilled on this study and twenty-four temporal bones trajectories were planned. Conclusion: Trajectory planning, distances measurements and drilling proposed on this study were viable. To validate the proposed procedure in pediatric population in a more realistic clinical setting, more studies will be conducted in the future.

Instrument flight to the inner ear

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Motivation: Robotic technology has the potential to overcome human operator limitations and allow reproducible, minimally invasive cochlear access and a controlled electrode insertion process. Robotic technology could lead to deliberate and accurate placement of the electrode in the inner ear, for higher consistency of residual hearing preservation and improved audiological outcomes. More importantly, the increased consistency of a robotic procedure potentially widens CI patient eligibility in the future (Weber et al. 2017).

Method: Our work has focused on the development of a precise and safe approach for robotic middle ear access. In a step-wise process we addressed all stages of middle-ear access for RCI: a precise, stereotactically and image controlled drill process using a task-specific robotic technology, secondary positional estimates using correlations of bone density and drill force and task-specific neuromonitoring to detect whether the robotic drilling process passes at a sufficient distance from the facial nerve . These stages are designed to permit middle ear access that intends to create reproducibly a keyhole drill trajectory (diameter 1.5 to 2 mm) from the skull surface to a predefined target on the cochlea (Figure 1b). Finally, to enable an end-to-end, robotic cochlear implantation procedure, strategies for optimal electrode selection and sufficient placement of the cochlear implant electrode through the robotic keyhole have been developed and validated.

Results: Here we describe how our robotic treatment model is applied to our technology and then used to carry out a first-in-man clinical trial. To date, 7 patients have been included in the trial and were treated with the technology (we expect to have finished the full trial n=10 by June 2018).

The presentation will focus on the technical aspects of the robotic technology and its safety systems, aspects of feasibility, perioperative safety and future directions of research.

Robotic cochlear implantation: first clinical results

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Introduction: Robotic cochlear implantation is a new minimally invasive approach for CI surgery. The procedure is currently evaluated in a clinical trial at the Inselspital in Bern, Switzerland. The aim of this presentation is to report preliminary clinical results of the first cases of robotic cochlear implantation.

Methods: The clinical study was approved by the local IRB and regulatory body. Preoperative assessments included morphological evaluation using CT, taste examination and facial nerve neurography. During surgery, four bone fiducial screws were inserted behind the ear and CT (0.2 mm resolution) was performed to plan a drill trajectory from

the mastoid surface, passing through the facial recess to the center of the round window. Access to the middle ear was drilled using a previously developed task specific image-guided robotic system. Sufficient

clearance of the drill trajectory from the facial nerve was confirmed using intraoperative cone beam CT imaging.

Upon completion of drilling and screw removal, a tympanomeatal flap was created and the round window membrane was exposed. An implant bed was prepared and the electrode array was manually inserted using a specifically manufactured insertion tube. Correct placement and nominal function of the implant was verified by telemetry and postoperative CT imaging. Postoperative facial nerve neurography and taste examination took place two weeks postoperatively. Audiological assessment was performed as part of routine clinical care.

Results: Robotic middle ear access was completed in 6 patients, with successful electrode insertion according to the preoperatively defined plan. Audiological results for all patients are currently being collected.

Conclusion: We have demonstrated in 6 patients that a CI electrode can be successfully inserted into the cochlea through a 1.8 mm keyhole access created by a surgical robot. The workflow with the robotic setup requires additional setup time and extensive teamwork.

Neuromonitoring during robotic cochlear implantation: initial clinical experience

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Objectives: During robotic cochlear implantation (RCI) a drill trajectory passes at distances below 1mm from the facial nerve (FN) and thus safety mechanisms for protecting this critical structure are required. Nerve monitoring (NM) is used during otologic surgery to aid the surgeon in localizing the FN in difficult revision cases (e.g. cholesteatoma surgery) or during CI. Herein, a facial nerve monitoring (FNM) approach specifically developed for RCI is validated during the initial cases of a first-in-man clinical trial.

Materials and Methods: The FNM system is based on a commercial electrical nerve stimulation and monitoring system customized with a multipolar stimulation protocol and proprietary software. The approach relies on three functionalities: (1) sensitivity monitoring of the nerve via a positive control stimulating channel (superficial FN branch), (2) free-running electromyography (EMG), (3) Safety distance assessment based on bipolar/monopolar stimulation at specific predefined locations near the FN (0.5mm axial steps). Safe (>0.4 mm) and unsafe (<0.1 mm) drill-to-FN distance margins were defined based on stimulus thresholds from in vivo preclinical studies (≤0.3 mA, bipolar stimulation).

Results: The FNM approach was successfully applied in all RCI cases where a trajectory was drilled through the facial recess into the middle ear (n=6 patients). The neuromonitoring approach determined safe passages in all cases (remaining bone thickness >0.4 mm) to the preoperative FN, as confirmed, first by intraoperative (CBCT) and then by postoperative (CT) image analysis. The ability of the approach to distinguish distances from the trajectories to the FN under the safety margin (<0.4 mm) could not be evaluated from the existing cases.

Conclusion: The proposed facial nerve monitoring approach aided the surgeon in decision making during the initial clinical cases of robotic cochlear implantation. The method is being prospectively evaluated during in vivo trials.

Image-based safety analysis for robotic cochlear implantation

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Objectives: During robotic cochlear implantation, a tunnel is drilled from the surface of the mastoid to the middle ear, passing through the facial recess utilizing image guidance technology. Herein, we present an image-based safety assessment method for intraoperative drill tunnel verification, which was evaluated on ex-vivo and in-vivo cases.

Methods: We performed robotic middle ear access in 23 human temporal bones. Drilling was stopped 3 mm before the level of the facial nerve and a titanium rod was inserted into the drill tunnel. Intraoperative images were acquired to detect the rod pose. Based on the detected rod, the distance between the drilled tunnel and the preoperatively segmented facial nerve was predicted. In addition, an experienced neuroradiologist manually predicted the distance to the facial nerve using a conventional MPR viewer. After drilling completion through the facial recess, the predicted distances were compared with the postoperative distances (micro-CT, 0.06 mm isotropic). In addition, the applicability of the proposed method was evaluated on cases of our first-in-man clinical study.

Results: In the ex-vivo experiments, our method predicted the distance with higher accuracy (average = 0.05 mm, min = 0.00 mm, maximum= 0.15 mm) than manual prediction.

The algorithm was applied in 7 in-vivo cases and successfully verified safe and unsafe trajectories.

Conclusion: The proposed method seems to be valuable as additional safety measure in RCI procedures. Assessment by manual prediction (limited by resolution and contrast) can be improved with computer-assisted approaches.

RBANS-H:

Repeatable Battery for the Assessment of Neuropsychological Status for hearing Impaired Persons

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Background: Currently, an independent relationship between hearing loss and cognitive decline in older adults is suggested by prospective studies. In general, cochlear implants improve hearing and the quality of life in severely to profoundly hearing impaired older persons. However, little is known about the effects of cochlear implantation on the cognitive evolution in this population. To investigate cognitive functioning in this hearing impaired population, the addition of visual support to a cognitive test battery is considered necessary. Only by providing visual and auditory instructions allows testing in a reliable and identical manner before and after implantation to make sure that a possible improvement on the cognitive test cannot be attributed to the improved hearing with the CI.

Aim of the instructional course: The primary goal of this course is to provide a detailed discription of the use (performing and scoring) of the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS), adjusted to test Hearing impaired subjects (RBANS-H).

RBANS_H. The RBANS assesses five cognitive domains (Table 1). The administration of the test is accompanied by the use of a PowerPoint presentation shown on an external computer screen connected to a laptop. By means of this presentation all the oral instructions are supported by written explanations to ascertain that the subject understands the instruction even though he or she does not hear what is being said. The major added value is that this test makes it possible to calculate one total score of overall cognition, and also provides the opportunity to calculate the index RBANS-H scores per domain. The RBANS is sensitive to detect mild cognitive impairments in individuals aged 12 to 89 providing extended normative data per age category. The test effectuates the possibility to differentiate in a wide range from normal to moderately severe cognitive impairments. Another major advantage of the RBANS is that this test has a good sensitivity to change with 90% and 95% confidence intervals provided for the total score as well as each index score. The test is validated and available in English and Spanish, and easy to translate to other languages through the process of forward-backward translation. It takes around 30 minutes to administer the RBANS.

TABLE 1. Cognitive subdomains of the RBANS(-H)
1. Immediate Memory (List Learning, Story Memory)
2. Visuspatial/constructional (Figure Copy, Line Orientation)
3. Language (Picture Naming, Semantic Fluency)
4. Attention (Digit Span, Coding)
5. Delayed Memory (List Recall, List Recognition, Story Recall, Figure Recall)

EFAS-Session:

Audiologic CI-assessment in patients with special needs

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This session of the European Federation of Audiology Societies (EFAS) addresses topics pertinent to the pre- and postoperative assessment of cochlear implant (CI) candidates and recipients with special need. Specifically, the three topics CI assessment in children, objective fitting of CI in children and adult candidates with psychogenic hearing loss are addressed.

Since the implementation of universal newborn hearing screening has been well developed in many countries (e.g. in France since April 23rd2012), the diagnosis of children's hearing disorders can be done very early. Both behavioral and objectives audiometry testing associated with a complete ENT examination have to be performed rigorously and correlated providing an accurate and early diagnosis. Multidisciplinary teams, strict selection criteria, long-term intervention programs, and strong engagement of parents and caregivers have provided successful CI outcomes.

Regarding the fitting of CI-systems, electrically evoked auditory steady state brain responses (EASSR) can be used to objectively determine hearing thresholds in cochlear implants. Also, it has been demonstrated that the local variability in modulation coding as reflected by the ASSRs is highly correlated with speech perception in noise.

Occasionally, CI centers see adults with psychogenetic hearing loss and the explicit wish for a cochlear implantation. Usually, we see bilaterally very poor hearing thresholds in pure tone audiometry, but either much better or even normal thresholds are found when using objective tests such as OAE and ABR. An overview over some aspects of this special group of CI-candidates, such as psychiatric co-morbidities, are presented.

Instructional Course:

How I do it: the Fundamentals of Structure and Hearing preservation Cochlear Implant Surgery

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Objectives: To provide a guide on how to perform structure preservation surgery in cochlear implantation in order to maximise hearing preservation and balance function.

Materials and Methods: Review of the key elements of structure preservation surgery and discussion of the evidence supporting the different steps in structure preservation surgery with indication of future directions

Conclusion: The evolvement of the techniques of structure preservation surgery over the last decade have led to improving and reliable preservation of inner ear function. New pharmacologic agents,insertion devices and refinements in electrode array design and materials will continue to improve structure preservation in cochlear implantation.

Focus Sessions

FS 57: Supportive Surgical Measures

Are intraoperative and postoperative complications a stress factor for the surgeon?

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The preoperative assessment of children and adults for the cochlear implant is the surgeon's main concern. Esplication is a simple one: the knowledge and evaluation of cochlear malformations in order to prevent unexpected complications in the surgical procedure.

At the ORL Tirgu Muresam clinic were performed a retrospective observational study of the performances after single and bilateral cochlear implantation. 40 patients with a single and bilateral cochlear implant were performed during 2014-2017.

The results showed the presence of an intraoperatively associated with cochlear malformation with Gusher syndrome, 1 case of peripheral facial paralysis ,3 weeks after surgery, 1 implant extrusion at 2, 6 years after implantation.

In conclusion, we can say that the apathy of Gusher syndrome could be anticipated as a result of malformation by imaging. Postoperative complications could not be anticipated despite careful postoperative care investigations. Whatever the complications they may have, they are an additional stress factor for the surgeon, but it does not affect the operator's prospects.

The emotional impact of cochlear implant revision on pediatric patients and their families

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Objective: To evaluate to psychological impact and expectations on CI users and their families after cochlear implant failure and revision experience.

Method: a survey was provided to complete by 12 pediatric cochlear implant recipients between the age of 7 and 18 years , who had or having device failure experiences . Ten users had one device failure and underwent re implantation and two of those users had more than one device failure at young age and did not prefer to go through the second revision.

Results: in process.

The role of antibiotics in cochlear implant surgery

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There is no consensus regarding the use of perioperative or postoperative (prophylactic) antibiotics specific for cochlear implant (CI) surgery. Prophylactic antibiotics inhibit the growth of contaminating bacteria. With particular respect to prosthetic implants they can reduce adherence to the device.

The aim of this study is to assess our perioperative and prophylactic prescribing of antibiotics who have undergone cochlear implantation in a single centre. The overall incidence of post-operative infection following CI surgery in our centre is also determined.

Methods: A retrospective review was performed of all adult and paediatric patients who underwent cochlear implantation at St. Thomas' Hearing Implant Centre between 01/06/2014 and 30/09/17.

Relevant data for the study were collected from the departmental implant database (Auditbase). Relevant information regarding antibiotic prescribing (both perioperative and postoperative) was obtained from the patient's record.

Results : 435 CI cases were identified. All received intravenous antibiotics peri-operatively but prophylactic antibiotics varied.

The overall infection rate was 5.5% (n=24/435), including 17 superficial wound infections and 7cases of AOM. These were categorised into minor infections (n=18, 4.1%

of total) and major infections (n=6, 1.4%). With respect to the minor cases, 17 patients required oral antibiotics and one patient required topical treatment. Five of the six major cases resolved with intravenous antibiotics, followed by oral antibiotics. One case resulted in explantation.

Of the 24 cases of post-operative infection, 6 patients (25%) had received intravenous perioperative antibiotics only, compared with 18 (75%) who had received a one week course of prophylactic oral antibiotics in addition.

Conclusion: There is insufficient evidence found in the literature to suggest that prophylactic antibiotics in ear surgery reduces postoperative complications, which is consistent with our findings.

The use of prophylactic antibiotics should be used at the discretion of the surgical team and based on sound reasoning with respect to the individual patient's risk factors and the micoorganisms that need to be covered. We acknowledge that antibiotics will be required in a cohort of patients.

Cochlear implantation in head and neck irradiated patients – Special considerations and surgical techniques

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Background: Despite newer techniques in the delivery of Irradiation for Head and Neck Cancer patients such as IMRT and Proton therapy, many patients receiving Irradiation suffer delayed onset severe to profound senosorineural hearing loss. This is compounded by the concurrent or adjuvant administration of platinum based chemotherapy. As such, these patients often have need for cochlear implantation when all other avenues of hearing augmentation have been exhausted.

Materials and Method: A retrospective study of 511 cochlear implant surgeries from 1997-2015 were reviewed. This showed a total of 10 adult implantations with a prior history of head and neck irradiation. These patients all completed their radiation therapy more than 5 years prior to implantation and had no clinical or radiological evidence of cancer recurrence. The follow up period ranged from 6 months to 11 years.

Outcomes: 1 patient was lost to follow up and another patient deceased due to age related cardiopulmonary arrest. Amongst the rest, 2 patients suffered major wound infections. In 1 patient, the implant was salvaged using a variety of methods including wound debridement and local rotation flaps. In the other patient, there was complete extrusion of the device necessitating explantation. There was a total of 6 patients had co-existent chronic suppurative otitis media. The hearing outcomes of this group of irradiated patients compared very similarly to reference non-irradiated control patients matched according to age, gender and similar pre-implant hearing profile. Surgical techniques have evolved and now the standard is to perform a 2 stage surgery with a 1st stage subtotal petrosectomy and blind sac closure with a 3 month interval before proceeding to the 2nd stage cochlear implantation.

Management of major surgical wound infections in cochlear implantation: Successful salvage rates and lessons learnt

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Background: The most commonly reported major complication in Cochlear Implant surgery is surgical site/flap infection with a range of incidence of between 1-12%. Such a major wound infection is dangerous and may have potentially devastating consequences including intracranial infections, extrusion of the implant and also eventual need for explantations. Chung et al., 2010; Hopfenspirger et al., 2007;

Methods and Results: A 14 year retrospective review of all cochlear implant surgeries performed in a single tertiary institution was performed. There were a total of 385 patients (286 paediatric and 99 Adults) who underwent a total of 420 cochlear implant surgeries. There was a total of 7 patients from this single tertiary hospital who had to be admitted for management of their major wound infections. There was another 1 patient who had his cochlear implant surgery performed in another institution but was admitted to this hospital for further management of his major wound infection. The total incidence of major surgical wound infection was therefore 1.66% (7 out of 420 CI Surgeries). Of the 8 major surgical wound infections, 6 were able to salvage their cochlear implants, resulting in a salvage rate of 75%. The majority of the infections occurred in children whereas there were only 2 adults who presented with major wound infections and in both these patients, there was a prior history of Irradiation to the Head and Neck region due to previous malignancies.

There was a positive bacterial culture in 50% of the patients and all the positive cultures were for Staphylococcus aureus. The earliest onset of infection occurred at 1 month postoperation whereas the latest presentation of infection was 3.5 years after the cochlear implant operation.

The most common etiology amongst these patients was that of a stitch abscess. This was found in 62.5% of the patients (5 out of 8). The suture material used in these stitch abscesses were prolene in 4 of them and vicryl in 1 of them. Another major contributing factor was that of prior irradiation to the head and neck region due to underlying previous malignancies, which accounted for 25% of the wound infections.

Management issues: Management of these surgical wound infections would be showcased including the use of intravenous antibiotics, surgical debridement of the wound, the use of local rotation soft tissue flaps as well as the creation of an alternate receiver stimulator well more anteriorly. These aggressive management steps have led to a successful salvage rate of 75% of the infected wound sites/implants. Lessons learnt include the avoidance of using

prolene for tie down sutures and the need for lifetime surveillance given the possibility of very delayed onset of the surgical wound infections.

Cochlear implantation complications and explantations decision

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Objectives: To review cases involving implant failure and local complications leading to revision surgery or explantation in our pediatric cochlear implantation program.

Materials and methods: We used a retrospective study to analyze cases whom showed complications and failures among pediatric population fitted with cochlear implantation over a period of nine years, between January 1st , 2009 and Mars 31st , 2018

Results: 141 patients received unilateral cochlear implant in three different hospitals. The vast majority represented by 133 cases (94%) of children at the time of implantation. Per operative complications are mostly represented by 02 cases of intratympanic inflammation and its consequences, which induce bleeding while performing surgery. Two retro auricular hematoma, which required a surgical drainage, represent the immediate postoperative complications. The complications in the medium post-operative period are mainly represented by 07 cases of delayed wound healing among whom 4 cases require explantation and the others managed with medical treatment against infection and controlled wound healing. The late complication are represented by one hard failure three years after cochlear implantation on a girl fitted with a Nucleus CI512 with Contour Advance electrode from Cochlear before their voluntary recall. The second complication is represented by a keloid.

Conclusion: Diagnosis of failed cochlear implants or complications, with subsequent explantation or reimplantation remain the main problems for cochlear implant programs. The assessment of implant function, and received site, start with the skin incision and never end. The analysis should take into account all relevant factors, including in particular, speech perception considerations, device type, cause of failure and surgical challenges related to revision. However, despite these complications, cochlear implantation remains a simple and safe procedure regarding to benefits.

FS 58: Intra-operative Measurements in CI

Quantification of intracochlear Auditory Evoked Potentials (AEPs)

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Objectives: The objectives of this study were: 1) to identify the most sensitive frequency for recording of cochlear microphonics (CM) in cochlear implant users with a wide degree of hearing abilities and deep electrode insertion; 2) to identify the optimum location within the cochlea for recording of intracochlear potentials.

Material and Methods: Eight females and 8 males were implanted with Flex 20 (n=1); Flex 24 (n=8); Flex 28 (n=1); Flex Soft (n=5); Medium (n=1) and Standard electrode array with cochlear implants Pulsar, Concerto or Sonata, Med-El Corp. Intracochlear acoustically evoked potentials (AEPs) were recorded from the cochlear implant electrodes.

Results and Conclusion: The mean degree of electrode insertion for tone pips of frequency at 250, 500, 1k, 2k and 4 kHz and for the 1 ms click at the location within the cochlea where the maximum CM peak-to-peak amplitudes and peak-to-peak amplitudes occurred were: 312.2 ±198.5, 294.4 ±182.1, 248.4 ±181.0, 171.6 ±149.6, 152.8 ±129.2, and 295.3 ±218.2 μV, respectively, and the mean maximum ACMpp amplitudes were: 109.5 ±116.2, 154.3 ±151.8, 161.3 ±170.2, 148.1 ±229.5, 106.1 ±147.6, and 166.4 ±171.2 μV, respectively.

Among the tone pips of various frequencies, 1k or 500Hz were the most sensitive for cochlear implant users. The most sensitive place in the cochlea to record the CM potentials depended on the tone frequency used. The deeper into the cochlea the mean maximum CM peak-to-peak amplitude was measured, the lower the stimulating tone frequency was.

Long term monitoring of the inner ear function during and after cochlear implant insertion using cochlear microphonics

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Introduction: To preserve residual hearing during cochlear implant (CI) surgery it is desirable to use intraoperative monitoring during the electrode insertion. A promising method is the recording of cochlear microphonics (CM). The aim of the monitoring is to identify critical steps as well as to modify the ongoing insertion procedure

immediately if necessary. Within this project the relation between intraoperatively recorded CMs and long term preservation of residual hearing shall be investigated.

Method: During the insertion of hearing preservation electrodes, different modes of intraoperative CM recordings were performed. In one mode the potentials were recorded extracochlearly using a cotton wick electrode at the promontory wall before, during and after insertion. In a second mode the potentials were recorded intracochlearly directly after insertion and postoperatively during the follow up appointments. These recordings were conducted using the CI electrode (MED-EL) and a special software tool. The acoustic stimulation with tone bursts (250 Hz, 500 Hz, 1000 Hz) was delivered via insert earphones. The follow up recordings are planned to take place up to one year after implantation. So far 10 patients are included who currently have passed multiple appointments.

Results: Extracochlearly recorded CMs showed spectral peaks of maximal 0.5 µV at the stimulus frequency bin for most patients. Intracochlearly, peaks of up to 30 µV were detected. In the primary long-term data, the amplitudes of CMs measured at consecutive appointments throughout one year seem to correspond well to the audiometric pure tone thresholds measured at the same appointments.

Conclusion: Both measurement setups were found to be very feasible for recording CM. The amplitudes of intracochlearly recorded CMs were observed to be much larger than the extracochlearly recorded CMs. Long-term thresholds detected via the CM response correlated to audiometric pure tone thresholds.

Correlation between extracochlear electrocochleography responses during cochlear implantation and hearing preservation

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Background: Minimizing cochlear trauma during cochlear implantation has become a goal in all CI surgeries for multiple reasons. Electrocochleography (ECoG) is promising method to monitor the cochlear function and possible trauma during cochlear implantation. The goal of this study is to assess by EcoG at which times during cochlear implantation changes of the cochlear function occur, and to correlate EcoG changes with postoperative hearing thresholds.

Methods: Extracochlear EcoG responses to acoustic tone bursts and to click stimuli were recorded multiple times before, during, and after insertion of the cochlear implant electrode array. The recording electrode was placed on the promontory and left in an unchanged position for all EcoG recordings. Pure-tone audiograms were conducted 1 day before and 4 weeks and after surgery.

Results: During insertion of the cochlear implant electrode two different patterns occurred: 1) EcoG responses remained stable, suggesting atraumatic cochlear implant surgery, 2) At one point during insertion a decrease of EcoG responses occured – suggesting cochlear trauma - and continued until the last EcoG recording. Decrease of high-frequency EcoG responses to click stimuli occurred without detectable changes of low-frequency EcoG responses. A reduction of EcoG responses during insertion was associated with a hearing loss of > 11 dB 4 weeks after surgery in all cases. Stable EcoG responses did not exclude postoperative hearing loss.

Conclusions: Changes in cochlear physiology during cochlear implantation can be monitored using extracochlear EcoG recordings. Cochlear trauma during insertion of the cochlear implant electrode array seems to cause deterioration of cochlear function which continues during the early postoperative phase and is associated with a postoperative hearing loss exceeding 11 dB. Atraumatic insertion does not exclude postoperative hearing loss which suggests postoperative mechanisms to play a role.

Relationship between electrophysiological parameters and the intracochlear electrode position of Cis

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Objectives: The electrode position of cochlear implants is important for the electrode-auditory nerve interaction. In clinical practice, the position is assessed by radiological imaging, resulting in a radiation exposure to the patient. Electrophysiological characteristics such as electrode impedances as well as ESR and ECAP thresholds proved to be appropriate for the quality control of the electrode-auditory nerve interaction. This work therefore investigated the relationship between spatial and electrophysiological parameters.

Material and Methods: The study was conducted retrospectively on 55 adult patients, implanted with a Nucleus® CI532 or CI512 system (Cochlear Ltd.). Intraoperative electrode impedances, ECAP thresholds and ESR thresholds as well as one month after first fitting obtained impedances and ECAP thresholds were compared with spatial parameters as wrapping factor, insertion angle and electrode-modiolus distance. The Electrode position was determined by CT or DVT imaging which had been measured in the first week after surgery.

Results: Variations in wrapping factor have no effect on the electrophysiological characteristics for the investigated implants. ECAP and ESR threshold are significantly related to the electrode-modiolus distance and insertion angle. As expected, no significant relation was found between impedances and spatial parameters.

Conclusion: Electrophysiological parameters such as ECAP and ESR thresholds are related to the intracochlear position

of cochlear implants, but other factors as surviving nerve cells as well as tissue growth around the implant also play a role. Further investigations have therefore to deal with the relationship of these factors to the electrophysiological parameters.

Objective intraoperative identification of electrically elicited reflex thresholds during cochlea implantation with a fully digital surgical microscope

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Introduction: Electrically elicited stapedius reflex thresholds (eSRT) are used as an objective measure for the determination of discomfort level of patients after cochlear implantation. Intraoperative visual observation of eSRT during cochlear implant surgery may help to predict initial comfort level for the fitting of the speech processor of the cochlear implant. Currently, the intraoperative identification of eSRT is done optically by the surgeon and dependent of his subjective assessment. Furthermore, the optical method is only a binary method (reflex yes/no) and any quantification is nearly impossible because of the small movements after stimulation.

Materials and Methods: Based on the imaging of a digital surgical microscope (ARRISCOPE, Arnold & Richter Cine Technik, Munich, Germany) we developed an algorithm to automatically identify the eSRT and to measure the deflection of the stapedius muscle during stimulation. For evaluation, video captures from eSRT of n=6 cochlea implant surgeries were analyzed. In the audio track of the videos the moment of stimulation was encapsulated by linking the stimulation computer to the microscope which is recording the video. Identified eSRT by the software were then compared with the intraoperatively visually identified eSRT by the surgeon.

Results: Overall 390 electrical stimulations were performed. In n=175 stimulations an eSRT was identified optically by the surgeon, the software identified n=207 reflexes, respectively. Additionally, a correlation of the stimulus strength with the length of the motion vector on the stapedius muscle could be calculated.

Conclusions: It could be shown, that an automated detection and quantification of eSRT is possible with a digital surgical microscope. Furthermore, the automated routine is more sensitive than the surgeon´s assessment. If, in a larger data series, these results can be confirmed, an objective correlation between current units and eSRT with comfort levels for cochlea implantees could be established. A real-time tracker for intraoperative analysis could help to improve the standardization for post-operative fitting of cochlear implants.

Relationship between electrophysiological parameters and the intracochlear electrode position of Cis

Mewes A.[1], Brademann G.[1], Müller-Deile J.[2], Hey M.[1]

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Results: Variations in wrapping factor have no effect on the electrophysiological characteristics for the investigated implants. ECAP and ESR threshold are significantly related to the electrode-modiolus distance and insertion angle. As expected, no significant relation was found between impedances and spatial parameters.

Conclusion: Electrophysiological parameters such as ECAP and ESR thresholds are related to the intracochlear position of cochlear implants, but other factors as surviving nerve cells as well as tissue growth around the implant also play a role. Further investigations have therefore to deal with the relationship of these factors to the electrophysiological parameters.

Intracochlear auditory evoked potentials

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Objectives :Currently, it is possible to implant patients with Partial Deafness (PD), with normal hearing up to 1.5kHz and with high frequency severe to profound sensorineural hearing loss with certain degree of hearing preservation after the cochlear implantation. Using minimum invasive insertion technique significant amount of residual hearing could be preserved.

Having functional hearing in low and mid frequency region and implant electrode in the vicinity of hearing cells gives an opportunity to record acoustically evoked or acoustically and electrically evoked responses directly from the cochlea.

Our work showed that recordings of acoustic evoked potentials directly from the different places of cochlea are possible using implant electrode.

Material and Method: 50 implanted adults participated in this study. All of them use Med-El devices like Pulsar, Sonata, Concerto and Synchrony.

The acoustical stimuli (250Hz, 500Hz, 1000Hz, 2000Hz and 4000Hz) were presented via inserts placed in the ear canal of the subject in implanted ear. The personal computer with Synergy system was used for controlling and providing acoustical stimulation. Near field responses were recorded from multichannel intracochlear electrode using MAX programming interface.

Results: Responses for all frequencies were obtained for 37 of 50 patients. Ampilitude of the responses vary from patient to patient as well depend from stimulation and recording parameters.

Conclusions: Preliminary results, presented in this work, show possibility of acoustically evoked responses from the cochlea using multichannel electrode of cochlear implant. Additionally, the results point to parameters which maximize the probability of receiving responses.

The ‚pullback' technique - Electrophysiologic changes slim modiolar cochleaimplant electrode arrays

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Introduction: The exact position of the CI electrode array within the scala tympani is essential for a satisfying audiological outcome. If the electrode array is closer to the modiolus a better hearing outcome as well as lower NRT-thresholds can be expected. By using the ‚pullback' technique a closer perimodiolar position of the electrode can be achieved.

The aim of our study was to characterize intraoperative electrophysiologic characteristics after the ‚pullback'.

Material and Methods: In a prospective monocentric setup ten patients were implanted with a slim modiolar electrode array. After complete insertion NRT-thresholds were measured. A ‚pullback' was performed and NRT-thresholds were measured again. Postoperative the intracochlea position of the electrode array was verified with flat panel tomography.

Results: Electrophysiologic significant lower thresholds were found after the ‚pullback'. Postoperative the position of the electrode array was verified within scala tympani in all cases with adequate insertion depth.

Discussion: The cochleaimplantation for hearing impaired patients with bilateral and unilateral deafness has become a major role in modern auditory rehabiliation. Perimodiolar electrode arrays are closer to the modiolus and show lower NRT-thresholds. Lower NRT-thresholds were found after the ‚pullback'. Nevertheless dead regions of the spiral ganglion have to be kept in mind.

FS 59: Connectivity with Sound Processor and Listening Devices

Early experience with the Nucleus® 7 sound processor

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Objectives: To determine the impact of enhanced mobile connectivity of the Cochlear™ Nucleus® 7 Sound Processor on clinical practice.

Materials and Methods: The Nucleus 7 offers direct audio streaming from a compatible mobile device, and can be controlled and monitored with the complementary Nucleus Smart App. Prior to its release, clinical surveys were collected from 50 clinics in EMEA countries over a three-month period.

Results: Direct audio streaming figured with 33% amongst the top three key reasons for candidates to choose the Nucleus 7 over the off-the-ear Kanso™ Sound Processor. Other reasons were the cosmetics of the behind-the-ear option (57%) and battery options (38%). Evaluating their Nucleus 7 experiences, clinicians identified a few challenges on additional knowledge required around mobile connectivity that had to be yet established after training. The majority of initial activation sessions took a similar amount of time compared to fitting other Nucleus Sound Processors. 38% of recipients with a compatible mobile device successfully downloaded and logged into the Nucleus Smart App prior to their first fitting. In case recipients needed assistance on this prior to the fitting, recipients most often contacted the clinic (71%). Overall, 91% of the clinicians agreed that the Nucleus 7 was easy to fit. A trend was seen in a change of clinical practice (19%). This was mainly noted in the area of scheduling longer clinical sessions due to the increased number of features to cover, e.g. mobile connectivity, wireless accessories etc.

Conclusion : Early experiences indicated that fitting the Nucleus 7 including its enhanced mobile connectivity was easy and not a significantly different experience than with previous processors. Clinics experienced a steep learning curve on how to optimize their counselling and fitting practice, as they found themselves in an increasingly connected environment with an increasing number of auxiliary devices to handle.

Acceptance and use of wireless accessories in adult cochlear implant recipients

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Difficulty understanding speech in background noise is a common problem for the hearing-impaired. Remote microphone devices are intended to provide listeners with a good signal-to-noise ratio (SNR), thus improving signal audibility and speech understanding. Assistive listening devices such as FM systems and wireless remote microphone accessories can improve speech understanding in situations that cochlear implant recipients find challenging such as in noisy listening conditions and over distance.

The objective was to explore the perceptions of CI users regarding acceptance, benefit and use of the wireless accessories.

A cross-sectional observational study, using a self-reported survey, involved 85 wireless accessories, 70 adult CI recipients fitted in the initial 3-month post-operative period.

The questionnaire response rate was 89%. Ages ranged from 30 – 86 years. Take-up rate varied between devices. The overall preference was for the Mini Mic and Phone Clip compared to the TV Streamer. Device compliance was high with10% non-users. The recipients aged between 70 and 80 years of age were more likely to purchase two devices. There was a trend showing greater Phone Clip use in adults aged below 70 years of age. Occupation had no effect. Recipients used their wireless accessories in a wide variety of situations, integrated with other technology and reported many benefits. The Phone Clip was most often used for workplace assistance and to listen to music, while the Mini Mic was typically used to improve listening for social activities. Recipients preferred the Mini Mic and Phone Clip in challenging listening environments and for telephone use compared to CI alone. Most recipients found the technology easy to use.

This research highlights a model of service delivery in which decisions are made jointly by the team and the CI user. The research provides insight into the patient reported use and benefits of wireless accessories.

Evaluation of a wireless CROS device with the Naida Q90 processor

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Many adult cochlear implant (CI) recipients are unilaterally implanted with no aidable hearing in the contralateral ear. In the hearing aid field, contralateral routing of signal (CROS) devices have been available for some time to treat unilateral deafness. Essentially the CROS device operates as a microphone placed at the deaf/unaided ear and wirelessly transmits sound to the hearing instrument on the aided ear, overcoming the head shadow. With the Naida Link CROS device, such technology is now also available for the Naida CI sound processor. The CROS device also makes the advanced binaural beamformer StereoZoom available to unilateral CI users. This study evaluated a CROS device in combination with a Naida CI Q90 sound processor.

Speech intelligibility in noise was tested in ten unilateral CI subjects using an adaptive sentence test. Speech reception thresholds (SRTs) were compared between listening with the CI alone and listening with the CI in combination with the CROS device. Subjective feedback was collected using questionnaires.

The addition of the CROS device resulted in speech intelligibility benefits of up to 7.4 dB in directional noise when used in omnidirectional microphone mode. The ability to use the binaural beamformer StereoZoom for speech sources in front of the listener in highly challenging noise, yielded 4.3 dB benefit. All subjects indicated high satisfaction with the CROS device in everyday life.

The addition of a CROS device to alleviate head shadow, led to significant improvements in speech intelligibility. Use of the StereoZoom beamformer in a highly challenging listening condition also led to a significant improvement. These results suggest that the availability of CROS leads to substantial improvements in speech intelligibility for unilaterally implanted CI recipients compared to the CI alone.

Supported by AB

Watching television with cochlear implant – influence of the audio source type and settings on message understanding

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Goals: The goal of the present study was to evaluate whether, by changing the audio source of a commercial television or the relative audio settings, it would be possible to improve the understanding of the TV message for cochlear implant (CI) users. The quality of the sound, reproduced by TV loudspeakers, is usually poor, with a highly non-linear frequency response, mainly lacking power in the low-frequency range, and can cause CI users to hardly perceive important sound components.

Methodology and type of study: 10 adults affected by acquired hearing loss, with a CI-usage experience of at least 6 months, have been tested. They have been randomly exposed to different TV clips and they have been asked to answer to open and closed questions about the content of the clips, evaluating their understanding, in three different conditions:

- Listening through regular TV speakers with default audio settings (settings 1)

- Listening through regular TV speakers with enhanced low frequencies output, set through the integrated TV equalizer (settings 2)
- Listening through external loudspeakers (settings 3)

The frequency response of each setting has been measured and described.

Audio clips were presented at a volume level defined by each patient.

Results and Significance: 9/10 patient performed significantly better using settings 3 while all of them reported a more full and pleasant sound quality, with respect to settings 1.

6/10 patient performed slightly better in settings 2, even if all of them reported an equal or better perceived sound quality, with respect to settings 1.

Conclusions: Present study highlights the need of deeper understandings of the technical characteristics that might influence understanding of TV message for CI recipients, in order to properly counsel them and improve their quality of life.

Specifically, the role of the transducer frequency response, especially for low frequencies, seems to play a key-role in enhancing TV understanding for CI users.

Effect of mini microphone on speech discrimination in cochlear implant recipients

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Objective: The Cochlear Wireless Mini Microphone is a miniature, wireless remote microphone that transmits the audio signal captured at the microphone directly to the recipient's Nucleus 6 and Kanso Sound Processor via the proprietary GN Resound digital radio frequency transmission protocol on the 2.4 GHz band. It enhances speech recognition, sound quality and overall listening experience in situations that are known to provide the most difficulty for cochlear implant recipients. In the literature it was showed that the Mini Microphone resulted in significantly better speech recognition when compared to performance with the Nucleus 6 or Kanso alone.

Aim: To assess the speech recognition ability in experienced cochlear implant recipients with and without the Mini Microphone.

Material and Methods: 15 unilateral cochlear implant recipients participate in this study all who are fitted with Nucleus 6 or Kanso sound processors. Duration of cochlear implant use is at least 3 years. The recipients use the Mini Speech recognition ability in quiet and in noise were then assessed with and without the use of Mini Microphone. Recipients are seated 1 m from loud speakers which are located at +/-45 degree azimuths in a S-45N45 configuration. The Mini Microphone is positioned 20 cm directly below the loudspeaker that is used to present the target signal. Turkish Matrix Test was done for testing speech recognition ability. It was conducted via ten well-known Turkish names, numbers, adjectives, objects, verbs, from which syntactically fixed sentences were randomly composed.

Results and Conclusion: Using the Cochlear wireless mini microphone improves speech recognition ability in cochlear implant recipients. When the SNR is increased in Turkish Matrix sentence test, speech recognition can show better scores.

Effective use of assistive technology in post lingual adult bilateral CI users

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Cochlear Implantation(CI) is considered as one of the last resort for people with hearing loss.The magnitude of the expectation doubles if the population opt for CI will be a postlingual subject.The aim of the current topic is to enhance the importance of using the assistive listening devices(ALDs) in day to day life of post lingual adults and the expertise and experience of the author,who works with a multcultural population.

The presentation would highlight how well a postlingual CI enhances their performance academically and in work environment with the support of ALDS. The topic also shares the clinical cases seen in the Audiology clinic in a teritiary care hospital in Sharjah UAE.This would enchance the current knowledge among the clinicians on how effective is ALDs in CI users and also pave a clinical and research take home message for the attendees on using or sufficiently equipping the CI users with latest technology for enhancing their communication level.Thus, with the continous evolving nature of CI and its users,ALDs coupled with CI would bring a staggering outcome in postlingual patient population.

Effects of speech recognition in noise in children with cochlear implantation or hearing aids, that use FM or wireless system

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Objective: There is growing evidence that early application of a cochlear implant in children affected by profound congenital hearing loss is important for the development of an adequate auditory performance and language skills. The recent studies suggest that listening in noise shows a greater difficulty for listeners with CIs than for peers with normal hearing; especially in school where children are exposed to mean sound levels between 65 and 87 dB.

Previous research has suggested that FM systems improved speech recognition performance in noise in children with

CI/HA. The purpose of this study was to compare speech recognition performance in noise in children using CI or hearing aids with or without frequency modulation (FM) system or adaptive digital wireless radio transmission system.

Materials and Methods: This study included 20 children with severe to profound hearing loss, ranging in age from 5.5 to 14 years, with unilateral CI (with or without contralateral hearing aid) or bilateral hearing aids. Word identification, phoneme identification and bisyllabic words and sentences recognition were tested at 70 dB speech in quiet and with competing noise at 70 dB noise levels. Participants (8 cochlear implant, 12 hearing aids) were tested with CI/HA alone and CI/HA coupled to FM receivers or wireless systems.

Results : The results suggested that FM receivers provided significantly better speech-recognition performance in noise than the CI/HA alone, with a noise reduction of about 80%. The adaptive wireless systems provided better performance than FM systems at 70 dB competing noise of about 20%.

Conclusion: The study supports the use of FM and wireless systems in classroom of students with hearing impairment. According data there is a benefit of the new digital adaptive wireless radio frequency transmission systems.

FS 60: Topics in Active Middle Ear and Bone Conduction Implants

Bonebridge implant following mastoid obliteration and blind sac closure for the chronic draining ear

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Introduction/Objective: The patient with a chronic draining ear following canal wall down surgery for cholesteatoma usually requires frequent micro-debridements and ototopical treatment, and has significant conductive hearing loss with inability to wear a hearing aid.

Objective: To present our technique of managing the chronic drainage and hearing loss.

Materials and Methods: To eliminate the infection and chronic drainage, and the need for life-long cavity care, we performed a 2-stage procedure in five patients. The first stage included a radical mastoidectomy with extirpation of the cavity lining, obliteration using a temporoparietal fascia flap and blind sac ear canal closure. The second stage was implantation of the Bonebridge device using the middle fossa placement.

Results: One patient developed an early post-op wound infection. All had resolution of chronic discharge. All patients derived improvement in speech understanding scores to within normal limits.

Discussion/Conclusions: The chronic draining mastoid cavity results in life-long clinic visits and associated hearing loss. Our two stage procedure with the active transcutaneous Bonebridge implant solves both problems in patients who have normal cochlear reserve. Furthermore, the blind sac closure and the absence of a percutaneous abutment eliminate all skin breaches and issues related to chronic infection. With the middle fossa placement, long term follow-up with diffusion weighted MRI should be possible as advances are made in metal artifact reduction sequences.

The Vibrant Soundbridge for rehabilitation of complex hearing loss secondary to chronic otitis media

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Background: The rehabilitation options for hearing loss as sequelae of chronic otitis media (COM) typically include acoustic hearing aids, ossicular chain reconstruction surgery and bone conduction implants. Although the majority of patients will derive sufficient benefit from one or more of these options, each has potential advantages, disadvantages and limitations. The Vibrant Soundbridge is a semi-implantable electromagnetic middle ear device. The recent introduction of new or updated couplers has expanded options for attaching the floating mass transducer (FMT) to the most appropriate middle ear structure with improved surgical efficiency.

Objective: This presentation describes challenging cases of hearing rehabilitation in the context of COM, the decision making process, surgical and audiological outcomes and potential pitfalls.

Method: The study evaluated five patients with a known history of COM who were referred to our centre specifically for hearing rehabilitation between 2014 and 2017. Previous history of middle ear surgery and hearing aid usage were noted. Assessment included pure tone audiometry (PTA), Bamford Kowal Bench (BKB) and Arthur Boothroyd (AB) speech perception testing (at 65 dBSPL and 50dBSPL sound presentation levels). Device activation was typically carried out six weeks post-operatively. Aided speech perception scores were obtained after at least three months of device usage.

Results: The FMT was coupled to the stapes in two cases, to the round window in two and the long process of incus in the other. No surgical complications were encountered. There was no significant change in the bone conduction (BC) thresholds. Significant improvement in speech perception scores was observed in all cases. All

patients are highly satisfied with their implant and use the device all day.

Conclusion: The Vibrant Soundbridge is a valuable addition to the armamentarium for rehabilitation of complex hearing loss secondary to chronic otitis media.

Bonebridge® and Soundbridge® in children and adolescents: indicatons and outcome

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Objective: BONEBRIDGE® (BB) and SOUNDBRIDGE® (VSB) are active hearing implants certified for use in patients less than 18 years of age since few years. The indications are overlapping and long term results still limited. The aim of this study was the comparison of indication, safety and efficacy of hearing loss rehabilitation in juvenile patients.

Study design: Retrospective chart study, single-subject repeated-measures design. All patients younger than 18 and implanted between 2012 and 2017 with a BB or VSB were evaluated.

Setting: Single tertiary referral center.

Patients and methods: 26 patients aged 5 to 17 years received 34 implants. 21 BB and 13 VSB were used. Seven patients were implanted bilaterally. In a single patient VSB was explanted and replaced by a BB.

Air and bone conduction threshold and improvement in word recognition scores in aided and unaided condition were measured. Tests varied according to individual abilities and age groups.

Results: A variety of individual surgical situations and indications was observed. In the majority of the patients hearing impairment was caused by a malformation or revision surgery. A few cases of single sided deafness were also included.

Intraoperative complications were not seen, however in few cases VSB plan was switched to BB due to anatomical variation. Significant speech discrimination improvement was found in all patients tested after 3 months.

Conclusion: Both BB and VSB are both approved for use in children and adolescents. These active hearing implants provide variable and effective options for hearing rehabilitation in patients not able to use a conventional hearing aid. In our hands complication rate was low and limited to skin problems especially in cases of percutaneus BAHA replacement.

Pitfalls of measuring aided thresholds with active middle ear implants

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Objectives: In conventional hearing aids, gain can be measured objectively, in a 2cc coupler or in real ears. In active middle ear implants (AMEI), the output signal is not accessible to objective measurements, so effective gain is usually determined psychoacoustically, by measuring aided sound field threshold and subtracting unaided threshold (sound field for SNHL, bone conduction for mixed HL). However, the measured "aided threshold" may be influenced by factors other than the patient's hearing loss and AMEI amplification. These extraneous factors were investigated by modeling and by analysis of clinical data, and their impact on estimation of AMEI effective gain determined.

Results: One confounding factor is the expansion programmed into the gain-vs-input behavior of the processor, i.e. a prominent reduction of gain for input signal levels below the expansion kneepoint. This may or may not be accessible via the AMEI fitting software. The predicted impact on measured aided thresholds of the expansion kneepoint programmed into the Cochlear™ Codacs™ System direct acoustic cochlear implant matches data from a clinical study.

Another confounding factor, for devices with a subcutaneous microphone such as the Cochlear Carina® System, is the intrinsic noise of the microphone, which is typically higher than for a hearing aid microphone in air. Here, measured "aided thresholds" may actually be masked thresholds, determined by the masking level of the microphone noise, rather than thresholds in quiet. The predicted impact on measured aided thresholds matched clinical observations.

Conclusion: These factors are irrelevant if the aided thresholds are only used to estimate outcomes for an individual patient, because they do reflect actual audibility. However, if aided thresholds are used to estimate AMEI device performance (gain), to make decisions regarding future patients, then these effects need to be taken into account.

Validating intracochlear pressure measurements in cadaver ears as a method to predict the clinical efficiency of implantable middle ear hearing device actuators

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Introduction: Laser Doppler Vibrometry (LDV) is the gold standard to characterize implantable middle ear hearing devices (IMEHD) in temporal bones. However, LDV is not suitable for all actuator coupling configurations. An

alternative to characterize IMEHD efficiency is the measurement of intracochlear pressure difference (ICPD). Aim of this study was to compare actuator output levels calculated from ICPD and LDV and validate the output levels against clinical data for two different middle ear implants.

Methods: ICPD was measured through 2 probes that were inserted into the cochlear. Two different types of IMEHD actuators were used; The T2 actuator from the Cochlear™ Carina™ System, coupled to the incus and the Cochlear™ Codacs™ actuator that stimulates the cochlear through a stapedotomy. Actuator output was measured from LDV and ICPD. Clinical data was measured from bone conduction thresholds and "direct thresholds" using the sound processor as a signal generator.

Results : For the T2 actuator coupled to the incus, both LDV and ICP measurements matched well with clinical data; only LDV showed small deviations < 9 dB below 3 kHz and above 4 kHz. For the Codacs actuator, measurements correlated well with the clinical data below 600 Hz and above 4 kHz, but deviated up to 20 dB for the mid-frequency range. A hypothesis, that tissue growth in patients would seal the stapedotomy and create additional sound transmission paths was disproved through an additional set of temporal bone experiments where the stapedotomy and cavity around the actuator was filled with fibrin glue.

Conclusion: In incus stimulation IMEHD actuator output levels calculated from ICPD were similar to output levels based on SFP vibration and matched clinical data which allows prediction of clinical performance of these types of middle ear actuators. For direct acoustic stimulation however, a discrepancy in the mid-frequency range was observed and requires further investigation.

Making the most of cochlear reserve with active middle ear implants (AMEI)

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Objectives: The indication ranges of AMEI overlap with those of other device categories such as hearing aids or cochlear implants, and we are faced with the question which device category is the optimal treatment for a given audiological situation. Here, it is important to consider how much of the patient's residual hearing range or cochlear reserve can be covered.

Results: At the severe end of the hearing loss spectrum, the question is whether the cochlear reserve is large enough such that acoustic hearing (from an AMEI or a direct acoustic cochlear implant DACI) enables better speech perception that electric hearing from a cochlear implant. We found (Kludt et al 2016 Hear Res) that in the region of overlap between CI and DACI, acoustic hearing via a powerful DACI provides somewhat better hearing in quiet, substantially better hearing in noise, and less variable outcomes than a CI, up to 70 dB HL (PTA4).

When mixed hearing loss is treated with a combination of middle ear surgery and a conventional power hearing aid, the dynamic range available to the patient may be limited by the device rather than the patient's cochlear reserve. In an analysis of audiological needs vs technical device limitations, we found that in ca. 20% of our mixed loss patients, audiological needs in terms of gain and dynamic range (MPO) could not be satisfied by conventional hearing aids (Wardenga et al 2018 submitted). A take-home trial with a state-of-the-art power hearing aid confirmed that in patients where we predicted suboptimal outcomes due to insufficient gain or MPO, speech perception in quiet and in noise were indeed inferior. By comparison, clinical outcomes in matched patients with a DACI, bypassing the conductive loss, achieved undiminished outcomes.

Conclusion: AMEIs and DACIs that circumvent the middle ear are an indispensable option for optimal treatment results.

The role of multicentre collaboration in the development of a surgical questionnaire for clinical registries: Vibrant Effectiveness and Reliability Study

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Recent trends in bone conducting hearing implant technology have led to the development of a range of transcutaneous (i.e. no skin penetrating components) devices, both for bone conduction hearing devices and middle ear implants. Transcutaneous devices promise the possibility of fewer wound complications, but are surgically more complex. Two such devices are MED-EL's Bonebridge bone

conduction hearing device and Vibrant Soundbridge middle ear implant.

As part of both a multicentre NHS UK study to review the long term complication rates and reliability and the development of a UK national registry of the outcomes of the Bonebridge and Vibrant Soundbridge, intra-operative and post-operative surgical questionnaires have been developed for both devices.

This paper reports the development of these questionnaires through an iterative process based on available literature and expert review

FS 61: Different Outcome Measurements in CI

Pupillometry assessment of listening effort in adult cochlear implanted patients

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Objectives: Cochlear implant (CI) users often experience high levels of listening effort particularly in challenging environments, when they are forced to use more cognitive resources to decode auditory information and to adapt to the changes in the encoding of stimuli. In this context, one limit of conventional audiometric tests is that they do not reflect the real cognitive effort that each patient makes.

In the present study we developed and evaluated a procedure to measure the extent to which the pupil response indexes the listening effort in CI patients, through pupillometry.

Material and Methods: Eleven CI experienced users (Oticon Medical CIs) were included in this prospective interventional study with minimal risk. Speech perception scores were measured simultaneously to pupillometry. Three lists of disyllabic words were presented in quiet and then in noise. Speech target was at 55 dB SPL with a signal-to-noise ratio of +10 dB.

Results and Conclusion: Results show that that the onset of the noise caused an increase in pupil dilation compared to the quiet during the background, pre-target window. This increase was statistically significant on average at 0.05 ± 0.08 mm in noise background, relative to the quiet control condition 0.006 ± 0.08 mm.

Interestingly on the contrary, the main peak pupil dilation in reaction to the onset of the target-word, led to a peak effect showing the same value for the three conditions: quiet not recognized, noise recognized and noise not recognized. This suggests the existence of a ceiling-effect for the peak dilation, with all conditions except the easiest one (quiet recognized).

In conclusion the analysis of pupillometric traces, obtained during vocal audiometry in quiet and in noise in CI users, can provide much more detailed information about the different aspects engaged in this task. We can therefore state that there is a potentially high clinical relevance of pupillometric measures applied to CI users.

Combining pupil dilation and the timing of lexical mapping to track individual differences in speech processing by CI users

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Cochlear implant (CI) users show great individual variability in their speech comprehension outcomes. This variability is a challenge when we study the role of ageing in speech perception outcomes in CI users. We investigate how individual listeners vary in processing effort, and whether objective measures of effort can be used to identify sources of processing difficulties for individual CI users. Pupil dilation, as an index of increased attentional control during sentence comprehension, is combined with the measure of gaze fixations as a direct index of listeners' integration of sentential information for efficient mapping of the signal onto meaning.

34 experienced CI users, and 34 normal-hearing (NH) age-matched controls were tested. Participants' ocular responses (gaze fixations and pupil dilation) were recorded when they were listening to sentences that contained a target words (e.g. *hamster*), which was depicted on a screen together with a picture of a competitor word with overlapping onsets (e.g. *ham*) and two unrelated pictures. The sentence preceding the targets allowed listeners to anticipate the durational relations between syllables within the sentence, and hence to anticipate the distinction between the target and the competitor if listeners were able to integrate this rhythm information on time. Proportions of fixations towards the target versus fixations towards the competitor where then analysed together with listeners' pupil dilation over time.

Gaze fixations results for NH listeners show a fast uptake of acoustic information for a quick disambiguation of the target and competitor, and the pupil dilation data shows a targeted use of attention during disambiguation. For the CI listeners we find that individual differences in the timing of pupil dilation reveal different demands of the task - speech processing - on individual listeners. The data will

be discussed and related to its potential for enabling more individualised hearing rehabilitation.

Using the eye-tracking technology to monitor the progress of cochlear implant rehabilitation of deafened adults

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Objective: The aim of this study is to complete and refine speech comprehension tests to monitor the progress of deafened adults wearing a Cochlear Implant (CI).

Material and Method: 171 subjects are included. 44 deafened candidates for a CI in a longitudinal study and 127 normal-hearing subjects (NH). This large number of NH subjects allows us to build a database of gaze strategy and lipreading scores. The subjects repeat Consonant-Vowel and Vowel-Consonant-vowel syllables which are pronounced by a real-3-dimension-speech-therapist and then in a 2-dimension-condition on an iPad. The subjects are also watching 4 short videos in a passive condition. They are evaluated before CI and after 3, 6 and 12 months of CI. The gaze duration and the number of visits on different areas of interest are recorded (ex: face, eyes, mouth, subtitles).

Results: All subjects present a high rate of visual fixations on the videos (85%). Pre-CI subjects look significantly more at the mouth than NH subjects when the videos are presented with sound ($p<0.029^*$). The hearing results in silence are stable from 3 months. But, it is only after 12 months of CI that the subjects fix significantly less the mouth than pre-CI subjects ($p<0.001^{***}$). Moreover, NH people eyes are more mobile on the faces ($F=3.478$; $p<0.033^*$), they make more visits on the eyes than the pre-CI subjects ($p<0.01^*$). But, it is not anymore the case after 6 or 12 months of CI ($p=0.09$, NS; $p=0.36$, NS). Pre-CIs look more at subtitles than NH people ($p<0.001^{***}$) and NH people look more at the face than pre-CIs ($p<0.001^{***}$), but this is no longer the case after 6 and 12 months of CI.

Conclusion: The eye-tracking technology is an excellent tool to evaluate the CI-rehabilitation. It provides information on the cognitive strategies used by implanted subjects. The data can be easily recorded by watching videos, even in a passive condition. This could allow the use of eye-tracking to automate speech therapy tests.

The Digits-in-Noise test: overcoming the language barrier in audiometric testing

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Objectives: The Digits-In-Noise Test (DiN) is a speech recognition test which utilizes digit triplets embedded in speech shaped noise. Due to the prevalent use of the English digits, the English DiN places less demands on linguistic ability than other English-based speech tests. Thus, we aim to test our hypothesis that participants with varying fluency in English perform equally well in the English DiN as that in their native language.

Study Design: Prospective, lab-based study using subjects as their own controls.

Methods: English and Cantonese speakers (aged 19-71 years) were recruited. These subjects were composed of normal hearing individuals, hearing impaired individuals and cochlear implant (CI) recipients. Language fluency was quantified through a questionnaire. Following a protocol from our previous study, an English DiN and Cantonese DiN was formulated using the same female talker. The test was administered via a speaker in a sound-proof booth. Each subject underwent 3 runs in each language, and in best-aided conditions. Statistical analysis was then conducted to compare the performance between both languages.

Results: All participants were able to perform the DiN task. The speech reception thresholds (SRTs) were the same across normal hearing individuals for English and Cantonese. More variability was observed with CI recipients. Test-retest reliability was high ($r=0.89$, $p<0.001$ and $r=0.85$, $p<0.001$ for English and Cantonese respectively).

Conclusions: Our early results suggest that performance on the English DiN is independent of fluency in English. Such a test would be useful in centres serving patients of diverse ethnicity.

The role of phonology in novel word learning in adults with CI

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Several studies have provided evidence that prolonged hearing loss can cause degeneration of long-term phonological representations. Profoundly hearing impaired adults were subjected to degraded auditory input, which resulted in underspecified phonological representations. This may have led to phonological working memory problems, which in turn could have resulted in slower language processing.

Therefore, we assessed the vocabulary of adults with cochlear implants and investigated the relation with speech perception and phonological processing abilities.

In this study 36 adults with at least 5 years experience with CI participated. Their average age was 57 years. Receptive vocabulary was assessed with the Peabody Picture Vocabulary Test. Auditory speech perception was measured with the Dutch Monosyllabic CVC word-test. The Bree non-word repetition task was used to assess the phonological processing abilities. Statistical analyses were carried out for pre- and postlingually deaf adults, separately. Linear regression analyses were performed to assess the relationship among speech perception, phonological processing abilities and vocabulary for both groups.

As expected, 75% of the prelingually deaf adults obtained vocabulary scores below -1 sd. Even 33% of the postlingually deaf adults obtained a score below -1sd. Remarkably, none of the postlingually deaf adults obtained a score of >1 sd. This shows that novel word learning is disrupted in both groups.

Linear regression analyses show different underlying mechanisms for pre- and postlingually deaf adults. In prelingually deaf adults speech perception is the main predictor of vocabulary. However, in postlingually deaf subjects vocabulary is mostly predicted by their phonological abilities.

Electrically elicited Stapedius reflexes in bilateral cochlear implant users

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Background: A factor contributing to spatial hearing in bilateral sequential cochlear implant (CI) users is equal loudness perception across ears. This can be achieved by setting maximum comfort level (MCL), in each implant, at the electrically elicited stapedius reflex threshold (eSRT). The incidence of eSR in paediatric, unilateral CI users is 63 - 83% (Hodges et al, 2013). This incidence is thought to be reduced and the percentage of inverted reflexes greater in bilateral CI users, due to an electrode carrier being present in both middle ears.

Objectives:1. To investigate incidence of eSR and changes in reflex direction, after CI to the second ear. 2. To demonstrate that eSRT based programming leads to both implants providing similar sound access as measured by individual ear, sound field threshold (SFT) testing.

Method: Over 30, congenitally, deaf children received a unilateral, MEDEL CI under the age of 24 months and a 2nd implant, sequentially, before 4 years. 1st implants were programmed using the objective, eSRT fitting method with the probe in the contralateral ear. At switch on of the 2nd implant the probe was placed in either ear. An attempt was made to fit both CI's using the eSRT fitting method. If eSR was not obtained before loudness discomfort, behavioural fitting methods were used. The number of CI users who continued to have eSR's after implantation to the 2nd ear and the direction of the reflex deflection was recorded. CI users were provided with programs for individual and bilateral CI use, to accomodate loudness summation. İmplant SFT's at 0.5, 1 and 4KHZ were measured on each ear separately, 4-6 months post bilateral fit to assess degree and equality of sound access.

Results: The incidence of eSR was reduced after implantation to the 2nd ear and the reflex was inverted more often than observed in unilateral CI users. SFT's recorded from each ear separately, closely resembled each other 4-6 months post switch on of the 2nd implant.

Conclusion: Although incidence of eSR is lower in bilateral than unilateral CI users, over 50% can still be fit using the eSRT fitting method. This fitting method allows for loudness to be balanced across implants leading to similar access to sound across ears. Balanced loudness across implants should access users to some vital binaural hearing cues.

Predicting the safety of active middle ear implant in MRI from measurements of tip displacement

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Introduction: Very few data are published concerning the safety of the AMEI during MRI exam. Measurements in temporal bones are the gold standard for preclinical testing of this safety. In this study we investigate the safety of the T2 actuator in temporal bones with a fully implantable AMEI (Cochlear™ Carina™ System).

Methods: Eleven temporal bones were implanted with the Carina actuator. The actuator was coupled on the incus short process. The position was determined by CT scan before and after 1 to 10 MRI field entrance to investigate the definite displacement. Actuator position and brain MRI imaging artefact were analyzed. The final displacement of the actuator was expressed as a % of displacement from the initial position in the 3D. The x, y and z axes were centered on the tip of the actuator. The x-axe was aligned with the implant body center. The transient displacement was assessed by the fitting software before and after every entrance in the magnetic field.

Results: We didn't found any actuator displacement on the CT-scan with a maximum resolution of 0.6 mm. The

loading curves on the fitting software remain similar before and after 10 MRI. We found a drop in the resonance pick of the actuator just after the first MRI without further modification after.. There is no final displacement of the device and the actuator is still working after 10 MRI entrance.

Conclusion: We were able to show that we cannot evidence any displacement of the Carina actuator and probably cannot injured the inner ear. The implant could be functional after a variable number of MRI.

FS 62: Speech in Noise Algorithms

Speech perception in quiet and noise with an off the ear cochlear implant processor enabling adaptive microphone directionality

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Objectives: Our study aimed at the investigation of the impact of the wearing position of an off-the-ear-processor (OTE) enabling adaptive microphone directionality on speech perception in quiet and noise.

Material and Methods: Sixteen adult subjects with bilateral severe-to-profound sensorineural hearing loss, 2 of them unilaterally and 14 bilaterally provided with cochlear implants, were included. Speech perception in quiet and noise was assessed for frontal presentation with the recipients behind-the-ear (BTE) processor CP810 or CP910 and the OTE processor Kanso. Additionally, speech reception thresholds in noise obtained with the OTE for spatially separated signal and noise sources were assessed.

Results: The recipients obtained a monosyllabic word recognition in quiet between 65 and 95% and speech reception thresholds in noise between 2.4 and -5.5 dB SNR with the OTE. Compared to standard directionality, the application of the adaptive directional microphone (Beam) with the OTE yielded huge median improvements of speech reception thresholds ranging from -3.7 to -11.6 dB for the three tested conditions with spatially separated sources (S0NIL, S0NCL, S0N180), and a slight median decrement of 0.6 dB for frontal presentation of speech and noise.

Conclusions: The beamforming algorithm in the OTE processor Kanso provides similar benefits as described in previous studies for BTE processors in conditions with spatially separated speech and noise sources. Adaptive microphone directionality can be successfully implemented in an OTE processor.

The impact behind-the-ear and off the ear speech processors on speech understanding in noise

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Objective: The aim of the study was to compare speech understanding in noise in adult cochlear implant patients using behind-the ear (Nucleus 6) and off-the ear (Kanso) speech processors.

Materials and Method: Twenty-seven cochlear implant patients between 16-70 years of age using Behind The Ear (Nucleus 6) or Off The Ear (Kanso) sound processor were included in the study. Participants were tested with both speech processors in the free field with warble tones and speech discrimination scores in quiet were obtained.

Matrix test was used to measure speech understanding in noise with five different loudspeaker settings. The sentences were presented from the front loudspeaker and the noise from the front (S0N0), the ipsilateral side of the CI (S0NIL) or the contralateral side of the CI (S0NCL), the back (S0N180) and both sentences and noise were presented from the back (S180N180). The results obtained with two speech processors were compared.

Results: Aided free field thresholds were significantly lower/better for N6 vs Kanso. Mean difference was 3.3 dB. There was no significant difference in speech discrimination scores in quite between Kanso and Nucleus 6 ($p > 0.05$). We did not obtain statistically significant differences of the speech intelligibility in five spatial settings in Matrix test ($p > 0.05$).

Discussion: Although Nucleus 6 and Kanso speech processors had different microphone locations the outcomes were found to be consistent with previous results in adult Kanso users, demonstrating equivalent speech understanding in quiet and in noise.

Auditory and visual speech perception measured in cochlear implant users measured with functional near-infrared spectroscopy

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In natural environments, speech is typically a dynamic multisensory stimulus, characterized by both an auditory and a visual stream. Non-invasive functional neuroimaging techniques can reveal the neural processes underlying the integration of multisensory processes required

for speech understanding in humans. Nevertheless, noise (from functional MRI, fMRI) limits the usefulness in auditory experiments, and electromagnetic artifacts caused by electronic implants worn by subjects can severely distort the scans (EEG, fMRI). Therefore, we assessed audio-visual activation of temporal cortex with a silent, optical neuroimaging technique: functional near-infrared spectroscopy (fNIRS). In this study, we use fNIRS to record supra-threshold auditory, visual and audiovisual (AV) speech-evoked activity from temporal cortex of normal-hearing adults and postlingually deaf unilateral CI users. Activation effects were visible; auditory, visual and audiovisual (AV) speech stimuli evoked concentration changes for all sensory modalities in both cohorts ($p < 0.001$). Auditory stimulation evoked larger concentration changes than visual stimuli ($p < 0.001$). A saturation effect was observed for the AV condition. The observed multisensory enhancement of an auditory cortical channel can be plausibly described by a simple addition of the auditory and visual signals with saturation.

Noise reduction algorithm spatialNR – Audiometric test results

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Objectives: A novel noise reduction algorithms was assessed. The SpatialNR algorithm aims to separate noise from speech due to additional use of microphone directionality. This study is going to analyze the effectiveness of the method for noise reduction. Speech comprehension tests in quiet and in noise were performed. The following hypotheses were tested: a) SpatialNR shows comparable speech comprehension in stationary and in babble noise for S0N0; b) SpatialNR shows improved speech comprehension in spatially-separated noise.

Material and Methods: Noise reduction method was compared in CI users concerning speech intelligibility in quiet for monosyllabic words at different intensities and for sentences in noise for various acoustic conditions (stationary and modulated noise; different noise source positions). Standard SmartSound options serves as a baseline condition for speech comprehension. 18 CI patients wearing a CI sound processor (Cochlear Limited) took part in the investigations. All patients showed postlingual onset of profound sensorineural hearing loss. Intra-individual comparisons were performed. Examination of individual differences in speech comprehension were measured after 2-3 weeks adaptation.

Results: Improved speech comprehension is found for SpatialNR with S0N0 testing. There is a tendency of improved speech comprehension using SpatialNR in fluctuating noise (S0N0). Best speech comprehension was found for separated noise sources when using SpatialNR in fluctuating noise.

Conclusion: SpatialNR showed improved speech comprehension in different tested conditions. This shows potential to improve speech comprehension for specific listening situations by offering specific SmartSound options.

Perception and mitigation of impulse noise in cochlear implants recipients

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Introduction: Little is known about the effect of transient noises on cochlear implant users perception. Hearing aid users perceive impulses as annoying, and occurring quite prevalently in the environment, making up to 30% of listening environments. Technologies to remove impulses have been trialled in hearing aids, and recently with cochlear implant users, with mixed outcomes, but look to provide benefit in some narrow environments. This study investigates cochlear implant user's perceived loudness and prevalence of impulses in the environment, as well as the clinical assessment of transient noise reduction technologies for cochlear implant users.

Methods: Research participants from three global centres (n=54) participated in a survey to rate the perception of impulses in their everyday environment. Speech perception and listening quality rating was tested to investigate impulse noise reduction technologies with research participants in Australia (n=14) with impulse noise reduction technologies.

Results: Limited perceived annoyance was found through survey results, with most impulsive noises rated in the comfortable, and many occurring only occasionally. Clinical speech performance testing found a small but significant improvement with one impulse noise reduction technology. A listening quality rating test found a small but significant improvement with a different impulse noise reduction technology. A noise annoyance rating test did not find a difference with any of the impulse noise reduction technologies.

Conclusions: Impulse noise is not a significant perceptual problem for CI users. Although small intelligibility or quality improvements seem to be possible, they seem to be limited to extreme conditions. Furthermore, no impulse noise reduction technology was able to provide a performance and a listening quality benefit. This study suggests that the current cochlear implant system seems well equipped to deal with impulse noise.

FS 63: The Use of Auditory Evoked Potentials in Fitting of Cochlear Implants

Cortical reorganization after cochlear implantation for adults with single-sided deafness

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Background: Adults with single sided deafness (SSD) have lost binaural function, which limits sound source localization, speech understanding in noise, and quality of life. For SSD patients, restoration of bilateral auditory input is possible only with a cochlear implant (CI). In this study, cortical auditory evoked potentials (CAEPs) and behavioral performance were measured in SSD patients before and after cochlear implantation. We hypothesized that improvements in behavioral performance would be accompanied by changes in CAEPs after cochlear implantation.

Method: Nine right-handed adult SSD CI patients participated in the study. CAEPs were recorded before cochlear implantation and at 6 and 12 months post-implantation. CAEPs were elicited using speech stimuli (/ba/) delivered in sound field at 70 dBA. The latencies and amplitudes of different components were measured at central electrode Cz and at temporal and mastoid sites in each hemisphere. Behavioral measures (sentence recognition in noise, with and without spatial cues) were collected at the same intervals.

Results: At 6 and 12 months post-implantation, a significant increase in the T-complex amplitude and a reversal in the polarity of the [N1-P2] complex amplitude was observed at the mastoid and temporal sites contralateral to the CI ($p<0.05$). Scalp map potentials showed contralateral activation on the temporal side of the ear implanted. In the fronto-central electrodes, no significant change was observed. A significant improvement for speech understanding in noise was observed at 12 months when speech was presented to the CI ear and noise to the non-implanted ear ($p=0.02$).

Conclusion: After cochlear implantation, speech understanding significantly improved when speech and noise were spatially separated. The increased CAEP amplitude of temporal and mastoid components may reflect cortical reorganization and restoration of binaural function in SSD patients after one year of experience with the CI.

Neural network algorithms in the fitting of cochlear implants

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The effectiveness of cochlear implantation (CI) depends directly on the quality of the fitting. For small children and special group patients, objective hearing test data is important for fitting of the CI system. In most CIs, an electrically evoked compound action potential (eECAP) can be realized. Correlation of the maximum comfort levels with the results of objective methods with standard results processing is not enough. (Walkowiak A1 2010 Hughes, M.L 2000)

Objectives: to study the peculiarities of using neural networks for processing electrically evoked compound action potential in patients with CI.

Methods: we examined 90 patients with CI from 18 to 72 years old. All patients used CI for more than 1 year. All patients were registered with the growth function of the amplitude of eECAP. We have developed a new method for processing the eECAP neural response with a higher correlation with comfort levels. To train the neural network, the raw data of the amplitude growth function eECAP was used. The most comfortable loudness level (MCL) of the CI of the program used, determined experimentally, was used. 10% of patients did not participate in the training sample and formed a comparative control group.

Result: after the complete preparation of 80 neural networks, the best neural network was chosen. For the network to work, it turned out that it's enough to use only three significant parameters. The network structure consisted of three input neurons, three hidden neurons and one output neuron. The proportion of the correct forecast for this network was 98%.

Conclusion: the use of a neural network increases the correlation between eECAP and MCL. Thus, to optimize the efficiency of fitting the speech processor CI in young children and special groups of patients.

ECAP based fitting of cochlear implants

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Objectives: The fitting of a cochlear implant (CI) is usually based upon the feedback of the recipient. For each channel the maximum comfort stimulation level (MCL) needs to be determined. This may be cumbersome in very young

children where observation of their behaviour is necessary and interpretation not unambiguous. Also adults may encounter difficulties in describing their hearing perception. Therefore objective measures are desirable to serve as a base for the first fitting map for the audio processor. Determining thresholds of auditory nerve activities by recording electrically evoked compound action potentials (ECAP) is a widely-used approach to generate a first map. Currently a method to create an ECAP-based map, naming Auditory Response Telemetry Fitting (ARTFit), has been embedded in the latest release of the clinical software, Maestro7, of the MED-EL Company. Within this clinical study, the efficiency of employing ARTFit for fitting purposes is compared to a conventional fitting method.

Materials and Methods: 32 experienced CI users (22 adults, 10 children) will be included in the study. Three different fitting maps are stored on the patients' audio processor. One map ("clinical") corresponds to the program mainly used in daily life, one map ("classical") is newly generated by an audiologist quite similar to a classic initial fitting procedure and one map ("ARTFit") is based on ECAP thresholds. The latter two maps are compared concerning fitting time, MCL and speech performance.

Results: Eleven patients have been measured so far. Compared to the clinical map, the deviation between MCL profiles is 15% for both the classical map and the ARTFit map. While also speech understanding is comparable between both fitting methods, the mean fitting time is approximately half as long for ARTFit (4:05 minutes) in comparison to the classical method (9:13 minutes).

Conclusions: First results indicate that ARTFit could be used appropriately for initial fitting purposes.

Channel interaction and temporal effects on ECAP thresholds in different STIM rates and charges

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The aim of the study was to quantify the change in eCAP thresholds with higher stimulation rates or pulse widths in cochlear implant patients, and whether the amount of change in these situations can be explained by the refractory time or the spread of excitation.

Prospective exploratory study. Intraoperative measurements of the neural response telemetry thresholds (tNRT), recovery (REC) and spread of excitation (SOE) functions of patients implanted with a straight array device (CI 422) were collected in three electrodes (e16, e11 and e6). Neural response telemetry thresholds (tNRT) were assessed with AutoNRT algorithm (250Hz of stimulation rate), and with 80 Hz of stimulation rate using pulse widths of 25ms and 37ms. REC was recorded as a function of twenty masker probe intervals, from which the absolute (T0) and relative (tau) refractory period were collected in microseconds. The SOE was recorded as a function of eleven masker electrodes. Custom Sound> EP software provides SOE width in millimeters and for this study it was considered at 75% transection level. Spearman test was used for the correlation analysis.

Intraoperative recordings from 32 children and 26 adults were collected. The effect of changing stimulation rates produced differences in thresholds that varied from –26 to +41cu in children and from –24 to +50cu in adults. The effect of increasing pulse width produced differences in thresholds that varied from –12 to +57cu in children and from –27 to +48cu in adults. Statistical correlation was only found between the rate effect and the relative refractory period in e16 in children and adults. Charge effect showed no correlation with the studied variables.

The increase in tNRT with higher stimulation rates and decrease with wider pulse widths was not found in all patients. The change found in the tNRT with different stimulation rates could only be correlated with the refractory properties in the apical region on the cochlea in this sample.

Neuromodulation and cochlea implant – a contemporaneous solution for the patient?

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Objective: Actually an increasing number of devices for neuromodulation like deep brain stimulation (DBS) in dystonia or Parkinson's disease or occipital nerve stimulation (ONS) in occipital neuralgia are implanted successfully by neurosurgeons. The cochlea implant (CI) remains the standard in hearing rehabilitation of severe to profound sensorineural hearing loss. A progressive number of patients will exist with the indication of a supply for both devices. Uncertainness is present within the counselling of patients concerning possible interference of both systems.

Materials and methods: By the help of a retrospective chart analysis of two cases in our department we like to point out the possibilities of a Cochlea Implant surgery in a patient with a formerly implanted, working DBS system as well as the implantation of an ONS system in postoperative refractory occipital neuralgia after Cochlea Implant surgery.

Results: Although using different strategies in stimulation (constant vs. intermittent stimulus, different pulse rates, amplitudes and pulse width) it is possible to have both implant devices working within their specification and without interference in the combination DBS and CI as well as CI and ONS.

Conclusion: The simultaneous supply of a patient with a Cochlea Implant and a neuromodulation device like DBS or ONS is a possible treatment option and both

systems are able to work within their specification without interference.

Clinical interest of cortical auditory evoked potentials in implanted children with auditory neuropathy spectrum disorder

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Purpose of the study: The aim of this study is to examine the relationship between the presence or absence of Cortical Auditory Evoked Potentials (CAEPs) and the speech performances of children with Auditory Neuropathy Spectrum Disorder (ANSD). Children with ANSD are tested first without hearing aids, then, if the evolution is insufficient, with hearing aids, and if still insufficient with CI.

Materials and Methods: 21 patients were included in this study, aged between 1 year and 7 months and 20 years old. 10 children had cochlear implants, 7 children were fitted with hearing aids and 4 children were unaided.

CAEPs were recorded with the HEARLab system (Frye Electronics). The test stimuli were the speech sounds /m/, /g/ and /t/ at 250 Hz, 1250 Hz and 3250 Hz respectively. The presentation levels were 55dB SPL, 65 dB SPL and 75 dB SPL.

Linguistic performances were evaluated using the Nottingham's perception and production language development scales (CAP and SIR).

Results: In the groups of the unaided children and the children fitted with hearing aids we found a good correlation between the language outcome and the presence of CAEPs.

In the group of the implanted patients, the children with the best CAP and SIR scores had CAEPs for the 3 stimuli at the lowest intensity. The children with the lowest CAP and SIR scores had no CAEPs or for only one frequency stimulus at the highest stimulus level. CAEPs were found in all except two very premature ANSD patients. They had very little stimulation before implantation due to complex medical conditions. They have a very poor language development. Unclear CAEPs were found in one child who had no clear cochlear nerve on MRI imaging. A present, this child has no language evolution.

Conclusion: This study, using an automatic device of CAEPs, shows a positive relationship between the presence or absence of CAEPs and the language outcome for children with ANSD without hearing aids, post hearing aid fitting and post-implantation. This result suggests that the device is an interesting tool to help the difficult evaluation of the outcome of ANSD children.

FS 64: Bilateral and Bimodal Communication with Implants

The effect of binaural beamforming technology on speech intelligibility in bimodal cochlear implant recipients

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Objectives: Although the benefit of bimodal listening in cochlear implant users has been agreed on, speech comprehension remains a challenge in acoustically complex real-life environments due to reverberation and disturbing background noises. One way to additionally improve bimodal auditory performance is the use of directional microphones. The objective of this study was to investigate the effect of a binaural beamformer for bimodal CI users.

Methods: This prospective study measured Speech Reception Thresholds (SRT) in noise in a repeated measures design varying in listening modality for a static and a dynamic listening condition.

Results: A significant improvement in SRT of 4.7 dB was found with the binaural beamformer switched on in the bimodal static listening condition. No significant improvement was found in the dynamic listening condition.

Conclusion: We conclude that there is a clear additional advantage of the binaural beamformer in bimodal CI users for predictable/static listening conditions with frontal target speech and spatially separated noise sources.

Comparing two hearing aid fitting algorithms for bimodal cochlear implant users

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Objective: To investigate the possible advantage of the use of a dedicated bimodal hearing aid fitting formula, the Adaptive Phonak Digital Bimodal (APDB), compared to a frequently used standard hearing aid fitting formula, the NAL-NL2. We evaluated the effects of bimodal hearing aid fitting on provided hearing aid gain and on bimodal auditory functioning in a group of experienced bimodal cochlear implant users. A second aim of our study was to determine the effect of broadband loudness balancing on the prescribed gain of those two fitting formulas.

Methods: This prospective study used a cross-over design in which two fitting methods were compared varying in basic prescription formula (NAL-NL2 or APDB fitting

formula). The study consisted of a three-visit cross-over design with three weeks between sessions. Nineteen postlingually deafened experienced bimodal cochlear implant users participated in this study. Auditory functioning was evaluated by a speech in quiet test, a speech in noise test, and a questionnaire on auditory performance.

Results: Significant differences between the two fitting formulas were found for frequencies of 2000 Hz and above. For these frequencies less gain was provided by the APDB fitting formula compared to NAL-NL2. For the APDB fitting formula a higher compression ratio for frequencies of 1000 Hz and above was found compared with the NAL-NL2 fitting formula. Loudness balancing did not result in large deviations from the prescribed gain by the initial fitting formula. Bimodal benefit was found for speech perception in quiet as well as for speech perception in noise. No differences in auditory performance were found between the two fitting formulas for any of the auditory performance tests.

Conclusion: The results of this study show that cochlear implant users with residual hearing at the contralateral ear substantially benefit from bimodal stimulation, regardless of the fitting method which was applied. Although significant differences between the output and compression ratio of the NAL-NL2 and the APDB fitting formula existed, no differences in bimodal auditory performance were observed. Therefore, NAL-NL2 or the APDB fitting prescription both seem suited for bimodal fitting purposes. Additional loudness balancing has a marginal effect on the provided hearing aid output.

Influence of directional microphones on speech perception in noise of CI users

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Introduction: For cochlear implant (CI) users understanding of speech in noise remains a challenge. In such conditions the use of directional microphones (beamformers) improves the signal-to-noise ratio (SNR) by attenuating sounds from back and sides of the listener while maintaining signals from the front. The Naída CI sound processor as well as the Naída Link hearing aid (HA) offer an adaptive beamformer called UltraZoom (UZ) as well as a four-microphone binaural beamformer called StereoZoom (SZ) in order to improve speech perception in noisy situations. This clinical study aims to compare speech intelligibility in noise with both beamformers to the omni-directional microphone setting in different CI user groups: unilateral (only UZ), bilateral and bimodal and compare to a normal hearing reference group.

Methods: In this study 39 experienced adult CI users with a Naída CI processor were recruited plus 10 normal hearing listeners. All CI user groups performed speech perception tests with UltraZoom versus the omni-directional microphone setting, bilateral and bimodal subjects were tested with StereoZoom in addition. Speech perception threshold (SRT) in noise were measured via the Oldenburg sentence test (OlSa). Speech was presented from the front (0°), while noise was presented in two different loudspeaker configurations: (A) +/-60°, +/-120° and 180° and (B) +/-30°, +/-60° and 180°.

Results: Speech perception for unilateral CI users was significantly improved by up to 4.0 dB with UltraZoom compared to omni-directional microphone. For bilateral subjects a significant improvement of up to 1.9 dB with UltraZoom and 3.3 dB with StereoZoom was achieved, while bimodal subjects benefit by up to 4.2 dB or 5.8 dB, respectively, when using the two beamformers. The absolute median values for speech perception in noise when using StereoZoom reached values comparable to the results of the normal hearing reference group.

Conclusions: All CI user groups benefit from the use of the adaptive beamformer UltraZoom in challenging noisy situations when listening to a speaker from the front. For CI users with two hearing devices the binaural beamformer StereoZoom provided an additional benefit and leads to results comparable to normal hearing listeners in the test setups.

Supported by AB

No squelch effect after sequential bilateral cochlear implantation in postlingually deafened adults: Is there a first ear advantage?

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Objectives: To investigate whether a squelch effect develops in postlingually deafened adults after sequential bilateral cochlear implantation.

Study design: Prospective study as part of a randomized controlled trial on the difference between simultaneous versus sequential bilateral cochlear implantation.

Setting: Tertiary referral center.

Participants: Sixteen postlingually deafened adults.

Intervention: Sequential bilateral cochlear implantation with a 2 year inter-implant interval.

Main outcome measure: A squelch effect was defined as a better bilateral score than unilateral score on a speech-intelligibility-in-noise test with spatially separated sources. The squelch effect was evaluated for the participants' best performing ear and for the left and right ear separately in the condition with speech from -60 degrees azimuth and noise from +60 degrees azimuth (S-60 N+60) and vice

versa (N-60 S+60). Evaluations took place 1, 2 and median 4 years after sequential implantation.

Results: No significant squelch effect was found, except for N-60 S+60 after 2 years. No differences in speech perception-in-noise from straight ahead were seen between CI1 and CI2. Comparing performance of participants whose better or worse ear was implanted first did not reveal differences either.

Conclusions: Participants who underwent sequential bilateral cochlear implantation with a 2 year inter-implant interval did not develop an evident squelch effect on group level after a median follow-up of 4 years. This was at odds with our group of simultaneously implanted bilateral cochlear implant users. Neither a difference between CI1 and CI2, nor implanting the better or worse ear first could explain the less evident squelch effect in these patients.

Trial Registration: Dutch Trial Register NTR1722

Predicting sequential cochlear implantation performance: a systematic review

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Background: Bilateral cochlear implantation is becoming a standard procedure in an increasing number of countries. In the decision making process of providing a second cochlear implant (CI), several factors may be considered. Literature on factors that influence hearing performance following sequential cochlear implantation is scarce.

Aim: A systematic review of the literature was performed in order to reveal which preoperative factors affect sequential cochlear implantation outcomes in adults. The findings can help health care professionals provide evidence-based advice on the expected benefits from a second cochlear implant (CI).

Methods: We searched Pubmed, EMBASE and Cochrane from November 1977 to August 26, 2017 using the terms 'sequential cochlear implantation' and its synonyms as domain, all possible predictive factors and their synonyms as determinant and 'speech perception or localization' and their synonyms as the outcome. Ten studies were included. The effects of age, duration of hearing loss, time between implantations, preoperative hearing, etiology of hearing loss, hearing aid use and duration of follow-up on sequential CI performance were studied.

Results and Conclusions: The literature demonstrates that duration of deafness, age at onset of deafness, etiology of hearing loss and preoperative speech perception score are (inversely) related to unilateral cochlear implantation outcome in adults. One would expect that these factors would also affect sequential bilateral implantation outcome. However this review shows that the success of sequential bilateral implantation performance does not depend on the same factors as in unilateral cochlear implantation. Based on the best evidence available to date, advanced age, a long duration of deafness or a long interval between implantations does not necessarily lead to poor sequential cochlear implantation outcome.

FS 65: Experiences with pediatric ABI

Language production outcomes after pediatric auditory brainstem implantation

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ABI is a very recent development in pediatric hearing restoration (Puram & Lee, 2015). Some studies have already shown clear auditory gains after pediatric ABI (both sound and speech perception) (Sennaroglu et al., 2016). But, at present studies investigating spoken language development of children with ABI (speech production) are virtually lacking.

In this study, the speech production development of two children is investigated. Both children received an ABI around their second birthday. One child was three at beginning of data collection, the other child four. Monthly video-recordings of these children's spontaneous interactions with parents and siblings have been made for at least a year and a half. The effect of implantation on spoken language is addressed. In other words, the children's spontaneous language productions are investigated in terms of volubility: what is the amount of oral utterances, the amount of signed utterances and the amount of mixed (oral+signed) utterances? How do they develop with longer ABI use? In addition, prelexical and lexical oral development is investigated by looking at the number and types of prelexical (vocalizations/babble) and lexical (words) productions.

ABI surgery has a clear effect on spoken language volubility in both children, even though there are large individual differences in the amount of oral, signed and mixed utterances. Results also show a prelexical and lexical development, which seems to follow the same pattern as in other groups of children, e.g. children with typical hearing and children with cochlear implants. Children with ABI's oral productions develop from vocalizations to babble to one- and more-word utterances.

Even though there are individual differences, ABI implantation shows a positive effect on oral language production

in children with severe-to-profound hearing loss and should therefore be taken into consideration when cochlear implantation is not applicable.

Rehabilitation of deaf-blind child with ABI

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Objectives; An ossification of cochlea is revealed in 80% patients with deafness in consequence of meningitis. In a case of complete cochlea's ossification the only possibility to restore auditory perception for child is auditory brainstem implantation.

Methods: The child (age 2 years 4 months) lost hearing and vision owing to meningitis at the age 2 months. Because of bilateral complete ossification of cochlea the child was implanted with ABI (Concerto, MED-EL). Intraoperative and postoperative electrically evoked auditory brainstem responses, free field audiometry with warble tones were performed. Child's auditory reactions were assessed by observation at speech therapy sessions and questionnaires. The rehabilitation course included development of auditory perception and vocalizations with support of tactile sensations. Since the child had blindness and cerebral palsy the rehabilitation included development of motor activities with objects and orientation in space.

Results: The electrically evoked auditory brainstem responses were registered at intraoperative and postoperative periods at all electrodes in child. During processor fitting a level of electric stimulation was increased and 4 electrodes (of 12) eliciting adverse effects were switched off. In 7 days the child began to react at knock, handclap and loud voice, increased vocal activity. During 4 mounts he wears processor without discomfort reactions during awake time, demonstrates the different reaction on music, father's voice, phone call, cat's mew, uses vocalizations for communication, became more active. Psychological assessment revealed the increment of the parent's anxiety.

Conclusions: The ABI is a unique solution of auditory input for deaf-blind children with complete bilateral cochlea ossification. The postoperative rehabilitation of such children should include the development auditory perception in combination with motor activities and orientation in space.

Long term outcomes and the use of ABI in non NF2 children

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Objective: To measure the systematic and periodical long term outcome in children with Auditory Brainstem Implant.

To monitor the device safety over the performance of the children with Auditory Brainstem Implant.

Materials and Methods: Ten children with Auditory Brainstem Implant were monitored for a period of two years. The average age at time of enrolment of the study was 3.5 yrs, 7 females and 3 males. All children were congenitally deaf due to bilateral cochlear nerve aplasia. None of the children were previously implanted with a Cochlear Implant.

Their listening, Speech and Language outcomes were measured periodically from pre-operative, surgery, first fitting, 3months, 6 months, 12 months 18months and 24 months, the primary end point was at first fitting and secondary end point at 24 months. The outcomes were measured using LiP, MTP 3 words, CAP, SIR, MAIS, MUSS,LEAQ and Auditory performance checklist. The communication mode, status of the electrode and adverse events were also documented periodically to monitor the device safety.

Results: All children used the device regularly. The scores of LiP, MTP 3 words, CAP, SIR, MAIS, MUSS,LEAQ and Auditory performance checklist showed significant improvement at 12 months and 24 months compared to presurgery. However the rate of development of the skills is variable across measurement interval. With LittlEARS scores increased but slower and with a lower plateau than for children wearing a CI, however some children reached test scores close to the children with Cochlear Implant. All children were using oral and sign language at 24months compared to pre–surgery were they using total communication and sign language. In most of the subjects all electrodeswere activated while in few subjects some elctrodes were switched of due to non-auditory sensation. Three children had adverse event which were resoved, out of which two were non-device related and one were classifes as probably device related. In one child adverse event was fatal and were classifed as not device related.

Conclusion: All children used device regularly, having predominantly oral communication with supplemental sign language. Three out of ten children reached LEAQ and EARs test scores comparable to children with Cochlear Implant. Very minimal rate of device or procedure related events were observed. ABI surgery is a safe and effective treatment in children with hearing impairment who are not CI candidates.

A review of auditory brainstem implantation in Malaysia

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Introduction: Auditory brainstem implant (ABI) restores hearing in patients with bilateral hearing loss by direct stimulation of the cochlear nucleus in the brainstem. To date, ABIs have been performed on more than 700 individuals worldwide. The main indication of ABI is bilateral damaged cochlear nerves or inability to perform cochlear implantation with present of cochlear nuclei. We report the first three cases of auditory brainstem implantation in Malaysia.

Aims: This case series report aims to review the three ABI cases in term of surgical, audiological and speech recognition outcomes over a follow-up period of 12 months for two patients and 6 months for one patient.

Results: We performed 3 cases of ABI from June 2016 to January 2017. The patients' age ranged 26 to 45 years old. All three of them had bilateral profound sensorineural hearing loss for at least 3 to 6 years. Two patients had neurofibromatosis Type 2 (NF2) with bilateral acoustic neuromas and one patient had left ear post meningitis cochlear near total ossification and right ear cochlear aplasia since birth. The implantation surgeries were approached via translabyrinthine approach with MEDEL ABI, 12 electrodes. After placement of the plate electrodes, at least 11 electrodes were used intraoperatively. There were no major surgical complications postoperatively. During the switch on at 2 months after initial surgery, 2 patients had 12 electrodes stimulated and one had 11 electrodes stimulated. Their hearing was restored significantly after the implantations. At 6 months after switch on, average pure tone hearing level was 48 dB HL. Meantime, average closed set sound recognition of 77% and average closed set word recognition of 81% were achieved with only ABI at 6 months after switch on.

Conclusion: The promising outcome of hearing restoration and speech recognition with ABI can be observed in NF2 and non-NF2 patients. ABI is the otological implant of choice when cochlear implantation is not feasible. However, appropriate selection of patients is crucial to achieve good outcomes.

FS 66: Auditory/Electrically Evoked Potentials in CI

Longitudinal ART/AutoART data: a retrospective analysis

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Introduction: Auditory Nerve Response Telemetry (ART), the ECAP measurement software from Med-El, was integrated into their Maestro clinical programming software after FDA approval in 2007. More recently, in 2017, AutoART was introduced. This study examines the long-term behaviour of ECAP responses measured using ART/AutoART for the Med-EL family of compatible implants.

Intraoperative ECAP responses are measured routinely using ART at SCIC. Corresponding postoperative ECAP data were collected with AutoART, and compared retrospectively. The way the ECAP is measured using ART and AutoART differs slightly. Technical differences aside, intraoperative ART measurements tend to use higher stimulation levels with the sedated patient, whereas AutoART stimulation is limited to subjectively acceptable levels from the awake patients.

Method: Due to the differences in the range of stimulation levels between intraoperative and postoperative measurement sessions were made based on the ECAP amplitude growth function. Note that the ECAP response waveform morphology is not captured by this approach. Where appropriate, the ECAP response waveforms from the various sessions were also examined and compared.

Data from a total of 113 ears (left 56, right 57) were examined. The duration between the initial measurements and the most recent measurements ranged from as little as just over 2 weeks to 10 years.

Results: The majority of the ECAP data showed changes between sessions. At shorter measurement intervals, particularly postoperatively, the ECAP amplitudes tend to be more stable. The results will be discussed in greater detail.

Conclusions: In accordance with current literature, measurements of the ECAP were found to vary with time, particularly between intraoperative and postoperative measurements. The general implication is that if the ECAP thresholds were to be used to assist with sound processor programming, the most recent ECAP measurement should be used where possible.

Advanced recordings of electrically evoked compound action potentials in cochlear implant users

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The auditory nerve progressively degenerates following severe cochlear hair cell loss. Variability in auditory nerve degeneration is thought to be partly responsible for variability in speech perception among cochlear implant (CI) users (Kamakura and Nadol, 2016, Hear Res 339:132-141). An objective measure of auditory nerve degeneration could therefore give an indication of maximum achievable speech perception. In turn, this could be beneficial for personalization of speech perception therapy and for expectation management towards CI users. Advanced electrically evoked compound action potential (eCAP) recordings predicted quantified histological measures of the auditory nerve in guinea pigs (Ramekers et al., 2014, J Assoc Res Otolaryngol 15:187-202; Ramekers et al., 2015, Hear Res 321:12-24). Therefore, in the present study we have translated these promising methods to a human CI population. We have measured the effect of varying the inter-phase gap (IPG; 2.1 and 30 μs) of a biphasic electric stimulus on eCAP characteristics. We also recorded the response to the first and last 10 biphasic stimuli in pulse trains with varying inter-pulse interval (IPI; 0.4-1.6 ms). Speech perception was tested with consonant-vowel-consonant words in silence and in noise, and digit triplets in noise. In all subjects eCAP amplitudes increased with an increase in IPG. In addition, eCAP amplitude modulated with successive pulses when IPIs were applied. Both results are consistent with findings in guinea pigs (Ramekers et al., 2014, 2015) and human CI users (Hughes et al., 2012, Hear Res 285:46–57). Our preliminary data urge us to continue exploring advanced stimulation paradigms including varying IPG and IPI.

EEG alpha activity as a neural marker of listening effort during speech-in-noise perception in cochlear implant users

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Objectives: Cochlear implant (CI) users commonly report difficulty with understanding speech in challenging environments, such as in noise or with competing talkers. To overcome the difficulty, CI users must exert more listening effort (LE), or mental demand to attend to and understand speech, which over time can lead to exhaustion and sometimes discontinued CI use. The physiological processes underlying LE are not well understood, making it difficult to target these mechanisms to assist with rehabilitation. Our past research however has suggested that in both normal-hearing and CI listeners, inter-individual differences in LE relate to the degree of each person's cortical alpha activity (8-12 Hz oscillations) recorded by electroencephalography (EEG) in a speech perception task. Thus alpha activity may be a candidate neural marker of LE. The goal of the current study is to determine if changes in alpha activity can explain different degrees of LE exerted by the same CI user.

Methods: While recording the 64-channel EEG, adult CI users using their everyday CI setting were tested on the digit triplet test (DTT) in an 8-speaker free field. The DTT presents trials of three spoken digits (centre speaker) in multi-talker babble noise (peripheral 7 speakers) at different signal-to-noise ratios (SNRs). After each trial, CI users verbally reported the digits that they heard, and rated LE on a 1-10 scale. SNRs were adjusted per individual in a pre-experiment task designed to identify levels corresponding to the highest and lowest LE, while maintaining audibility across all trials.

Results: In four CI users collected to date, LE ratings significantly correlated to single-trial alpha power in left frontal or right parietal brain areas, regions consistent with networks involved in the deployment of attentional resources.

Conclusions: Results suggest that alpha activity may be used as an objective neural marker of listening effort in CI users.

Electrophysiological and psychophysical electric-acoustic masking in cochlear implant users with ipsilateral residual hearing

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Objectives: Cochlear implant (CI) users with ipsilateral residual hearing combine acoustic and electric stimulation (EAS) in one ear. In EAS users, masking can be shown for electric probes combined with acoustic maskers and vice versa. The stage at which interaction between the two modalities takes place is so far unclear. In CI users with residual hearing it is possible to record intracochlear potentials with a high spatial resolution via the implanted electrode array. An investigation of the electrophysiological effects during combined electric-acoustic stimulation in humans might be used to assess peripheral mechanisms of masking.

Methods: Nine MED-EL Flex electrode users with ipsilateral residual hearing participated in an psychoacoustic 3I-AFC paradigm experiment to measure the changes in thresholds due to the presence of maskers. Subjects were stimulated electrically with pulse trains using a research interface and acoustically with pure tones delivered via

headphones. Neural response telemetry was used to obtain electrically evoked compound action potentials (ECAP) and electrocochleography (ECochG) separately and for combined electric-acoustic presentation.

Results and Conclusion: Behavioral thresholds of probe tones, either electric or acoustic, were significantly elevated in the presence of acoustic or electric maskers, respectively. So far intracochlear electrophysiological measurements could be obtained in four subjects. Preliminary analysis shows a change in ECAP amplitude due to additional acoustic stimulation in one subject, seemingly dependent on the phase of the acoustic stimulus. Additionally, in one subject, the ECochG difference potential showed reduced spectral peaks with additional electric stimulation for some frequencies. This indicates that peripheral masking effects might have been observed.

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Frequency discrimination and the acoustic change complex in cochlear implant users

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Background: CI users can reach impressive speech perception abilities, however, they show a large variability. The clinical audiometry measures to evaluate their hearing are subjective, age-dependent, and require linguistic skills. An objective, cortical auditory evoked potential, like the acoustic change complex (ACC), might be helpful to assess their auditory performance and could even give an insight in cortical auditory processing capabilities. In a previous study we found the ACC and psychophysical frequency discrimination to be predictive for speech perception in patients with moderate sensorineural hearing loss. The aim of the current study is to evaluate whether the ACC and frequency discrimination are predictive for speech perception in CI users as well.

Methods: We recorded the ACC in 8 bilaterally and 3 unilaterally deaf adult CI users with more than one year CI experience. The ACC was evoked by a pure tone stimulus directly presented in the center of the frequency band of the medial or apical CI electrode, with frequency changes corresponding to inter-electrode distances. Speech perception was assessed in quiet and noise. Frequency discrimination was assessed using a 3-interval, 2-alternative forced-choice, adaptive staircase procedure using the same reference frequency of the ACC stimulus.

Results: In all subjects reliable ACCs could be evoked. Increasing frequency changes resulted in increasing N1-P2 amplitudes and decreasing N1 latencies. The ACC amplitude was significantly correlated to speech perception in noise. The frequency discrimination threshold was significantly correlated to speech perception in quiet.

Conclusion: The ACC amplitude is a potentially useful objective measure to contribute to better rehabilitation of CI users, as it is a non-attentive test, which correlates with postoperative performance. Since the simple non-linguistic frequency discrimination test is related to speech perception in quiet, it is especially interesting for clinical evaluation of poor performing CI users.

Objective measures with the Nucleus® CI532 cochlear implant

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Objective: We explored the impact that basal medial-lateral electrode position had on threshold (T) and comfortable (C) levels and ECAP thresholds (T-NRT): Medial-lateral position as measured by wrapping factor (WP) indicated that the array was generally positioned close to the modiolus (mean WP=0.62, S.D. 0.05). There was however quite some variation in medial-lateral position of electrodes within the first 180° of the basal turn; mainly dependent on the number of markers inserted in the cochlea opening.

Method: Basal medial-lateral position was categorized into "poor", "moderate" and "good" indicating some lateral wall contact, mid-scala position or perimodiolar position. Electro-physiological data and psycho-physical levels were analysed by electrode position group.

Results: Across the three groups ECAP thresholds were higher for basal electrode contacts compared to apical ones with ECAP thresholds being consistently low across the three groups for apical electrode contacts. However there were differences in ECAP thresholds between groups for basal electrodes with ECAP thresholds for the "poor", laterally-positioned basal electrode contacts being higher than for the other two groups. A similar trend was seen for T and C levels. Longitudinal ECAP data for a smaller group of patients indicated that ECAP thresholds generally reduced over time; by approximately 20 current level units.

Conclusions: ECAP thresholds varied across the electrode array for patients implanted with Nucleus CI532. ECAP thresholds for basal electrode contacts varied according to medial-lateral position, however ECAP thresholds were consistently low for apical electrode contacts. These results reinforce the importance of inserting only to the

first position marker of the CI532 to ensure the best perimodiolar position and lowest stimulation levels. However levels generally reduced over time and fitting methods based on objective ECAP threshold measures are compatible with the CI532.

Cortical auditory evoked responses in cochlear implant users with early onset single-sided deafness: indicators of the development of bilateral auditory pathways

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Objectives: Cochlear implantation for early-onset single-sided deafness gives a unique insight into the development and cortical reorganisation of binaural pathways. This case series aimed to investigate the impact of duration of deafness on cochlear implant outcomes as measured by cortical evoked auditory potentials.

Design: Four adults with early-onset single-sided deafness, were studied after cochlear implantation. The adults had a duration of deafness of 22, 24, 42 and 38 years before implantation. Cortical auditory evoked potentials and speech perception in noise were used to investigate binaural cortical pathways and function.

Results: Our 4 subjects lost their hearing at the ages of 3, 6, 5 and 6 (S1, S2, S3 and S4 respectively). CAEPs were present bilaterally in S2, S3, and S4. S1's, who had the least experience with a cochlear implant, cortical responses at one month post-CI activation showed cortical responses from the CI ipsilateral pathway, but no responses from the CI contralateral pathway. At 3 and 6 months S1 displayed significant cortical responses from the CI contralateral pathway for two speech tokens. An improvement in speech perception in noise testing was seen in all four participants.

Conclusion: This case series indicates that long duration of deafness for early-onset single-sided deafness is not a contraindication for cochlear implantation and may not impact the long-term outcomes in this population. The electrical stimulation from the cochlear implant integrates with the normal hearing ear to produce bilateral cortical projections and functional improvement in speech perception in noise. This early data gives us surprisingly positive results and calls for larger scale research to be conducted.

FS 67: Hearing Outcomes in Older Adults

Demographic changes in Latin America, and impact of hearing loss on dementia and Alzheimer's

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Odjetives: Dementia has long been thought of as an inevitable part of aging, but researchers are increasingly learning that it is not completely true. About one-third of dementia cases could actually be avoided by changing habits that better protect our brain's health. The new demographic structure in Latin America and the Caribbean En 2040, with 757 million people, will surpass the population of Europe and will occupy the third place in amount of population after Asia and Africa, and in 2070 will reach the 788 million Actually there are 30 million people with hearing loss in Latin America: 5.5 million with severe to profound loss 6000 children are born deaf every year and there 500 adults over 65 for each child born with deafness.

Material and Method: Information extracted from different sources: WHO, PAHO, CEPAL, WORLD BANK, etc

Conclusion: This adults over 60 years old will continue growing and the call of WHO in their report of Alzheimer Report of 2016i is based about taking action on dementia , it was unanimously supported by 80 nation-states, referring to the inalienable human rights of those affected, as well as the need to focus efforts on low- and middle-income countries, emphasize the need for; Universal health coverage and a focus on all aspects of dementia, including ffacilitating equitable access to social health for people living with dementia and their caregivers

Association between speech and high frequency hearing loss and depression, anxiety and stress in older adults

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Background: Age-associated hearing loss and depression are considered leading causes of disability in older adults. This cross sectional study investigated the association between the severity of speech and high frequency ARHL and depression, anxiety and stress in older adults.

Study design: Cross-sectional study of a community-derived sample of adult volunteers.

Methods: A total of 151 participants (73 males and 78 females; M = 64.44± 10.77 years) were recruited. The participants were divided into normal hearing, mild to moderate hearing loss, and moderately-severe to profound hearing loss groups based on better ear speech (0.5, 1, 2, & 4 kHz) and high frequency (6 & 8kHz) hearing thresholds. All participants completed a hearing assessment and the depression, anxiety and stress scale (DASS-21).

Results: A binomial logistic regression analysis revealed that the respective odds ratio (OR) (95% confidence interval) of clinically significant depression, anxiety and stress for participants with a moderately-severe to profound hearing loss across the speech frequency range were: 27.51 (3.25, 232.95), 5.89 (1.95, 17.73) and 5.64 (1.55, 20.48). Similarly, the respective OR of clinically significant depression, anxiety and stress were 6.54 (0.75, 57.02), 6.21 (1.52, 25.33) and 5.32 (1.02, 27.75) for participants with moderately severe- profound hearing loss across high frequencies. Non-parametric Cuzik test revealed a statistically significant positive ($p<.05$) trend of association between both better ear speech and high frequency hearing loss and depression, anxiety and stress scores.

Conclusion: The observed graded association between the severity of hearing loss and clinically significant depression, anxiety and stress symptoms suggest that hearing loss is one of the causative factors of clinically significant depression, anxiety and stress symptoms.

Relationships between cognitive measures, speech understanding and cochlear implant benefit in high-performing cochlear implant users

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Introduction: Cochlear implant (CI) recipients vary in their speech understanding abilities. While some understand speech in the absence of visual cues, others struggle with basic speech comprehension. At present, there is no way to predict how an individual will perform with a CI. Cognitive skills play an essential role in complex auditory processing yet there are no guidelines for assessing cognitive skills in CI users. There is growing evidence, however, that modifying the modality of test material may improve the accuracy for quantifying cognitive skills in a hearing-impaired population. This study investigated the impact of visual versus auditory-visual presentation for assessing working memory skills in CI recipients; standard measures of nonverbal IQ, cognitive efficiency and processing speed as well as speech perception testing, and subjective report of CI benefit were also completed.

Methods: 21 adult CI users (3 unilateral, 13 bimodal and 5 bilateral; all post-lingual hearing loss) with clinical speech understanding scores in quiet of ≥ 60% on AzBio sentences (in first ear if implanted bilaterally) were recruited. All participants demonstrated normal nonverbal IQ (mean=107, SD=7.86). Auditory-visual and visual working memory, processing speed and cognitive efficiency were assessed in addition to clinical measures of speech understanding (i.e., AzBio) and subjective rating of CI performance (i.e., Glasgow Benefit Inventory (GBI)).

Results: Participants had greater recall for visual rather than auditory-visual working memory items. Visual working memory related with speech perception, unlike auditory-visual working memory. No correlations between speech perception and processing speed, cognitive efficiency, or IQ were seen. Speech perception, however, was positively associated with subjective CI GBI benefit.

Conclusions: In high-performing CI users, visual working memory correlates with speech understanding unlike auditory-visual working memory, cognitive efficiency, processing speed and IQ. Higher subjective ratings of CI benefit, as measured by the GBI, translate into greater speech perception.

Assessment and outcome in non-traditional cochlear implant candidates

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Aim: The objectives of this study were to assess: i. Patient expectations met as a measure of outcome in early deafened, late implanted (non-traditional (NT)) cochlear implant recipients and ii. Preimplantation predictive factors for postoperative speech perception.

Materials & methods: The notes of 13 recipients at the Royal National Throat, Nose & Ear Hospital were retrospectively reviewed. Mean age of onset of profound deafness was 1.5 years (range 0-6). Mean age at implantation was 37 years (range 22-51 years).

Results: Patient expectations were assessed one year post-implantation. They were met or exceeded in 129/140 (92%) domains overall. All patients found their implant to be a complete or partial success at one year postop and their three most important preoperative expectations were met in 85% of patients. A higher Speech Intelligibility Rating and audio-visual CUNY sentence score pre-implantation were found to be positive predictive factors for improved speech discrimination post-CI.

Conclusion: CI is an effective method of hearing rehabilitation in NT candidates. Measures of speech perception show a great deal of variation but generally do improve,

though to a lesser degree than in traditional candidates. Patients with positive predictive features including more intelligible speech, some speech perception and oral communication are likely to get greater improvement in speech perception scores. Patients with negative predictive scores can still get considerable subjective benefit. It is extremely important to provide appropriate counselling to develop realistic expectations.

Older adults with ci: communication skills, social participation and quality of life

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Objectives: The success of cochlear implantation in post-lingually deafened adults is usually measured by pure-tone and speech audiometry. However, the WHO states in the ICF that rehabilitation should also be assessed according to individual communication skills, social participation and quality of life. We developed and implemented a questionnaire that focuses on everyday communication and allows comparison between people with normal and impaired hearing. A parallel version for assessment of the CI-users' communication by their significant other was also developed. Additionally, we assessed social participation and quality of life of CI-users before implantation and with 4 months CI experience

Sources and methods: In a prospective pilot study, five post-lingually and progressively deafened participants (55-80 yrs) and their significant others answered questionnaires concerning communication behaviour (questionnaire developed by the authors), social and emotional handicap (HHIA, HHIE, HII-SOP) [1-3], and quality of life (AQoL-6D) [4] at two timepoints: before implantation and with 4 months CI experience. Hearing ability was measured using pure-tone and speech audiometry and the SSQ [5]. Five matched normal-hearing participants served as controls.

Results: Participants with 4 months CI experience reported fewer misunderstandings, higher communicative success and less communicative effort than before implantation, though they did not reach the level of normal-hearing controls on these measures. CI users still often pretend that they have understood spoken communication and are still dependent on their significant other. They wish for further communicative success and greater independence.

Conclusion: Cochlear implantation alone does not lead to normal communication behaviour and social participation. These issues and the role of the significant other should also be focused on in rehabilitation alongside auditory training. Apart from the AQoL-6D the questionnaires used in this study proved to be suitable instruments for documenting the course of rehabilitation.

Cognitive performance in severely hearing-impaired older adults before and after cochlear implantation: preliminary results of a prospective, longitudinal cohort study using the RBANS-H

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Objective: Hearing loss has been associated with accelerated cognitive decline and cognitive impairment in older adults. For severely hearing-impaired patients, cochlear implantation is an efficient solution which positively impacts upon communication and quality of life. Yet, the effect of cochlear implantation on cognition remains unclear. The present study aimed to evaluate cognitive functioning in severely hearing-impaired older adults up to one year after cochlear implantation.

Methods: Twenty older adults (mean age: 71.5 (8.0) years) were assessed prior to, and at 6 and 12 months after implantation. The main outcome measure was the Repeatable Battery for the Assessment of Neuropsychological Status for Hearing-impaired individuals (RBANS-H), an audiovisual cognitive assessment tool. It provides a total score of cognition and five index scores. In addition, best-aided speech audiometry in quiet (monosyllabic words) and in noise (Leuven Intelligibility Sentences Test) was conducted, as well as patient-reported measures of health-related quality of life (NCIQ), self-perceived hearing disability (SSQ12), sound quality (HISQUI19) and states of anxiety and depression (HADS).

Results: The RBANS-H total scores improved significantly after 12 months of CI usage ($p<0.001$). At index level, significant improvements were observed in the Immediate and Delayed memory domain ($p=0.005$ and $p=0.002$), and to a lesser extent also in the Attention domain ($p=0.047$). Furthermore, speech perception in quiet and in noise improved significantly after 6 months and remained stable after 12 months. Similarly, a significant improvement was observed on all patient-reported measures after 6 months. These results remained stable after 12 months, except for the HADS.

Conclusion: A significant improvement in overall cognition after 12 months of CI usage was established. Yet, future research is imperative to further disentangle possible practice effects from the effects of cochlear implantation and auditory rehabilitation. The significant, positive effect of cochlear implantation on speech perception and patient-reported measures was confirmed.

FS 68: Complex Inner Ear Malformations and CI

Imaging evaluation of unilateral hearing loss

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The prevalence of UHL is estimated 1 per 1000 children at birth, increasing with age; appoximately 10% of children born with UHL eventually develop bilateral hearing loss.

Although genetic causes are predominant for bilateral hearing loss, this seems not true for UHL. Some syndromic causes can be associated with UHL, for example Waardenburg or BOR syndrome. Although families with sensorineural HL have been reported, only a few genetic mutations have been identified as being possibly associated with UHL. Other important causes include congenital CMV infection, meningitis and trauma, but in a high percentage of UHL the cause still remains uknown.

A very important point is that the incidence of temporal bone anomalies in congenital UHL is high compared with congenital bilateral HL. Large Vestibular Acqueduct and cochlear nerve aplasya/hypoplasia are increasingly identified using high resolution CT and MRI. Malformations of the inner ear with unilateral hearing loss can be associated with an increased risk of developing bacterial meningitis in the pediatric population.

Matherial and Methods: We reviewed imaging findings of pediatric subjects with sensorineural or mixed UHL consecutively diagnosed between 2013 and 2017 in our Audiology and ENT department.

Results: The likelihood of identifing a malformation depends on the severity of UHL. LVA and IAC stenosis with cochlear nerve hypo/aplasia are the most frequent anomalies. More severe losses are associated with a greater percentage of anatomical abnormalities.

Conclusions: All children with unilateral sensorineural hearing loss should undergo radiologic examination with CT and MRI. In these cases, genetic counseling and prognosis are influenced by imaging results. Finally, because of the risk of ipsi- and contralateral progression also in normal temporal bone imaging group, long-term audiological surveillance is needed.

Cochlear implantation in CHARGE syndrome – A systematic review

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Introduction: CHARGE syndrome is a congenital collection of anomalies of various organs including various functional and structural anomalies of the ears. Surgical management of hearing loss in CHARGE syndrome is challenging due to various anatomical malformations of the middle and inner ear. Cochlear implantation surgery for profound sensorineural hearing loss is technically difficult due to these malformations whilst cochlea nerve hypoplasia or aplasia may compromise outcomes. Aberrant facial nerve position may increase perioperative morbidity whilst developmental delay often makes global assessment of patients with CHARGE difficult. We aim to provide surgical guidance on managment of patients with CHARGE

Methods: We performed a systematic review of all trials involving cochlear implantation in CHARGE syndrome. We searched Cochrane Central Register of Controlled Trials, PubMed, EMBASE through Ovid SP and Web of Science. Primary outcome measures included Health-related quality of life, audiological outcomes as well as adverse events and complications. We also assessed the most commonly recorded ear anomalies including the findings of aberrant facial nerve positon.

A retrospective series of patients with CHARGE syndrome assessed for cochlear implantation at Great Ormond Street Hospital was also performed.

Results: 15 patients with CHARGE were assessed at our centre between 1993 and 2017 with ten cochlear implantations performed. Semicircular canal aplasia and vestibulocochlear dysplasia were seen in all patients. All patients had abnormal facial nerve anatomy.

These findings were in keeping with the findings of our systematic review which consisted of case series/retrospective reviews. No randomised controlled trials were identified. Data from the systematic review is presented in an easy-to-interpret table.

Conclusions: Cochlear implantation in CHARGE patients is surgically challenging with variable outcomes. We describe our experience and compare this to the literature through a systematic review of published outcome data.

The effect of gusher on hearing preservation in cochlear implantation: a comparative series

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Aim: To investigate residual hearing preservation post cochlear implantation in patients with gusher and to compare their hearing preservation over time with patients who experienced no gusher during implantation.

Methodology: We retrospectively compared two cohorts of paediatric cochlear implant recipients with symptomatic partial deafness secondary to congenitally malformed cochleas, consisting of 5 children with gusher during implantation and 6 patients who experienced no CSF gusher.

All patients underwent hearing preservation cochlear implantation (HPCI) using 24 mm lateral wall electrode arrays as well pharmacologic steroid protection.

All patients went through a standardised audiologic and radiologic implant assessment overviewed by a hearing implant MDT for CI. Hearing preservation rates and speech perception outcomes were assessed at 1, 6, 12 ,24 ,36, 48 and 60 months after Cochlear Implantation.

Results: The patients with no gusher demonstrated complete hearing preservation. The patients with gusher presented with a significant postoperative reduction of hearing thresholds which declined at a significantly higher pace during follow up. All patients demonstrated significantly better speech performance after cochlear implantation irrespective of the degree of the postoperative hearing loss.

Conclusion: The present study suggests that intraoperative gusher during cochlear implantation is associated with a sudden and significant drop in residual hearing which may be related to the large and rapid reduction in intracochlear pressure that likely occurs during the gusher, and continues to affect hearing preservation over time. Despite the loss of residual hearing over time, better speech performance was demonstrated in all gusher patients.

Morphological study on cochlea and surgical outcomes after cochlear implantation in children with incomplete partition

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Objective: To study the variations of cochlea in size and shape and to evaluate performance after cochlear implantation (CI) in children with incomplete partition (IP).

Methods>Twenty seven children with incomplete partition who have performed Cochlear Implant in Beijing Tongren hospital participated in this study. All subjects were diagnosed as severe hearing loss of both ears. They were divided into 2 groups, IP I and IP II, according to the kind of incomplete partition. The computed tomographic scan images of their temporal bones were recorded and reconstructed with three-dimensional multiplanar reconstruction and curve planar reconstruction techniques. The length the cochlea canal and the shape of the bottom of the cochlea was measured. Two years after surgery, all subjects were evaluated by Categorise of Auditory Performance (CAP), Speech Intelligibility Rating (SIR), Meaningful Auditor Integration Scale (MAIS) and Meaningful Use of Speech Scale (MUSS).

Result: The mean age of IP-I patients at the time of CI was 21.76 ± 10 92 months. The length of the cochlea canal are 20.29 ± 4.39mm.The length and width of the bottom of cochlea are 8.11±0.91mm and 5.39±0.73mm, respectively. And the width and height of the cochlea canal in the bottom are 2.55±0.91mm and 3.10±0.94mm, respectively. The score of CAP, SIR, MAIS and MUSS were 5.76 ± 1.53, 3.21 ± 1.03, 26.84 ± 7.63, 20.84 ± 8.23, separately. The mean age of IP-II patients at the time of CI was 18.2 ± 8.94months. The length of the cochlea canal are 24.35 ± 2.92 mm. The length and width of the bottom of cochlea are 8.58 ± 0.55 mm and 5.72 ± 0.66 mm, respectively. And the width and height of the cochlea canal in the bottom are 1.94 ± 0.26mm and 2.37 ± 0.80 mm, respectively. The score of CAP, SIR, MAIS and MUSS were 6.30 ± 0.95, 3.50 ± 0.85, 28.40 ± 5.92, 25.40 ± 5.58, separately. There is a positive correlation between length and width of the bottom of cochlea. Compared with normal ears, the cochlea shape of CI has more changes. The performances score of IP-I and IP-II were related with the length of cochlea.

Conclusion: The length of cochlea canal and the shape of cochlea in IP differ with normal ears. And it varies a lot in different people with IP. The measurement of cochlea before surgery will provide otologist with a lot of information.

Intelligibility of naturally produced and synthesized Mandarin speech by normal-hearing and cochlear implant Chinese listeners

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Mandarin is a tonal language, and it is important to preserve lexical tone information in synthesized speech. With natural speech, Chinese cochlear implant (CI) users have difficulty perceiving voice pitch cues important for lexical tone perception; it is unclear whether this difficulty persists in Mandarin synthesized speech. In this study, intelligibility of naturally produced and synthesized Mandarin speech was measured in Chinese normal-hearing (NH)

and CI listeners. Five synthesized voices were selected to represent different talker genders (male, female, child), speaking rates (normal, slow), and speaking styles (emotional, accent). The data showed that modern Mandarin text-to-speech (TTS) systems can provide excellent Mandarin speech intelligibility for NH listeners, even when the synthesized voices were emotional or accented. However, intelligibility was significantly poorer for CI users than for NH listeners ($p<0.001$), and performance with synthesized speech was significantly poorer than with natural speech in CI users ($p<0.001$). CI listeners were also highly sensitive to the "extra-atypical" synthesized emotional and accented speech. Performance with each of the synthesized speech types was significantly correlated with performance with natural speech in CI users ($p<0.01$ in all cases). While modern TTS systems offer educational and communication benefits to CI users and hearing-impaired individuals, the selection of synthesized voices should be carefully considered in education applications of TTS for hearing-impaired individuals, especially CI children, since poor intelligibility performance may affect language learning.

FS 69: Future of CI and AMEI

Cochlear Implantation ın Alzheimer's disease: A Case Study

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INSTRUCTION: Large prospective studies have established an independent association between hearing impairment and cognitive decline (Lin FR et.al. 2011, Gallacher J et.al. 2012). Individuals with mild to severe hearing loss have a 2- to 5-fold increased risk of developing dementia compared with those with normal hearing (Lin FR et.al. 2011). Moreover, neuroimaging studies (Peelle JE 2011, Lin FR et.al. 2014) report an association between peripheral hearing impairment and temporal lobe cortex and whole brain atrophy. A combination of several interdependent mechanisms could account for this association, such as vascular risk factors, neurodegenerative processes affecting both peripheral auditory pathways and the cerebral cortex, social isolation, and reduced cognitive stimulation. Based on these reports, hearing rehabilitation using conventional hearing aids has logically been proposed as a treatment to help improve neurocognitive performance; however, the impact of the rehabilitation generated controversial results, with a beneficial effect reported in only half of the elderly groups presented in the published analyses (Mulrow CD et.al. 1990, Tesch-Römer C 1997, Acar B et.al. 2011, Choi AY et.al. 2011, Lin FR et.al. 2013, Van Hooren SA 2005). In cases of acquired severe to profound hearing loss with no benefit from conventional amplification, cochlear implantation that uses direct electrical stimulation of the auditory nerve has proved to be successful; patients 80 years or older are one of the groups receiving benefit (Carlson ML et.al. 2010, Williamson RA, et. al. 2009). Moreover, similar to younger patients with cochlear implants, most elderly patients who have received implants show an increase in social activities and improved confidence (Vermeire K et.al. 2005, Clark JH et.al. 2012, Olze H et.al. 2012). To the best of our knowledge, the relationship between hearing benefit following cochlear implantation and cognitive abilities in elderly patients has not been investigated. The longitudinal multicenter study was to assess speech perception, cognitive abilities, and quality-of-life scores before implantation and at 6 and 12 months after cochlear implant activation inpatients 65 years or older (Isabelle Mosnier MD et.al. 2015). So we aimed to determine these benefits on Alzheimer's Disease.

CASE HISTORY: A 81 year old woman presented for evaluation of postlingual bilateral hearing loss which had been increased progressively during 25 years. She had been used hearing aid on left ear for 24 years. She had been diagnosed with Alzheimer's Disease for 15 years.

Preoperative Evaluation: The case's preoperative evaluation included audiologic, otolaryngologic, linguistic - rehabilitative (included Ling's sound, three syllables - one syllable – sentences discrimination tests), cognitive, quality of life, depression and neurological assessments.

Surgical Procedure: A left cochlear implantation of a nucleus 22 CI24RE (ST) device was performed without difficulty. Radiologic findings confirmed that the implant had been properly positioned. The patient was discharged from the hospital the following day.

Postoperative Evaluation: After one month an operation, the case's implant was connected to Nucleus 5 speech processor. Impedance levels of all electrodes were normal. NRT of the default electrodes (included 22, 16, 11, 6) were normal, but there was no NRT on first electrode. Mapping and aural rehabilitation procedures were performed according to standard guidelines. Audiologic tests, mapping procedure were repeated at 1, 3, 6 months, 1, 2 years postoperatively, and results were compared with the preoperative findings. Rehabilitation procedure was repeated at 3, 6 months, 1, 2 years postoperatively, and results were compared with the preoperative findings.

Conclusion: Epidemiologic studies demonstrate that the anticipated number of people aged 60 years or older will double by the year 2050. As a consequence, the number of people with cognitive impairment and dementia will dramatically increase, reaching more than 100 million worldwide by 2050. Because there is no curative treatment available for cognitive decline, clinical research is needed that focuses on identification of risk factors to establish preventive measures that may reduce the burden of the disease. Further research is needed to evaluate the longterm influence of hearing restoration on cognitive decline and its effect on public health (Prince M et.al. 2009, Brookmeyer R et. al. 2007).

Dynamics of tinnitus in patients with cochlear implant

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Most studies confirm that the use of a cochlear implantation (CI) significantly reduces tinnitus. However, there are examples of the appearance of tinnitus (up to 3% of cases), the amplification of the already existing tinnitus after CI (up to 9% of cases). Objective: To investigate changes in the characteristics of tinnitus in patients after CI.

Methods: We examined 50 patients with a CI aged 25-72 years and complaints of tinnitus within 4 years. Data on changes in the characteristics of tinnitus were recorded in the questionnaire. The severity of tinnitus patients was assessed on a visual analog scale from 0 to 10 points.

An analysis was made of the dependence of the dynamics of tinnitus on sex, age, duration and etiology of deafness, the duration of use of the speech processor (SP), with the SP turned on and off.

Results: Most patients, 48 months after the first connection of the SP, noted a decrease in the level of tinnitus. Of these, in 54% of cases, tinnitus decreased only when using a SP, including on the opposite ear.

In 42% the effect was preserved even when the SP was switched off. In 4% of cases, tinnitus remained unchanged.

In patients with a period of deafness less than 5 years, the most pronounced decrease in tinnitus level was noted 18 months after the connection of the SP.

In patients with a period of deafness more than 15 years, the most pronounced decrease in the level of tinnitus was observed 48 months after the connection of the SP.

Conclusions: Dynamic observation for 48 months revealed the heterogeneity of the dynamics of tinnitus in patients with CI depending on sex, age, duration and etiology of deafness, duration of use of the SP CI, with the SP turned on and off.

The effect of cochlear implantation on tinnitus perception

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Objectives: Tinnitus occurs in 65-100% of patients with profound sensorineural deafness. CI has become a standard treatment for profound sensorineural hearing loss and has been shown to have an effect on concomitant tinnitus complaints. Although auditory masking is often postulated to explain tinnitus suppression in CI-users, the exact mechanism remains unknown. The purpose of this study is to assess the prevalence of tinnitus complaints in our adult CI population and to quantify the effect of implantation on tinnitus perception.

Material and Method(s): Adult patients, receiving CI at the ENT department of Ghent University Hospital for uni- or bilateral hearing loss, were prospectively included since January 2016, regardless of any tinnitus complaint. Demographic, implant, pre- and post-operative tinnitus and audiometric data were collected. Tinnitus questionnaires were filled in before the operation, and 3 and 6 months post-CI.

Result(s): Until now, data of 65 patients were analyzed, with variable follow-up time. Tinnitus prevalence pre-implantation was 58.5%, with a mean Tinnitus Functional Index (TFI) score at baseline of 38. 17/26 tinnitus patients showed a clinically significant tinnitus reduction (TFI reduction >13 points) 3 months after implantation, which persisted after 6 months. 50% of tinnitus patients reported a lasting residual inhibition. TFI score at baseline was significantly correlated with tinnitus reduction ($r=0.825$, $p<0.001$). No other included factors were found to be significantly associated with tinnitus change. Tinnitus complaints occurred or intensified in 13/26 patients, usually lasting a few days post-surgery.

Conclusion(s): Our study shows a reduction of tinnitus perception in 65.4% of the CI population, with suppression mostly occurring in close association with switch-on. The residual inhibition effect could suggest a central neuronal plasticity involvement. TFI score at baseline is significantly correlated with tinnitus reduction.

Lexical-access ability and cognitive predictors of speech recognition performance in adult ci users

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In patient counselling, judgment of candidacy, and evaluation of the rehabilitation progress there is need for a more detailed understanding of the factors that determine the success of cochlear implantation. Not all of the variance in speech-recognition performance of cochlear-implant (CI) users can be explained by biographic and auditory factors. In normal-hearing (NH) listeners, linguistic and cognitive factors determine most of sentence-in-noise performance. In a study with 24 postlingually deafened CI users the influence of visually measured lexical-access ability on speech recognition was compared to the influence of other cognitive factors. Speech-recognition performance was measured with consonant-vowel-consonant monosyllables in quiet, sentences in noise (SIN) and digit-triplets in noise (DIN). In addition to a composite variable

of lexical-access ability (LA), measured with a lexical-decision test (LDT) and word-naming task, vocabulary size, working-memory capacity (Reading Span test, RSpan), and a visual analogue of the SIN test (text reception threshold test) were measured.

Working-memory capacity explained, combined with hearing loss duration, 55% of the variance in SIN thresholds. When corrected for auditory performance using the difference between SIN and DIN, LA and RSPan separately explained, combined with hearing loss duration, respectively 37% and 46% of the variance in SRTdiff outcome. The results suggest that the relation of RSpan and LA with SIN is complex, but that poor verbal working-memory capacity, and to a lesser extent poor lexical-access ability, limit speech-recognition ability in listeners with a CI. Measuring lexical access in the auditory domain can shed additional light on the relationship between hearing ability, SIN and LA. This was studied in 11 NH and 22 CI users. Measures of working-memory capacity and lexical access add information to improve counseling of individual CI candidates and to evaluate speech-recognition performance with a CI to optimize individual rehabilitation programs and should be incorporated in clinical care programs.

Preoperative audio-visual speech perception influences on audio-visual, but not audio-only performance of cochlear implantation in post-lingual adults

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Objective: Postlingual deaf patients usually depend on the visual information in their deaf period, and their lipreading ability could influence on CI outcomes. Auditory cortex reorganization by visual information is a current issue in cochlear implantation (CI) outcome. In the present study, we aimed to evaluate the association between the preoperative auditory-visual perception and CI outcomes.

Methods: In this retrospective case-comparison study, we assessed 75 patients with postlingual deaf patients who underwent unilateral CI at a single tertiary referral hospital. Speech perception test was performed with both auditory-visual (AV) and auditory-only (AO) status before and after the implantation. All patients also evaluated the Category of Auditory Performance (CAP) scores.

Results: There is no significant correlation between deaf duration and postoperative AO (pAO) speech perception (R2=0.0005084, P=0.8477). There is also no significant correlation between deaf duration and postoperative AV (pAV) speech perception (R2=0.0007705, P=0.4539). There is no significant correlation between iAV speech perception and pAO speech perception (R2=0.00006475, P=0.9454). However, iAV and pAV speech perception only shows a positive correlation, significantly ($R2 = 0.1041$, $p < 0.05$).

Conclusion: The results of the present study suggest that the patients with the better iAV speech perception showed the better pAV speech perception, which means patients who have a good initial speech perception with enhanced lipreading

Cognitive factors effective on pre- and post-cochlear implantation outcomes

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Adult cochlear implant users' expectations and outcomes are varied among them. The factors impact on cochlear implant outcomes also differentiates than the pediatric group. Such as duration of hearing loss, the configuration of hearing loss, and duration of hearing aid use are essential in pre-implant assessment. However, there are other essential variables that involve cognitive abilities for example verbal learning, visual memory, and auditory memory. In the rehabilitation process, holistic approach is appropriate for comprehensive evaluation.

Materials and Methods:In this study, 15 cochlear implant users, who are older than 18 years old, were participated. In the inclusion criteria is using cochlea implant at least 6 months regularly. Before and after cochlear implantation following tests were used: adult sentence recognition test, word identification test, auditory memory test, Auditory-Verbal Learning Test, Glasgow Benefit Inventory, Montreal Cognitive Assessment and Draw a Clock Test.

Result: All patients showed significant improvement in all tests. Sentence recognition and word recognition scores were improved as expected. The patients also reported that their life quality increased after cochlear implantation. Patients' adaptation was improved to memory tests after CI. Some of them still need rehabilitation support for memory.

The holistic approach is needed to increase cochlear implant users' satisfaction after surgery. This approach helps us to understand patients' needs and expectations. After surgery optimal development can be achieved in all cognitive areas and quality of life in adults.