12th International Conference on Cochlear Implants and Other Implantable Auditory Technologies

Thursday, May 3, 2012
Scientific Session III Oral Abstracts
3:00 PM - 5:00 PM
Introduction: Today, the surgical challenge in cochlear implantation is the preservation of the anatomical structures and the residual hearing after cochlear implantation. In routine surgical practice, the electrode array is inserted manually with a limited visual and sensitive feedback. Histological damages caused by the array to the cochlea are unpredictable and the array positioning is not reproducible. These obstacles potentially hamper residual hearing preservation and may explain a part of postoperative speech performance heterogeneity among implantees. Materials and Methods: We designed and manufactured synthetic transparent models of scala tympani with a scale of 1:1 allowing the visualization of array progression during its insertion. In human temporal bone specimens, we also developed a microdissection technique to open the scala vestibuli in its whole length and to preserve the basilar membrane. The electrode array insertion in the scala tympani could be monitored visually under the partially transparent basilar membrane. Results: Motorized insertion tool allowed a smooth insertion with a constant speed. With this tool force profiles could be measured without any artefact due to hand tremor. The force measurements could not detect the collision of the array on the lateral wall nor the basilar membrane perforation. However, they showed a progressive increase probably due to the friction on the lateral wall and the reduction of scala tympani diameter. Conclusion: Insertion force measurements during array insertion provide valuable information on the array's mechanical behaviour inside cochlea. This work validated a simple procedure for array insertion force measurement and opens insights to a robot-based procedure for minimally invasive access and a force-controlled array insertion.

Learning Objective: Identify insertion force measurement a valuable tool to detect abnormal array progression in the cochlea.

Email: yann.nguyen@inserm.fr
**Topic:** Basic Science III  
**Title:** Impedance testing on cochlear implants after electroconvulsive therapy  
**Author(s):** Theodore R McRackan, Alejandro Rivas, Andrea Hedley-Williams, Vidya Raj, Mary Dietrich, Nathaniel Clark, Robert Labadie  
**Presenter:** Andrea Hedley-Williams  
**Abstract:** Objective: Electroconvulsive Therapy (ECT) is a commonly performed and standard therapy for numerous psychiatric illnesses. ECT involves applying a small electric current that results in generalized tonic-clonic seizures. Currently, ECT is contraindicated in CI patients based on the FDA and cochlear implant (CI) manufactures’ claim of a theoretical risk of damage to the implant and possibly the patient. Subject and Methods: Ten functional CIs were implanted in fresh cadaveric heads. Each head then received 12 ECT treatments—the standard ECT course. To ensure CI integrity, impedance testing was performed prior to CI insertion, after CI insertion, and after the first, third, fifth, seventh, ninth, and twelfth ECT treatment. Results: Twelve rounds of ECT (800mA per treatment) were successfully performed on each of the ten cadaveric heads by a staff psychiatrist. Afterward, none of the 22 channels in the 10 CIs revealed evidence of a short. In fact, there were statistically significant decreases in impedances when comparing pre-ECT values to those after 12 treatments. There was no statistically significant difference (all p>0.05) in impedance value changes when ECT was performed on the same side as the CI as opposed to the contralateral side. Conclusion: Based on impedance testing, ECT does not appear to incite any detectable electrical injury to CIs.

**Learning Objective:** Assess the lack of evidence that currently exists with regard to ECT and CI patients.

**Email:** tmcrackan@gmail.com

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**Topic:** Basic Science III  
**Title:** Comparison of physiological measures of channel interaction in cochlear implant users  
**Author(s):** Paul J Abbas, Christine P Etler, Carolyn J Brown  
**Presenter:** Paul J Abbas  
**Abstract:** Objectives: Our objective was to compare measures of channel interaction using two different techniques. Both methods used the compound action potential (ECAP) and pairs of pulses to stimulate different electrodes. Method 1 used relatively high level pulses and relied on refractory properties to assess interaction between two electrodes by observing a decrease in the response to the second pulse. Method 2 used relatively low-level pulses, at short interpulse intervals, resulting in an increase in the response to the second pulse. Study Design: The electrode of the probe pulse (second pulse) was fixed and the electrode of the first pulse (conditioner) was varied. The degree of channel interaction (interaction index) was quantified by measuring the average response amplitude normalized to response to the probe alone (unconditioned). Responses were measured in both adults and in children. The primary comparison was between methods 1 and 2. In addition, we assessed effect of probe electrode, stimulus level and compared subject groups. Results: Enhancement effects in Method 2 were evident over a small range of levels near ECAP threshold. Comparisons across a range of levels showed no change in interaction index. No significant differences in channel interaction index were observed across probe electrodes, or between children and adults. Method 1 (high level, refractory) generally resulted in a lower channel interaction index than Method 2 (lower levels, enhancement). Conclusions: The differences observed were likely due to mechanism of interaction and suggest that high level measures may not adequately characterize the interactions near ECAP threshold. This may be particularly important since levels near ECAP threshold are more typical of those used in normal CI stimulation at high rates. This research was supported in part by research grant 5 P50 DC00242 from the National Institutes on Deafness and other Communication Disorders.

**Learning Objective:** Describe methods of measuring channel interaction.

**Email:** paul-abbas@uiowa.edu
Objectives: Combined electrical stimulation and acoustic hearing with Cochlear™ Hybrid systems has been applied successfully as a rehabilitative strategy for patients with moderate to severe sensorineural hearing loss. The perceptual benefits accrued through Electro-Acoustic Stimulation (EAS) have been tempered by evidence from multi-center clinical trials demonstrating that some recipients subsequently lose a significant amount of their residual hearing in the implanted ear. This loss of low-frequency hearing potentially diminishes the benefits of EAS. Therefore the objective is to try to preserve this residual hearing. Study Design and Results: To identify the underlying cause of this low-frequency hearing loss, Cochlear has taken a systematic research approach. In this research program we have identified different variables/research directions of potential causes of residual hearing loss, including: surgical approach to the inner ear, electrode position inside the cochlea, silicone material effects, molecular biological processes, and the effect of electrical stimulation on residual hearing. We are investigating each of these research directions and have established animal models of EAS (cat and guinea pig) in which measures of hearing performance (acoustic and electric) can be assessed following partial deafening and insertion of EAS devices. These animal models allow investigation of the mechanisms of inflammatory processes including fibrosis and the loss of sensory function in the cochlea. The identification of the cell death pathways that are activated by the implantation and stimulation of an EAS prosthetic device, will be essential to understand the inner ear’s loss of residual hearing. Conclusion: The systematic analysis of different research variables identified as possible underlying causes for the loss of low frequency hearing in EAS recipients and the development of EAS animal models, provide the knowledge and potential to explore drug-based therapies designed to promote survival of neural and residual sensory cells in the inner ear and reduce fibrosis-induced inflammatory processes.

Learning Objective: Recognize the problem statement of residual hearing loss for recipients of Hybrid cochlear implant systems (Electro-Acoustic Stimulation).

Email: kverhoeven@cochlear.com

Objectives: Current focusing techniques in cochlear implants aim at decreasing the spread of neural excitation. Typically, multiple electrodes are used simultaneously to attenuate the field of a single electrode, e.g. in the case of (partial) tripolar stimulation and, as explored more recently, phased array stimulation. In the technique known as dual electrode stimulation (DES), simultaneous stimulation of two electrode contacts is used in an attempt to excite neurons in the area between two principal excitation areas, rather than to diminish the spread of excitation. The present study investigates the effects of combining current focusing techniques and DES. Study Design: Using a realistic computational model of the implanted human cochlea excitation patterns of dually stimulated monopoles, (partial) tripoles and phased array channels in lateral and perimodiolar electrode arrays were simulated and compared. Pitch percepts, loudness levels and excitation densities (the percentage of fibers excited at a specific location) were predicted as a function of current level. Results: Excitation density plots revealed that focused DES can create a more confined excitation region compared to conventional DES. However, this focusing effect was more prominent in lateral wall insertions than it was in perimodiolar insertions. It was found that DES with partial tripoles and phased array stimulation produces shifting pitch percepts similar to that of monopolar DES. Due to the presence of side lobes in their excitation patterns, full tripoles induce a non-monotonic shift in pitch. Focused DES requires more current to achieve the same loudness as conventional DES. Conclusion: The study indicates that combining DES with current focusing strategies can create intermediate pitch percepts as well as conventional DES can.

Learning Objective: Identify that combining DES with current focusing strategies can create intermediate pitch percepts as well as conventional DES can.

Email: j.j.briaire@lumc.nl
Thursday (3:00 PM - 5:00 PM) Marriott Grand 1 - 5

Presentation 58

**Topic:** Basic Science III

**Title:** Influence of the Intra-cochlear Position of the Cochlear Implant Array on Speech Intelligibility in Cochlear Implant Patients

**Author(s):** Goetz Brademann, Matthias Hey, Silvia Papazova, Joachim Müller-Deile

**Presenter:** Goetz Brademann

**Abstract:**

Objectives: To establish whether the insertion depth and the proximity to the modiolus of a CI-array have any influence on speech intelligibility of post-lingual deaf adults who received a CI.

Study Design: The X-ray images of 56 post-lingual deaf patients who received a Nucleus CI24 at the ENT Department of the University of Kiel, Germany (mean age at implantation 50.6; duration of deafness: median 1.1 years) were evaluated using the image analysis software “CView” [Cohen, LT (2003)]. The intra-cochlear CI-array positions with respect to the insertion depth and proximity to the modiolus were compared with the results of speech intelligibility in the Freiburg monosyllabic word test in quiet at 50, 60 and 70 dB and the adaptive measurement of speech comprehension in the Oldenburg sentence test at a noise level of 65 dB.

Results: The results achieved in the Freiburg monosyllabic word test at 70 dB and at 60 dB were on average 88±15 % and 82±17 %. Due to the ceiling effect, these good results cannot be correlated to the CI-array position. Only the data at 50 dB with speech intelligibility of 61±17 % could be used for the correlation. Speech comprehension using the Oldenburg sentence test at a noise level of 65 dB was on average -2.1±2.2 dBS/N. The maximum insertion depth of the CI-array was 425±36°. There was a correlation at the 5 % level between the insertion depth and the proximity of the CI-array to the modiolus.

Conclusion: There was no significant correlation between the parameters of position of the CI-array (insertion depth or the proximity to the modiolus) and the results of speech intelligibility in quiet and in noise.

**Learning Objective:**

Describe that post-lingual deaf patients with a short duration of deafness and with a surgically well inserted Contour electrode can achieve very good results of speech intelligibility and speech comprehension.

**Email:** brademann@hno.uni-kiel.de

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Thursday (3:00 PM - 5:00 PM) Marriott Grand 1 - 5

Presentation 59

**Topic:** Basic Science III

**Title:** Presbycusis Occurs After Cochlear Implantation Also: a Retrospective Study of Pure Tone Thresholds over Time

**Author(s):** Miriam Saadia-Redleaf, Samuel Trosman

**Presenter:** Samuel Trosman

**Abstract:**

Objectives: Previous studies have examined speech performance over time in cochlear implant users. These studies found that individuals’ performances on speech discrimination tests remained stable over time and, therefore, did not show any evidence of central presbycusis. However, to our knowledge these studies have not looked at pure tone thresholds over time in adults with cochlear implants. We hypothesize that cochlear implant users will show a similar deterioration of pure tone thresholds with age as seen in non-cochlear implant users.

Study Design: A retrospective chart review was performed, reviewing audiometric data obtained on 61 adult cochlear implant users. Independent variables were subject age at the time of test, as well as speech processor type, processor strategy, duration with the implant, and duration with a certain processor. Dependent variables were cochlear implant pure tone thresholds at 500, 1000, 2000, 4000, and 6000 Hz. Univariate and multivariate analyses using a mixed effect model were performed. Results: 61 subjects with 65 total implants were tested at ages 18-89, at 1 month to 20 years of follow-up. It was determined that the pure tone thresholds deteriorated at three or more frequencies with increased age and increased time with the implant in 47.5% (29/61) of subjects. 23% of subjects (14/61) had worsening thresholds over time at all five tested frequencies. Thresholds deteriorated at an average rate of 0.5968 dB per year with the cochlear implant across the five frequencies. These results were statistically significant at p < .05.

Conclusion: While cochlear implantation replaces cochlear function, the auditory nerve and the rest of the central auditory nervous system remain subject to deterioration and presbycusis.

**Learning Objective:**

Assess that adult patients with cochlear implants should be counseled on the possibility of worsening sensorineural hearing loss over time with the implant due to age-related changes in the auditory nerve and in the central auditory nervous system.

**Email:** mredleaf@uic.edu
Thursday (3:00 PM - 5:00 PM) Marriott Grand 1 - 5

Presentation 60

Topic: Basic Science III
Title: Osseointegration biomechanics and soft tissue approaches with new surgical procedures and the most recent implant developments
Author(s): Patrik Westerkull
Presenter: Patrik Westerkull
Abstract: The choice of suitable implant components becomes more important both when new surgical approaches applied and to be successful in more challenging for bone anchored hearing patients. The objective was to conclude the benefits and possible drawbacks of the most recent implant developments, and to demonstrate new surgical approaches and how proper implant components can be chosen in these situations. Specific biomechanical considerations and implant selection for different patient groups will be discussed and guidelines will be presented. A number of key implant design parameters were investigated in technical and biomechanical terms. The skin interaction for various surgical methods in relation to implant design was specifically reviewed. Biomechanical studies on soft tissue as well as in bone showed benefits with the new developments in terms of insertion torque, cantilever arm effects etc. A conclusion is that implant and abutment selection is of great importance when applying new developments in clinical practice but significant benefits may also be reached with new developments and new surgical approaches.

Learning Objective: Identify biomechanical conditions for osseointegrated implants for bone anchored hearing, to better assess the need for specific implant geometries in different patients.

Email: paw@oticon.se

Thursday (3:00 PM - 5:00 PM) Marriott Grand 6 - 10

Presentation 61

Topic: Outcomes
Title: Conductive Hearing Loss after Cochlear Implantation
Author(s): Richard A. Chole, Lisa G. Potts, Timothy E. Hullar, Timothy A. Holden
Presenter: Richard A. Chole
Abstract: Objective: The objective is to describe that cochlear implantation may lead to conductive hearing loss in patients who retain residual hearing. Background: As cochlear implant design has improved and less traumatic surgical techniques have been developed, residual hearing has been preserved in many patients. Observed residual hearing is often measured below the pre-operative levels. Although we assumed that this was due to changes within the cochlea, we wondered if the presence of the array and tissue in the area of the round window might cause a conductive hearing loss. Method: To determine if cochlear implantation can lead to a conductive hearing loss, we chose case studies of four patients, 3 adults and 1 child, who retained measurable hearing post-operatively. CT scanning (in the three adult patients), pre-and post-operative AC and BC audiometry were performed. Results: Cochlear implants were placed with a round window insertion or a “marginal” cochleostomy at the inferior margin of the round window with a connective tissue seal. Pre-and post-operative CT scanning showed electrode arrays within the scala tympani traversing the region of the round window in the three adult patients. Post-operatively all patients had preservation of some hearing and a significant air-bone gap. Conclusion: Cochlear implantation through the vicinity of the round window can lead to conductive hearing loss. We speculate that the mechanical effect of the electrode array on the round window and fibrous tissue in that region impedes the motion of the round window resulting in a conductive hearing loss. In the future, if residual hearing conservation is a goal of cochlear implantation, either with full length or short arrays, strategies for minimizing conductive losses should be developed.

Learning Objective: Describe that bone conduction testing in four cochlear implant recipients revealed a significant air-bone gap.

Email: rchole@ent.wustl.edu
**Thursday (3:00 PM - 5:00 PM) Marriott Grand 6 - 10**

**Presentation 62**

<table>
<thead>
<tr>
<th>Topic:</th>
<th>Outcomes</th>
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<tbody>
<tr>
<td>Title:</td>
<td>Preservation of Residual Hearing in Cochlear Implantation: Is it Maintained in the Long-term?</td>
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<tr>
<td>Author(s):</td>
<td>Kevin Green, Amanda McSorley, Iain A Bruce, Simon R Freeman, Simon K Lloyd, Deborah Mawman, Martin O'Driscoll</td>
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<td>Presenter:</td>
<td>Amanda McSorley</td>
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<tr>
<td>Abstract:</td>
<td>Objectives: To establish the extent to which residual hearing preservation is achieved in cochlear implantation and whether this is maintained in the long-term. Patients and Methods: All patients undergoing unilateral hearing preservation cochlear implantation between January 2008-December 2009 were included. Data were collected on gender, age at implantation and electrode used. Pre-operative audiograms were obtained and compared with post-operative results obtained at the following intervals: 0-6 months, 6-12 months. Hearing preservation was defined as complete (&lt;10dB loss), marginal (10-25dB) and not achieved (&gt;25dB loss). Results: A total of 15 patients, 6 male, 9 female were included. There were 13 adult and 2 paediatric patients and the mean age at implantation was 53 (range: 9 -79). 14 patients were fitted with a Medel Flex EAS electrode and 1 with the Medel Flex Soft. Mean audiogram values for pre &amp; 6-12 months post-operatively are presented in Figure 1. Complete hearing preservation up to 12 months was achieved in 3 patients. In 5 patients (4 adult, 1 paediatric) with Med-EL Flex Soft) marginal hearing preservation was achieved. Four patients displayed an initial hearing preservation of 10-25dB at 0-3 months post-operatively which deteriorated over the following 9 months. Hearing preservation was not achieved in a total of 3 patients (2 adult, 1 paediatric). Figure 1: Mean pure tone audiometry results, pre-operative &amp; 6-12 months postoperatively Frequency (Hz) 125 250 500 1000 2000 4000 Pre-operative (dB) 40 45 65 90 110 1156-12 months Post-operative(db) 60 70 90 105 120 120NB. Values are rounded to the nearest 5dB Conclusion: Hearing preservation of 25dB or better was achieved in 8 (53.3%) patients. In 4 (27%) patients an initial hearing preservation was achieved but this was not maintained. This study suggests there is a sub-group of cochlear implant patients who exhibit an initial preservation of hearing which gradually deteriorates. Further work is required to identify factors which may predispose to this outcome and the functional impact of this.</td>
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<td>Learning Objective:</td>
<td>Recognize a subgroup of patients who exhibit an initial hearing preservation which subsequently deteriorates over 3-12 months following cochlear implantation.</td>
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<td>Email:</td>
<td><a href="mailto:kmjgreen@me.com">kmjgreen@me.com</a></td>
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**Thursday (3:00 PM - 5:00 PM) Marriott Grand 6 - 10**

**Presentation 63**

<table>
<thead>
<tr>
<th>Topic:</th>
<th>Outcomes</th>
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<tbody>
<tr>
<td>Title:</td>
<td>Partial Deafness Treatment - 10 years of program and 13 year experience with hearing preservation</td>
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<tr>
<td>Author(s):</td>
<td>Henryk Skarzynski, Artur Lorens, Piotr H. Skarzynski</td>
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<td>Presenter:</td>
<td>Piotr H. Skarzynski</td>
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<tr>
<td>Abstract:</td>
<td>During last years of previous surgery in Our center we started to provide surgeries with possibility of hearing preservation. After some year it developed to Partial Deafness Treatment (PDT) which cover disorders. Partial deafness (PD) is a condition in which hearing loss occurs in at least 1 frequency critical to speech understanding. Current options for partial deafness treatment (PDT) rely on preoperative hearing preservation, which, along with the use of different means of acoustic and electric stimulation, enable extending the indications for various hearing devices. Possible solutions include acoustic methods only, the use of hearing aids or middle ear implants, electric supplementation, and a combination of electric and acoustic stimulation. From over 1160 patients with PDT indication we selected 95 patients with different types of middle ear implants - were treatment was by using middle ear implants like Vibrant Soundbridge,BAHA,DACS. Other classified in PDCI was treated with selected types of electrodes and the optimal “round window” approach to the inner ear. The first patients were implanted by Medel Standard electrode with 20 mm insertion. Presently we use Medel electrodes like FlexEAS,FlexSOFT,M,Flex28 and Cochlear CI422/SRA. The extension of PDT indications created an opportunity for patients with different hearing impairments who obtained no benefit from a hearing aid and did not qualify for standard cochlear implant application. The authors’ observations are based on the findings that preservation of preoperative hearing had been achieved in 97.1% of adult patients (the longest 10 years’ observation) and in 100% of children (the longest 8 years’ observation).Speech understanding in quiet(average improvement from 30% to 83%) and noise(average improvement from 5% to 62%) which are now the most important. To allow comparison of PDT results we use Skarzynski PDT classification.</td>
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<td>Learning Objective:</td>
<td>Assess that nowadays hearing preservation is possible with different types of types devices</td>
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<td>Email:</td>
<td><a href="mailto:skarzynski.henryk@ifps.org.pl">skarzynski.henryk@ifps.org.pl</a></td>
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Introduction During the last 3 years an extensive intra-operative measurement protocol was used to objectively measure the function and interaction of the cochlear implant (CI) outcome measures of auditory nerve fibers (ECAP) and implant evoked electrically auditory brainstem responses (impEABR). The aim of this study is to find out if these measurements can be used as a predictor of speech and language outcomes.

Method 25 patients who were implanted with a Cochlear Corp. cochlear implant device, were investigated by measuring intra-op for evoked compound action potential (ECAP) and implant evoked electrically auditory brainstem responses (impEABR). For ECAP measurements thresholds (AutoNRT) on each third electrode and sweeps at 220CL were obtained for all electrodes measuring the N1-P2 amplitude. For impEABR sweeps at 220CL were also obtained on all electrodes. These measurements were divided into three frequency areas; low frequency (electrode 20); middle frequency (electrode 13) and high frequency (electrode 6). The results from impEABR eV latency and amplitude and threshold levels of the T-ECAP and amplitude of the ECAP sweep of the intra-OP measurements were compared to speech and language performance with CI. We used a scaling system from 0-10 where “0” means absolutely no benefit with CI and “10” for the best performance. By using this category system all patients (small children to adults), all performance levels can be judged in a combined score. All patients had to use their CI for at least 9 months before performance evaluations were carried out.

Results Intra-OP measurements have shown a wide spectrum of responses, as well there were differences for the measurements such as poor ECAP and good impEABR results within the same patient. Preliminary results have shown a good correlation between large impEABR responses and good performance with CI. Patients with poor and no impEABR responses have shown no performance increase with CI.

Learning Objective:
Assess that impEABR are intra-OP easy to achieve and do not extend surgical time

Email: ralf.greisiger@medisin.uio.no
Six Years of Experience with a Totally Implantable Cochlear Implant


Objectives
To review the benefits, limitations and technical capability of a prototype totally implantable cochlear implant following six years experience at the HEARing CRC. Study Design
The totally implantable implant has a lithium ion rechargeable battery, a package-mounted internal microphone and sound processing electronics that enable the use of ‘Invisible Hearing’ without the use of an external microphone. The implant also functions with an externally worn sound processor as a conventional cochlear implant. The three implanted subjects have used the device in both Invisible Hearing and standard modes of operation since the time of implantation. Hearing performance, patterns of device use, and reports of body noise have been closely monitored. In addition, technical data has been collected to assess the performance of the implantable battery and microphone.

Results
There have been no surgical or medical post-operative complications associated with use of the device. Although speech perception using Invisible Hearing mode is poorer than that obtained in the conventional mode, all subjects report some benefit associated with use of Invisible Hearing in their daily lives. Two subjects report that they are never without hearing, with Invisible Hearing used at all times when the external device is removed. Specific benefits have been reported, including use of the device when swimming and in providing sound awareness when sleeping. Limitations of the device occur as a result of body noise, and there has been no evidence of habituation to body noise over the six years of use. The rechargeable battery continues to function well, with a cycle time indicating that the low-power implant design is effective.

Conclusion
After six years use of the totally implantable system, the device continues to function well and recipients continue to report benefit associated with use of the device. This experience has provided important insight into the potential of such a system.

Learning Objective:
Recognize the benefits and potential limitations of a totally implantable cochlear implant.

Email: kplant@cochlear.com

The effect of dead regions on the benefit of combined electric and acoustic stimulation

Ting Zhang, Michael F. Dorman, Rene Gifford, Brian C. J. Moore, Anthony Spahr

Abstract:
Cochlear implant (CI) patients who have low-frequency acoustic hearing in the ear contralateral to the implant benefit significantly from the combination of acoustic (A) and electric (E) stimulation (EAS). These patients typically have a dead region in the parts of the non-implanted cochlea responding to medium and high frequencies, where there are no functioning inner hair cells and/or auditory neurons. The hypotheses of present study is that the EAS benefit may be maximized by adjusting the amplification gain provided to residual acoustic hearing based on the value of edge frequency, \( f_e \), of any dead region. Adult, postlingually-deafened, listeners with a cochlear implant in one ear and low-frequency hearing in the other ear were recruited. Dead regions in the non-implanted cochlea were diagnosed and the value of \( f_e \) was determined by using the threshold-equalizing-noise (TEN) test and psychophysical tuning curves (PTCs). The recognition of CNC words in quiet and AzBio sentences in a competing babble at +10 dB SNR was evaluated in three stimulation conditions: A-alone stimulation, E-alone stimulation, and combined EAS. The acoustic stimuli presented to the nonimplanted ear were subjected to the frequency-gain characteristic prescribed by NAL-R formula. The gain was adjusted according to the edge frequency of dead region: (1) the \( f_e \) determined by PTCs; (2) the \( f_e \) determined by TEN test; (3) two times of the \( f_e \) determined by PTCs; (4) two times of the \( f_e \) determined by TEN test. The results showed that (1) the \( f_e \) value determined by PTCs was about 0.5- or 1-octave lower than that determined by TEN test; (2) speech-perception benefits were significantly improved when the amplification gain was not provided to the frequency range beyond the \( f_e \) determined by PTCs. These results suggest that PTCs are able to define the value of \( f_e \) more precisely than TEN test and the diagnosis.

Learning Objective:
Identify two methods of identifying dead regions in the cochlea.

Email: ting.zhang@asu.edu
Thursday (3:00 PM - 5:00 PM) Marriott Grand 6 - 10  Presentation 68

Topic: Outcomes
Title: Long Term Performance and Satisfaction with Cochlear Implantation in Elderly Patients
Author(s): Andrew van Hasselt, Joannie Yu, Terence K.C. Wong, Eddie C. M. Wong, Yu Hip Cho
Presenter: Andrew van Hasselt
Abstract:

Background: Cochlear implantation is an option for elderly patients with hearing loss at severe to profound levels who cannot benefit from conventional hearing aids. Elderly (>= 60 years) make up greater than 12% of the current Hong Kong population and by 2016 and 2033, will be 13.4% and 27% respectively implying an increase in potential candidates. Issues associated with cochlear implantation in elderly patients include long term post-implantation performance.

Objectives: A collaborative study between the two major cochlear implant centres in Hong Kong.

1. To evaluate the long term performance and benefits of a group of postlingually deaf elderly patients (age at implantation >= 60 years) who had been implanted for at least four years.

2. To compare the performance of this group with that of younger adults.

Study design: Retrospective, single subject design. Records for 10 cochlear implant patients aged 60 years or older at implantation with at least 4 years following surgery were analyzed for etiology and duration of deafness, ear specific pre-implantation speech perception performance and 6 months, 12 months, 24 months post-implantation speech perception performance. These patients were invited for reassessment of speech perception and requested to complete the subjective questionnaires including Abbreviated Profile of Hearing Aid Benefits (APHAB), International Outcome Inventory for Hearing Aid (IOI-HA) and Satisfaction with Amplification in Daily Life (SADL). Ten younger adult cochlear implant patients (age of implantation 18-55 years old) were recruited for identical tests.

Results: Long term benefit on speech perception and the subjective benefits on the elderly CI users, including correlation between the age and performance with the younger group, will be analyzed and presented.

Conclusion: Results provide insights into candidacy and counseling for elderly cochlear implantation candidates.

Learning Objective: Assess that performance and benefit for postlingually deaf elderly patients can be anticipated over the longer term.

Email: andrewvan@cuhk.edu.hk

Thursday (3:00 PM - 5:00 PM) Marriott Grand 6 - 10  Presentation 69

Topic: Outcomes
Title: Remote Intraoperative Support of Cochlear Implantation
Author(s): Vladislav Kuzovkov, Yuri Yanov, Sergei Levin
Presenter: Vladislav Kuzovkov
Abstract: The state CI program in Russia has grown from less than 100 surgeries in 2000 to more than 1000 in 2011. The main features of this program are its high centralization (three major CI centres in two cities and five minor centres over the entire country) and the great distances of patients from the centres. To overcome the problem of increasing numbers of patients at long distances from CI centres, the use of telemedicine technologies has been proposed. The concept of Long-term Remote Support of CI patients (RSCI) has been developed. The concept includes: 1. Remote candidate selection; 2. Remote surgery support; 3. Remote rehabilitation.

Teleconferencing equipment consisted of a Polycom video server, Webex teleconference software, 2 laptops, 2 webcams and an Internet line =5 MBit/sec. Remote Surgery Support consists of online live surgery with counselling and remote measurements (telemetry of implant, eSRT, ART). At first stage of the Remote Surgery Support study remote implant measurements has replaced on-site measurements by the audiologist at the Saint Petersburg. Second part of the study included intraoperative measurements and online surgery counselling in Krasnoyarsk, Chelyabinsk and Ekaterinburg by surgeons and audiologist located in Saint Petersburg. Eighteen patients aged from 1.5 to 61 years old were included in the study. Parameters of different CI centres were compared. The time of each component of the study was calculated; results of intraoperative measurements were assessed. Specially designed questionnaires were completed by specialists in Saint Petersburg and in distant cities. All intraoperative measurements were made remotely with mean time 15 min (7 min at the Saint Petersburg). Remote measurements were ease and time effective. The specialists’ responses to the questionnaires indicated that online counselling was successful. Distant centres specialists estimated learning efficiency more highly than did specialists at the Saint Petersburg (94% vs. 65%).

Learning Objective: Identify possibilities of remote telemedicine in cochlear implantation.

Email: v_kuzovkov@mail.ru
**Thursday (3:00 PM - 5:00 PM) Marriott Grand 6 - 10**

**Presentation 70**

**Topic:** Outcomes  
**Title:** Electroacoustic stimulation: are the recipients users?  
**Author(s):** Alain S Uziel, Adrienne Vieu, Frederic Venail  
**Presenter:** Alain S Uziel  
**Abstract:** Objectives: to determine the benefit of Electro-acoustic stimulation (EAS) after 1 to 4 years of implant use, the mode of implant use (electroacoustic, bimodal or combined) and evaluate the mode of EAS use in everyday life. Study design: Retrospective study on 12 patients with high frequency SNHL and relative hearing preservation at low frequencies, with speech discrimination < 50 % in the best aided condition, implanted from January 2007 to December 2010 (8 MedEl Flex and 4 Nucleus Hybrid L). All patients were regularly evaluated using a battery of tests (audiometry, PBK word recognition in quiet, sentences in noise, speech tracking). A questionnaire was designed to evaluate the common use of electroacoustic stimulation in everyday life. Results: Successful residual hearing preservation was achieved in 10/12 patients, 2 patients experienced a total loss of residual hearing. The mean scores for PBK word scores at 1 year were 60 % in cochlear implant alone condition, 68 % in EAS, 74 % in bimodal and 78 % in combined condition. After 1 year of implant experience, 7/12 patients continued to use EAS with ipsilateral and/or bilateral hearing aids, 3/12 used bimodal stimulation (implant + contralateral hearing aid) and 2/12 used cochlear implant alone. The causes of non-use of the ipsilateral hearing aid were mainly due to a low pre or postoperative preservation of hearing in the low frequencies. Discussion: This study demonstrates that 42% of patients initially scheduled for electroacoustic stimulation did not use the ipsilateral hearing aid in long term. In the future, longer electrodes might be used to enhance CI alone performance in patients with poor preoperative low frequency residual hearing or in patients with evolutive sensorineural hearing loss.  
**Learning Objective:** Recognize that 40 % of patients initially scheduled for electroacoustic stimulation did not use the ipsilateral hearing aid in long term  
**Email:** alain.uziel@wanadoo.fr

**Thursday (3:00 PM - 5:00 PM) Four Seasons Grand Ballroom**

**Presentation 71**

**Topic:** Surgical Techniques  
**Title:** The impact of insertion speed on electrode insertion and hearing preservation: Clinical observations  
**Author(s):** Jafri Kuthubutheen, Gunesh P Rajan, Georgios Kontorinis, Roberta Marino  
**Presenter:** Roberta Marino  
**Abstract:** Background: The importance of hearing preservation in cochlear implantation is widely debated, its impact in patients with partial deafness or residual low frequency is evident. Several factors influence hearing preservation, key variables are hair cell protection, electrode type, insertion technique and post-implantation inflammation processes. We wanted to investigate one key element of the insertion technique, the insertion speed and its impact of electrode insertion and hearing preservation. Methods: Prospective study comparing electrode insertion characteristics such as insertion stops, reinsertion rates and completeness of insertion between two groups of patients undergoing cochlear implant surgery through the round window approach. In the control group (n = 11), a standard insertion speed of 2 electrodes per second was used, in the interventional group a slow insertion speed was used, around 10 seconds per electrode. Above mentioned characteristics and hearing preservation rates were compared between the 2 groups. Results: In 81% of the control group (n = 9) and in 9% of the interventional group (n = 1) an insertion resistance and stop was encountered. In the control group, 17 insertion attempts for 11 electrodes were required, in the interventional group 12 insertion attempts were needed to implant 11 electrodes. In the interventional group 11 out of 11 electrodes (100%) were completely inserted as opposed to 6 out of 11 (54%) in the control group. Hearing preservation levels were higher in the interventional group (level 2) when compared to the control group (level 3 hearing preservation). Conclusion: Insertion speed is a key element of surgical technique for hearing preservation in cochlear implantation. Our observations suggest that a slow electrode insertion speed may facilitate full electrode insertion, reduce the numbers of insertion attempts required and might improve hearing preservation rates. Further ongoing studies are required to substantiate our initial clinical observations.  
**Learning Objective:** Describe insertion speed of the cochlear electrode is an important factor in cochlear implantation  
**Email:** jafri.kuth@gmail.com
Objective. Post-meningitic basal turn ossification is a challenge for successful cochlear implantation despite the availability of sophisticated implants and advanced drill out procedures. A less complex concept consisting of a cochleostomy near the apex with retrograde array insertion is evaluated clinically and experimentally with emphasis on imaging of intracochlear array morphology. Methods. Outcome, hearing performance and radiological findings including 3D reconstructions were assessed in the long-term in 8 retrograde implanted ears of 7 postmeningitic deaf patients and compared to an etiology- and device-matched control group of 17 basal turn implanted ears of 14 patients. Experimental insertions into three autopsy-derived human temporal bones were evaluated using high-resolution micro tomography, 3D reconstruction and histology. Results. No complications occurred. At the long-term follow-up, the average monosyllabic word test scores were 41 % for the study group and 67% for the control group (p=0.03). Radiological follow-up revealed insertion sites either into the apical or middle turn and frequent intracochlear array direction changes (n=5). Experimental implantations in temporal bones resulted in folding-free, retrograde, middle turn insertions (n=3). Conclusions. The retrograde cochlear implantation is a safe and efficient alternative approach in basal turn ossification. Despite a high occurrence of intracochlear array direction changes, open set speech discrimination was achieved in all patients. A postoperative CT is recommended for fitting the speech processor according to intracochlear array positions. The experimental insertion in temporal bones helped to optimize the approach.

Learning Objective: Assess alternative surgical strategies for cochlea implantation into ossified cochleas

Email: pascal.senn@insel.ch

Topic: Surgical Techniques
Title: Retrograde cochlear implantation in postmeningitic basal turn ossification
Author(s): Pascal Senn, Claudio Rostetter, Andreas Arnold, Martin Kompis, Matteus Vischer, Rudolph Haeusler, Christoph Ozdoba, Georgios Mantokoudis, Marco Domenico Caversaccio
Presenter: Pascal Senn
Abstract: Variations in cochlear anatomy and electrode design dictate that approaches to electrode insertion be adaptive to the apical or middle turn and frequent intracochlear array direction changes, open set speech discrimination was achieved in all patients. A postoperative CT is recommended for fitting the speech processor according to intracochlear array positions. The experimental insertion in temporal bones helped to optimize the approach.

Learning Objective: Identify how anatomical variations of the angle of the round window membrane affect electrode insertion trauma.

Email: tbalkany@miami.edu

Topic: Surgical Techniques
Title: Adaptive Cochleostomy
Author(s): Thomas Balkany, Peter Roland, Craig A. Buchman, Yisgav Shapira
Presenter: Thomas Balkany
Abstract: Objective: Both round window membrane (RWM) and bony cochleostomies have been advocated to reduce electrode insertion trauma and preserve residual hearing. The specific objectives of this study are to support the hypothesis that neither type of cochleostomy is ideal in all cases and that the procedure should be adapted to the patient, not the reverse. Methods: Fifteen cadaver temporal bones were prepared by a transmastoid-posterior tympanotomy approach, removal of the RW tegmen and cochlear surface preparation. Insertion of a straight electrode analog was studied from the surgical perspective using high-resolution digital microphotography and computerized morphometric analysis. Anatomic variability in presentation of the RWM was evaluated to determine possible limitations to RWM insertion. In addition, variability in the location of the proximal scala tympani was evaluated. Data were analyzed using the Mann-Whitney U test for independent variables and logistic regression analysis to correlate electrode position, RWM angle, and location of the scala. A peri-modiolar electrode (Nucleus Contour Advance) and a straight electrode (MED-EL Standard) were analyzed by computer morphometrics to determine compatibility with the two cochleostomy alternatives. Results: A wide variability in inferior angulation of the RWM was found ranging 27º from saggital (facing more toward the surgeon and facial recess) to 65º (facing more inferiorly). Inferior angulation of >45º occurred in two (13%) specimens and was associated with impingement of the straight electrode analog on the modiolus. The Nucleus System 5(CA) electrode is pre-curved (17± 5º) prior to stylet removal. Angulation of the proximal portion of S. tympani varied from 37.7º to 74.3º and had a substantial impact on the atraumatic location of bony cochleostomies. Conclusion: Variations in cochlear anatomy and electrode design dictate that approaches to electrode insertion be adaptive to two major variables, electrode type and patient anatomy.

Learning Objective: Identify how anatomical variations of the angle of the round window membrane affect electrode insertion trauma.

Email: tbalkany@miami.edu
Enhanced Coverage Of Long Electrode Cochlear Implants with Round Window Insertion Douglas Chen MD

Purpose: Long cochlear implant electrode placements have been advocated as a means of achieving improved performance through complete cochlear coverage. However, anatomical studies indicate that using cochleostomy insertion techniques will lead to a significant incidence of partial electrode insertions and incomplete electrode coverage. Similarly, anatomical evidence exists that the cochlear duct measured from the round window, as opposed to a traditional cochleostomy site, is longer. We hypothesize that long electrode cochlear implants inserted with the round window technique will achieve better electrode coverage than those inserted by cochleostomy techniques.

Methods: A retrospective review of all long electrode cochlear implant surgeries performed between 5/2005 and 10/2011 was performed. Insertion technique, round window versus cochleostomy technique was noted. Total, near total and partial insertions for each insertion technique were noted. Total electrode insertion was defined as all electrodes functioning. Near total electrode insertion was defined as all electrodes functioning except for one. Partial electrode insertion was defined as more than one electrode functioning. Results: A total of 67 long electrode cochlear implants were identified. 48 were placed thru a cochleostomy and 19 were placed through a round window insertion. Total electrode insertion was achieved in 13/19 (68.4%) for the round window group and 20/48 (41.7%) for the cochleostomy group (p=.048). Total and near total electrode insertion was achieved in 18/19 (94.7%) of round window insertions and in 26/48 (54.2%) in the cochleostomy group (p=.0016). In addition, the number of electrodes/ear that were not inserted was significantly lower for the round window group as compared to the (p=.017). Conclusion: The round window insertion of long electrode cochlear implants provides for better electrode coverage with higher chance of total and near total insertions and fewer extracochlear electrodes with partial insertions.

Learning Objective: Assess the length of the cochlear duct from the round window.

Email: douglasachen@yahoo.com
Topic: Surgical Techniques
Title: How to measure forces applied to the cochlea while insertion of the Contour Advance electrode in AOS technique.
Author(s): Omid Majdani, Thomas Rau, Jan-Phillipp Kobler, Daniel Beckmann, Tobias Ortmann, Thomas H. Lenarz
Presenter: Omid Majdani
Abstract: Objectives: Different groups have reported about force measurement studies for insertion process of the CI electrodes using similar setups with measuring the applied forces outside of the cochlea (external force measurement). Our intention was to include the sensors into an insertion tool to be able to measure the forces applied directly to the electrode (internal force measurement). Study Design: We designed an insertion tool consisting of two piezoelectric motors for advancing the electrode into the cochlea in Advance-Off-Stylet (AOS) technique. Micrometer strain gauge sensors have been implemented into the insertion tool. For the insertion process an Image Guided System has been used to be able to insert the electrode along the direction of the basal turn. A series of 14 insertion attempts of the CA electrode into a cochlea phantom have been performed while measuring the internal as well as the external forces applied to the cochlea. Results: The results are preliminary. The results of the internal and external forces showed a significant difference in proper insertion process while the results were similar in cases with intentionally induced tip-fold-over insertions. The external forces varied around 3mN while the internally measured forces varied around 40mN. By proper insertion process the external values were in negative range (pulling up the specimen from the underneath force sensor) as the modiolar hugging electrode pulled the specimen upwards while this effect was absent at the internal force data. The effect of the friction of the electrode at the insertion tool produced artefacts around 40mN at the internal force measurement (unfiltered data). Conclusion: External force measurements of CI electrode insertions do not reproduce the forces applied to the cochlea by the deformation process of the electrode. Internal force measurements avoid this problem, but the friction of the electrode to the insertion tool is being measured.

Learning Objective: Describe methods for force measurement during electrode insertion.
Email: majdani.omid@mh-hannover.de

Topic: Surgical Techniques
Title: Surgical issues of cochlear implantation with a Digisonic SP cochlear implant (Neurelec-France).
Author(s): Thierry Mom, Aurélie BASCOUL, Mohamed Akkari, Laurent GILAIN, Paul Avan
Presenter: Thierry Mom
Abstract: Introduction: We report here our experience with the Digisonic SP cochlear implant (Neurelec). Study design: Retrospective analysis of all surgical procedures for cochlear implantation with a Neurelec device from Digisonic SP type, available from January 2004. We looked at the depth of electrode-array (EA) insertion. We also looked at the duration of the procedure and device failures. The depth of EA insertion was assessed by counting the number of electrodes left out of non-malformed cochleas. Comparisons used contingency tables and a Chi-square test. A p<0.05 was considered significant. Results: 106 cases were analyzed (24 children, 54 males). Mean age was 53.8 +/- 16.2 years for adults and 3.5 +/- 2.6 years for children. The follow-up was on average 33 +/- 22 months. All implants were operated with the same procedure, that is, through a posterior tympanotomy. EAs were inserted through the round window in all but 8 cases. In cases with non-malformed cochleas (n=100), EAs were ended by either a straight square tip (n=39) or for last cases by a soft ogival tip (61). The insertion was deeper with the soft tip (Chi-square=26.089, dof=1, p<0.001) and gave a full insertion in 57 cases (93.4%). All but two cochlear implants were fixed by one (n=49) or two (n=55) auto-tapping screws leading to a one-hour procedure on average. No cases of postoperative displacement were reported. One case of failure device (0.9%) required a replacement of the implant. Conclusion: This cochlear implant has a good long-term reliability. It can be placed in a quick procedure due to the use of auto-tapping screws. The new EA of the Digisonic SP has led to a high rate (93.4%) of full insertions in non-malformed cochleas.

Learning Objective: Perform a correct cochlear implantation with a Neurelec cochlear implant through the round window.
Email: tmom@chu-clermontferrand.fr
**Thursday (3:00 PM - 5:00 PM) Four Seasons Grand Ballroom**

**Presentation 78**

**Topic:** Surgical Techniques  
**Title:** Posterior tympanotomy/endomeatal combined access in cochlear implantation.  
**Author(s):** Antonio Della Volpe, Italo Cantore, Gerardo Nolè, Gina Oliveto, Claudia De Canio, Michela, Santandrea, Valentina Santandrea, Rocco Cantore  
**Presenter:** Italo Cantore  
**Abstract:** Objective: We propose a combined posterior tympanotomy/endomeatal approach for cochlear implantation. 
Study design: Retrospective clinical study. Surgical steps and our results in a series of 32 patients (14 pre-verbal and 18 post-verbal) are reported. Results: We obtained good anatomic and functional results with intraoperative improvements in visibility and accessibility of cochleostomy site in difficult cases. At 12 months we did not observe any complication such as tympanic membrane perforation, external canal skin lesions or extrusion. Conclusions: The combined posterior tympanotomy/endomeatal approach facilitates the array insertion in conditions of bad exposition/accessibility of promontory and round window. Moreover, this double way access hinders an incomplete or incorrect positioning. It should be ever considered as an alternative to traditional posterior tympanotomy one way access.

**Learning Objective:** Identify alternative surgical technique  
**Email:** antoniodellavolpe@yahoo.it

**Presentation 79**

**Topic:** Surgical Techniques  
**Title:** Vestibular Loss after Cochlear Implantation: state-of-the-art  
**Author(s):** Andy J Beynon, Emmanuel Mylanus, Hieke Kieft  
**Presenter:** Andy J Beynon  
**Abstract:** Vestibular loss after cochlear implantation  
Background Cochlear Implantation will lead to auditory perception of speech and sounds. Surgical risks are involved, such as vestibular loss. Therefore, adequate information of risks is necessary for preoperative counselling of candidates. Aim of present study is to investigate risk of vestibular loss after implantation and find out whether central adaptation will take place postoperatively. A review of other previous studies will be compared with present data. Method In addition to the audiological- and MRI findings, electronystagmography was performed in CI candidates and patients. Pre- and postoperative caloric dysfunction of horizontal semicircular canal is compared and asymmetry in rotational testing is evaluated. Besides vestibular functional variables also ‘cause of deafness’, ‘age at implantation’, ‘surgical procedure’, ‘type of electrode’, ‘surgeon’, ‘time between surgery and ENG’ and ‘postoperative deterioration in pure tone threshold’ are taken into account. Dizziness Handicap Inventory (DHI) was used to assess postoperative vestibular handicaps in the functional, physical and emotional domain. Results 25% of CI subjects lost their vestibular function after cochlear implantation; 8% completely lost their vestibular function. Regression analyses suggest that candidates beyond age of 49 years are more susceptible to vestibular deterioration after implantation. Other variables do not play a significant role. Rotational chair data reveal that subjects postoperative show central adaptation that is in agreement with behavioral DHI results. Present data show no relationship between objective caloric test results and subjective handicap. Conclusion Adequate preoperative counseling of patients for possible vestibular function loss after CI is of importance, especially beyond the age of 49 years.

**Learning Objective:** Summarize that with the development and improvement of auditory devices, an increasing number of patients with significant residual hearing will be candidates for CI, thus leading to a higher risk of postoperative auditory and/or vestibular loss  
**Email:** a.beynon@kno.umcn.nl
Thursday (3:00 PM - 5:00 PM) Four Seasons Grand Ballroom  
Presentation 80

Topic: Surgical Techniques  
Title: Cochlear Implants: Surgical Issues in Complex Cases  
Author(s): Prepageran Narayanan  
Presenter: Prepageran Narayanan  
Abstract: Cochlear Implant surgery are routinely performed via a transmastoid posterior tympanotomy and cochleostomy. This approach works very well and is accepted as a work horse approach that is suitable in most cases. The authors would like to share their experience encountered during surgery in complicated cases as well as in atraumatic electrode insertion. Cases discussed would include round window electrode insertion, CSF gusher, ossified cochlear and a perilymph gusher. An abnormally high facial nerve that requires a subfacial nerve approach will also be highlighted. These would be highlighted with video clips of the surgical procedure and the difficulty encountered. The authors also share their experience with Flexsoft electrodes which are designed to be inflict minimal trauma during insertion.

Learning Objective: Recognize alternative surgical approaches to complex cochlear implant cases  
Email: prepageran@yahoo.com

Thursday (3:00 PM - 5:00 PM) Marriott Waterview Ballroom  
Presentation 81

Topic: Bone Conduction and Middle Ear Implantable Devices III  
Title: Three week loading for Baha BI-300® Implant System  
Author(s): Jack J Wazen  
Presenter: Jack J Wazen  
Abstract: Objective: The timing of loading of titanium craniofacial implants is dependent upon implant characteristics, host factors, and the bonding of titanium oxide and bone referred to as osseointegration. The purpose of this study seeks to determine the safety of early loading of the Baha BI-300 implant system (Cochlear Limited, Englewood, CO), which has been modified with novel surface texture and geometric design. Study design: Prospective within subject repeated measurements, compared to a control group. Setting: Tertiary care. Subjects and Methods: This prospective study measures implant stability as determined by clinical evaluation and resonance frequency analysis (RFA) at implantation, and 1, 3, 6, 12, and 24 weeks post-op in 20 patients who underwent single-stage implantation and exteriorization of the BI-300. The processor was loaded at 3 weeks post-op. The results are then compared to those of 12 patients with RFA measurements at 1 year postoperatively. Results: RFA measurements showed no statistical differences between values at implantation, 1, 3, 6, 12, and 24 weeks. There was also no statistical difference comparing the early loading group to the control group loaded at 6 weeks, and measured at 1 year. No implant loss or postoperative complications were encountered as a result of the 3-week loading. Conclusion: Three-week loading of the BI-300 implant did not result in any implant loss or failure of osseointegration. Earlier activation of the external processor with earlier hearing rehabilitation resulted in improved patient satisfaction.

Learning Objective: Identify the principles of osseointegration  
Email: ottonro@gmail.com
**Presentation 82**

**Topic:** Bone Conduction and Middle Ear Implantable Devices III

**Title:** Codacs: a new approach to treat severe to profound mixed hearing loss

**Author(s):** Thomas Lenarz

**Presenter:** Thomas Lenarz

**Abstract:**

**Introduction:** The Direct Acoustic Cochlear Implant (DACI), called Codacs, was investigated in a prospective clinical study at the Medical University of Hannover. Codacs is designed to directly stimulate the perilymph through a stapedotomy approach. The system with an electro-magnetic transducer is fixed on the rim of the mastoid while the piston is attached to the transducer through an artificial incus.

**Objective:** To demonstrate the safety and efficacy of direct acoustic stimulation in patients with severe to profound mixed hearing loss, especially for those with advanced otosclerosis.

**Methods:** 15 patients with severe to profound mixed loss due to otosclerosis have been implanted with a Codacs device using either a mastoidectomy approach or a combined translabyrinthine approach. Air and bone conduction thresholds were measured preoperatively and postoperatively as well as the speech performance in unaided condition, with conventional hearing aids and with the activated Codacs device at different times postoperatively.

**Results:** Postoperative bone conduction thresholds show no significant additional inner ear damage in all implanted patients. The functional gain was higher especially in high frequencies compared to conventional hearing aids. The speech perception in quiet and noise show significant benefit over preoperative unaided conditions and with conventional hearing aids.

**Learning Objective:** Discuss that the device should be used by experienced otosurgeons only due to the complexity of the surgical approach.

**Email:** lenarz.thomas@mh-hannover.de

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**Presentation 83**

**Topic:** Bone Conduction and Middle Ear Implantable Devices III

**Title:** Influences in Hearing Preservation based on types of electrodes and insertion approach

**Author(s):** Alejandro Rivas, David Haynes

**Presenter:** David Haynes

**Abstract:**

**Objective:** To assess the levels of residual hearing preservation during cochlear implant surgery by comparing electrode insertion techniques and electrode type.

**Study Design:** Retrospective chart review

**Subjects and Methods:** Subjects with preoperative low frequency hearing (≥ 90 dB HL at 250 Hz) who underwent cochlear implantation. Main outcome measures: Postimplantation pure tone threshold shifts were used as measure of intracochlear injury. Pure tone thresholds and pure-tone averages were calculated from preoperative and postoperative audiograms from 250, 500, and 1000 Hz. Electrode types were compared looking at differences between straight vs. perimodiolar and old generation vs. latest generation electrodes.

**Results:** Data from 165 implants were included in the analysis. The median postoperative low-frequency pure-tone average was 120, 103, and 105 dB HL for standard cochleostomy, soft surgery, and round window insertion techniques respectively (p=0.001). Pairwise comparisons showed a significant difference for standard cochleostomy versus soft surgery (p=0.009), and standard cochleostomy versus round window insertion (p=0.001). There were no statistical significance for round window insertion versus soft surgery (p>0.05). When looking only at new generation electrodes, there was no statistical significant difference between soft surgery and round window insertion (p>0.05). However, we encountered better preservation using perimodiolar electrodes (101 dB HL) than straight arrays (106 dB HL) (p=0.038). For round window insertion there was no difference regarding the electrode type (p > 0.05). Conclusion: There is no difference in hearing preservation when using either an atraumatic cochleostomy technique (SS) or round window insertion. However, the type of electrode used seems to impact the degree of preservation for each technique. When using a soft surgery approach we achieve better results with perimodiolar electrodes than straight array; but when using the round window both type of arrays provide equivalent preservation results.

**Learning Objective:** Assess that hearing preservation techniques have better outcomes than standard techniques for cochlear implantation

**Email:** alejandro.rivas@vanderbilt.edu
Thursday (3:00 PM - 5:00 PM) Marriott Waterview Ballroom  Presentation 84

**Topic:** Bone Conduction and Middle Ear Implantable Devices III

**Title:** Vibrant Soundbridge implantation in children with microtia

**Author(s):** John Martin Hempel, Alexander Berghaus, Joachim Michael Müller, Thomas Braun

**Presenter:** John Martin Hempel

**Abstract:**

**Background:** Aural atresiaplasty is a challenging procedure. Unfortunately, functional results after atresiaplasty turned out to be limited. Since October 2009, the MedEl Vibrant Soundbridge (VSB) is CE certified for implantation in children in Germany. This active middle ear implant opens new possibilities for atresia cases, allowing individual solutions to fix the floating mass transducer.

**Method:** The first author combines either a single stage pinna reconstruction with a porous polyethylene framework as introduced by Berghaus in 1982 and a temporoparietal fascia flap with the implantation of the Vibrant Soundbridge or the implantation of the Vibrant Soundbridge in atresia alone.

**Results:** So far, six children (age 5 to 17) received a combined reconstruction of the pinna and VSB implantation in our department. In another four cases with atresia (age 5 to 6), the author only performed VSB implantation. No complications have been seen. Several options have been used, such as modifying the original clip in a way that an upside down fixation to a malformed stapes superstructure was possible, using couplers or round windows applications. After activation of the VSB, speech understanding for monosyllables ranged from 95 to 100% for the atretic ear. Speech understanding in noise improved up to 20% with the VSB.

**Conclusions:** Reconstruction of the auricle and implantation of the VSB can be achieved in a single stage around the age of 5 years. The implantation of the VSB leads to a normal speech understanding for the atretic ear. Speech understanding in noise improves significantly.

**Learning Objective:** Identify that the reconstruction of the pinna, using Porous Polyethylene and implantation of the middle ear implant (VSB) can be achieved in a single stage procedure.

**Email:** john-martin.hempel@med.uni-muenchen.de

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Thursday (3:00 PM - 5:00 PM) Marriott Waterview Ballroom  Presentation 85

**Topic:** Bone Conduction and Middle Ear Implantable Devices III

**Title:** Impact of Age on Outcome in Adult Electric-Acoustic Stimulation (EAS) Patients

**Author(s):** Craig A. Buchman, Oliver F. Adunka, Meg Dillon, Marcia Adunka, English King, Harold Pillsbury

**Presenter:** Craig A. Buchman

**Abstract:**

**Objectives:** Advanced age has been associated with poor performance among patients receiving the Hybrid (10mm insertion; Cochlear Corp) cochlear implant. One potential explanation is that older patients may lack the plasticity needed to achieve the necessary place-pitch reallocation induced by short electrode implantation. The present study compares the outcomes of older (>65 years) electro-acoustics stimulation (EAS) patients with those of younger EAS patients using a longer electrode array (18 mm insertion; MedEL Corp). The longer EAS array may provide for easier integration of the combined signal, ultimately resulting in good performance even among the elderly.

**Study Design:** Of the 29 EAS subjects implanted at our institution (IRB-approved; MedEL US Clinical Trial), 20 (< 65 yrs=15 subjects; > 65 yrs=5 subjects) have completed the 12-month follow-up using combined stimulation in the implanted ear. The test battery consists of CNC words administered in quiet and adaptive CUNY sentences in steady-state noise at pre-op, 3, 6, and 12 months post-op.

**Results:** Overall, this population has experienced substantial gains in speech perception in both quiet and noise. There were no significant differences in mean CNC word scores between the two age groups of patients at any test interval. When CUNY sentences were administered in noise (+0 SNR), older adults (>65 yrs) performed significantly worse at the 3-month interval. By 6 and 12-months post-activation, differences were no longer apparent. Conclusions: These preliminary results appear different than those previously reported for the 10 mm Hybrid array and suggest that older patients can ultimately integrate combined stimulation using an 18 mm EAS array. These results imply effective signal integration and possibly suggest that less pitch-place reallocation is needed with this longer array.

**Learning Objective:** Discuss potential differences in speech perception outcomes for older adults receiving EAS.

**Email:** buchman@med.unc.edu
Topic: Bone Conduction and Middle Ear Implantable Devices II
Title: Sub-facial approach is a effective way in round window vibroplasty for some cases with severe atresia
Author(s): Pu Dai
Presenter: Pu Dai
Abstract: Objective: Sound bridge implantation have been increasingly performed in children with outer and middle ear malformations and aberrant courses of facial nerves. Some of these cases need special approach to create the optimal route of surgery or to ensure the correct placement of the FMT. We herein report two patients with atresia who underwent sound bridge implantation via retro facial nerve approach. Patient: Case 1 was a 15-year-old boy with anterior and inferior displacement of the facial nerve, which obscured the cochlea and promontary area. Intervention: A sub-facial approach to the round window membrane was used and ensured the correct placement of the FMT on Round window membrane. Case 2 was a 12-year-old boy with anterior displacement of the facial nerve, which obscured the whole round window niche. Intervention: The vertical portion of facial nerve was skeletonized and the FMT was placed on round window membrane via a Sub-facial approach. Results: Both patients successfully underwent the surgeries of sound bridge implantation. The complications like facial palsy or neuro-sensory hearing impairment weren’t encountered. After 3 to 6 months of VSB implant use, the patients’ hearing rehabilitation results were very encouraging. Conclusions: Sub-facial approach allowed for correct placement of the FMT in some atresia cases with obvious anterior displacement of facial nerve course.

Learning Objective: Evaluate if the sub-facial approach a effective in patients with severe malformed middle ear?
Email: daipu301@vip.sina.com

Topic: Bone Conduction and Middle Ear Implantable Devices III
Title: Cochlear implantation with the CONCERT pin system – new techniques for minimal invasive approaches
Author(s): Georg M. Sprinzl, Astrid Wolf-Magele, Johannes Schnabl, Viktor Koci
Presenter: Georg M. Sprinzl
Abstract: Objective: Minimal invasive approaches have been described for cochlear implantation in adults and children. Still the approach for electrode insertion is discussed controversially. We describe our experience with adult and pediatric cochlear implantation, the incision technique for the Concert-device and the insertion techniques for two different electrodes (Standard and Flex Soft electrode). Moreover we present the usefulness of the pin system, which enables an easy immobilization of the implant device itself. Methods: Among 68 cochlear implantations performed between July 2010 and December 2011, there were 10 pediatric and 58 adult cochlear implantations with the MED-EL Concert pin. In our technique, standard posterior tympanotomy and cochleostomy were performed after 3.5 cm minimal invasive incisions in the postauricular region. In fifteen consecutive cases, suture fixations were not used for the implant receiver, nor its electrode. We used for the insertion of the electrode the roundwindow approach in all cases. Results: There were 6 girls and 4 boys (range 1-6 years) with a mean age of 3.6 years. The mean follow-up duration was 3 months. In the adult group there were 28 female and 30 male subjects (range 18-78 years) with a median age of 45.8 years. In both groups no flap necrosis, hematoma or infection, nor implant migration, extrusion or breakdown were encountered. In all cases a full electrode insertion was carried out. Operative time was reduced down to 45 min in average. Conclusion: Minimal invasive cochlear implantation can be performed using small incisions without suture fixation of the receiver and its electrode in adults and children. However, a subtle drill out of the implant well is recommended in every case. For the insertion of the electrode the approach through the round window is recommended. The Concert Pin System enables the surgeon to use the most minimal technique with less trauma and less risk for the patient.

Learning Objective: Assess the usefulness of the Concert pin system for the immobilization of cochlear implants.
Email: georg.sprinzl@i-med.ac.at
Several implantable hearing devices (FMT: Floating Mass Transducer, MET: Middle Ear Transducer) are clinically used to stimulate the cochlea either through the oval window via the ossicular chain or the round window. The actuators of these systems have been originally intended or specifically designed to be coupled to the ossicular chain but not for coupling to the round window. Therefore the question arises whether round window stimulation of the cochlea differs from stimulation of the cochlea via the stapes footplate. In order to answer this question, we compared the differential pressure between the scala tympani and the scala vestibuli for both stapes and round window stimuli in fresh temporal bones. For stapes stimulation sound was applied to the tympanic membrane. For round window stimulation a piezo-electrical driven rod of 1mm in diameter was coupled directly and perpendicularly to the round window membrane. Laser Doppler Vibrometry was used to measure the input stimuli to the oval or round window, i.e. stapes velocity during sound stimulation and velocity of the driving rod during round window stimulation. The differential pressure between the scala vestibuli and the scala tympani (the stimulus to the cochlear partition) was measured with microscale fiberoptic pressure sensors with 150-200 um in diameter as described by Olson 1998. The differential pressures were normalized by the corresponding input velocity. Preliminary results show that the differential pressure for round window stimulation differs from the differential pressure for stapes stimulation. If these results are confirmed with further measurements, it might be useful for the modification of existing transducers used for round window stimulation or for the development of round window actuators which matches the transfer functions of sound stimulation. This could provide an efficient stimulation for the round window over the audible frequency range.

Learning Objective:
Recognize that microscale fiberoptic pressure sensors offer an additional measurement to characterize implantable actuators

Email: christof_stieger@meei.harvard.edu