Abstract: Tuberculous Otitis Media: Diagnosis and Treatment

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Objective: To emphasize the importance of early detection and treatment of tuberculous otitis media by providing information on various clinical presentations of the disease, results of diagnostic procedures and clinical and audiologic outcomes after medical and surgical management.

Background: Tuberculosis (TB) is a rare cause of chronic suppurative otitis media (<1%). The low prevalence explains the scarcity of knowledge on the clinical presentation of the TB otitis media that usually contributes to late diagnosis. By contrast, the Philippines is ranked number in incidence rate of TB which is one of the top ten causes of mortality in the country. Experiences gathered in areas like the Philippines may provide important information on the clinical course and management of the disease to clinicians practicing in areas where the prevalence of the disease is rare.

Study Design: Retrospective case series

Setting: Private clinic in a tertiary hospital

Materials and Methods: The clinical records of nine patients who were diagnosed with tuberculous otitis media during a five year period (2004-2009) were reviewed. All were healthy looking adults, aged 18-56 years old. Three were men and six were women. All were treated previously as cases of non-tuberculous otitis media prior to diagnosis of TB otitis media. Items in the history that were not included in the clinical records but which were relevant to the diagnosis of TB otitis media were gathered during follow-up visits or through phone interview. Before and after treatment otoscopic pictures, audiograms, CT scan images, and results of other diagnostic tests were retrieved and compared.

Results: Four patterns of otoscopic appearances were noted. One patient had perforated tympanic membrane, refractory otorrhea, and exuberant granulation tissue formation; two presented with perforated tympanic membrane, minimal but persistent otorrhea and no or minimal granulation tissue formation; three with intact tympanic membrane with middle ear effusion and another three with intact tympanic membrane with tumor-like tissue in the middle ear cavity. Diagnosis of tuberculosis was confirmed by biopsy in five of eight patients, polymerase chain reaction examination for mycobacterium TB in five of six patients, and TB culture in one of two patients. Examination of the TB bacilli by means of acid fast smear failed in two patients. The notable predictors of TB were poor response to prolonged antibiotic therapy, past history of pulmonary TB, work-related contamination of the infection, positive chest radiograph for TB, positive tuberculin test; and, hearing loss considered disproportionate to the otoscopic picture. Other identified predictors were CT scan images showing soft tissue density occupying the middle ear and mastoid bone with preservation of the mastoid air cell architecture, relative lack of mastoid bone sclerosis, absent erosion of ossicular bone structures and scutum; and, intraoperative finding showing the presence of abundant whitish to yellowish, soft granulation tissues over the middle ear and mastoid cavities. Patients with mild pathology had minimal intervention with resultant good clinical resolution and hearing preservation. Patients with more severe pathology had more extensive intervention, less favorable clinical response and audiometric results.

Conclusion: The study demonstrates the importance of integrating clinical and laboratory diagnosis for the early detection of TB otitis media cases that had more favorable results after intervention.
Title: Coenzyme Q10 in combination with Steroid therapy for treatment of Sudden Sensorineural Hearing Loss

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Abstract

Objective: To evaluate the therapeutic efficacy of coenzyme Q10 (CoQ10) added to systemic steroid in patients with idiopathic sudden sensorineural hearing loss (SSNHL).

Materials and Methods: A total of 120 patients diagnosed with SSNHL were enrolled in this study. All patients were treated with systemic steroid treatment for 2 weeks including 5 day-hospitalization. Patients were divided into the CoQ10 group which were treated with CoQ10 for 2 weeks and the control group which were not.

Results: The total hearing improvement rate after the treatment was 75.0% in this study. Although the CoQ10 group showed better hearing improvement (78.3%) than the control group (71.7%), there was no significant difference. However, the CoQ10 group showed significantly higher improvement of speech discrimination score and better hearing improvement at 1 kHz than the control group.

Conclusion: From this study, we suggest that CoQ10 may have beneficial effects in the treatment of SSNHL.

Key Words: Sudden sensorineural hearing loss, Coenzyme Q10, Steroid
The Baha System vs. Traditional Bone Conduction Hearing Aids

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Objectives: The purpose of this study was to compare functional gain at 500, 1000, 2000, and 4000 Hz for infants and children with bilateral conductive hearing loss who were initially fit with traditional bone conduction devices then progressed to Baha with Softband and finally to unilateral Baha implants.

Methods: Retrospective chart review of 10 children with bilateral conductive hearing loss due to congenital atresia and/or microtia. The Baha system was used in children via a Softband and then when appropriated implanted. The functional gain was then compared to functional gain of traditional bone conduction hearing aids previously worn by each patient.

Results: Participants in this study showed a statistically significant improvement when using the Baha Softband over traditional bone conduction hearing aids. An implanted Baha has statistically as much gain as a bone conduction transducer at all frequencies tested.

Conclusions: The Baha system is a valid treatment in conductive hearing loss via a Softband or implanted. It statistically outperforms the traditional bone conduction hearing aids and should be used as a first choice in intervention rather than a last option for inoperable conductive hearing loss.
Bone Anchored Implants for Single Sided Deafness in Children

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Objectives: Treatment options for profound unilateral sensorineural hearing loss, a.k.a. single sided deafness (SSD), in children has been limited. Bone anchored hearing aids (Baha) have been successful in adults but not explored in children with SSD. We subsequently examined the success of Baha in 22 children with SSD.

Methods: Two-stage Baha surgery with 6-month osseointegration was performed on children 5 years and older at a single institution. The Baha processor was placed two weeks following the second stage surgery. Results of Hearing-In-Noise Test (HINT) and Children’s Home Inventory for Listening Difficulties (CHILD) questionnaires were compared before and after Baha activation in children with UNSNHL.

Results: Pre-implant mean HINT scores at speech/noise ratio (SNR) of 0dB, +5dB, and +10dB were 42%, 76% and 95%, respectively. Post-implant mean HINT scores improved to mean SNR of 82%, 97%, and 99% at 0db, 5db, and 10 db, respectively. CHILD scores also improved from mean pre-implant ratings of 4.49 and 4.60, for patient and parents respectively, to post-implant ratings of 6.90 and 7.10. Both teenagers (n=15) and children under 13 years (n=7) displayed improved HINT and CHILD scores.

Conclusions: Baha is a durable treatment option with noticeable improvements in hearing in noise and listening difficulties for children with profound UNSNHL.
CONDITIONS FOR CLINICAL SUCCESS USING MENIETT DEVICE.

Distribution of Overpressure from Meniett to the Middle Ear and the Inner Ear Fluids in patients with Meniere´s disease.

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ABSTRACT

Introduction:

However clinical studies have shown statistically significant improvement in patients treated with pressure pulses, the all over clinical effects have been inconsistent and not fully satisfactory. It has been observed that however the pressure pulses produced by different devices were exactly the same, clinical results could differ significantly in the same patients. Obviously, we have been facing an unknown factor of major importance for desired clinical effect.

Objective:

To understand properties of overpressure pulses capable of decreasing the Endolymphatic volume/pressure and relieving symptoms in patients with Meniere´s disease.

Study:

Relative negative pressure has always been a problem when applying pressure pulses to the hydroptic ear since such pressure can aggravate inner ear symptoms. In this work, negative relative pressure has been identified and measured. A solution to evacuate a negative pressure component is presented. Dynamic properties of pressure pulses have not been analysed before. In this work clinical models have been used to demonstrate how the basic physical laws govern transmission of static versus kinetic energy between the different media such as air and fluid. The role of elasticity/volume of the middle ear in transmission of overpressure pulses from Meniett to the inner ear is shown. Displacement of excessive Endolymphatic fluid out of the Endolymphatic compartment is considered a sine qua non condition for clinical improvement when using Meniett. Certain important characteristics of overpressure pulses have been identified which can provide such a technical/clinical effect. Apart from a static energy component, kinetic energy is considered necessary to overcome inertia of the inner ear fluid and act on the mass of the endolymphatic fluid.

Key words; Endolymphatic hydrops, overpressure applications, kinetic energy.
Intratympanic injection of dexamethasone / hyaluronic acid in Menière's Disease

Marcel Gärtner, MD

Abstract

Introduction

Steroids are widely used for the treatment of cochleo-vestibular disorders. Direct steroid application in the middle ear cavity, combined with a round window membrane permeability-modulating substance increases the level of steroids reaching the target cells. Four years ago, we launched this newer therapy for patients suffering from Menières disease (MD). The treatment comprises the intratympanic injection of a solution of dexamethasone and hyaluronic acid. The patient’s tolerance and compliance, possible complications and its effect on the disease were evaluated.

Material and Methods

34 Patients having definite MD as outlined 1995 by the American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) were treated with intratympanic injections of 0,5ml dexamethasone/hyaluronic acid under topical anesthesia four times within ten days. The solution consists of 0.3ml dexamethasone and 0,2ml hyaluronic acid 0.2%. Six, 12 and 24 months after treatment audiological tests and vestibular function were evaluated according to the Guidelines of the Committee on Hearing and Equilibrium for diagnosis and evaluation of therapy in MD of the AAO-HNS.

Results

We will present our results at the symposium. The mean pre and posttreamtment pure-tone-average (PTA) were compared. Post-treatment vertigo control (Class A and B) is evaluated according to the Guidelines of the Committee on Hearing and Equilibrium for diagnosis and evaluation of therapy in MD of the AAO-HNS.

Conclusion

Intratympanic combined dexamethasone/hyaluronic acid application provides a reliable and safe therapeutic option without ototoxic side effects for improvement of vertigo-attacks and hearing loss resulting from MD. Our first results and those from the literature allow us to recommend the use of dexamethasone in the treatment algorithm of unilateral or bilateral MD.
Theory on the cause of the attacks of vertigo

Bill Gibson
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Hypothesis The cause of the attacks of vertigo associated with Meniere’s disease is due to episodes of longitudinal drainage of endolymph towards the endolymphatic sac with reflux of excess endolymph into the pars superior.

Background The commonly held concept that the attacks of vertigo are due to potassium influx into the perilymph following a rupture of Reissner’s membrane or a failure of cellular electrode pumps is difficult to justify in the light of recent research and electrophysiological evidence.

Methods Some relevant research findings are reviewed. The electrocochleography findings before, during and after attacks of vertigo are presented.

Results The electrocochleogram (ECochG) shows an abnormally large summating potential (SP) in ears affected by Meniere’s Disease. The ECochG potentials are present during attacks. The SP is larger prior to attacks and gradually reduces during attacks.

Conclusions The electrical potentials within the inner ear recorded by electrocochleography are present during attacks of vertigo. It is postulated that a gradual reduction in the SP relates to a reduction in the endolymphatic hydrops leading to more symmetrical basilar membrane movement.
ELECTROCOCHLEOGRAPHY IN MENIERE’S DISEASE

Bill Gibson
The University of Sydney, Australia

OBJECTIVES: to evaluate the effectiveness of transtympanic electrocochleography (TT ECochG) as a means of confirming the clinical diagnosis of Meniere’s Disease.

METHOD: A 2717 patients were referred for TT ECochG between August 1998 and September 2008. Each patient was assessed prospectively on clinical grounds according the AAOOHNs criteria and a scale devised by the author. A Meniere’s group and a non-Meniere’s group were determined and the TT ECochG results compared between the groups that had similar hearing levels for the particular stimulus employed.

RESULTS Click summating potential versus action potential ratio (SP/AP) measurements did not significantly differentiate between populations of Meniere’s ears and non-Meniere’s ears. Tone burst SP amplitude measurements were significant different between the populations especially using frequencies at 500Hz, 1kHz, 2 kHz

CONCLUSION: Transtympanic electrocochleography (TT ECochG) is helpful for the confirmation of Meniere’s Disease using tone burst stimuli to measure the amplitude of the frequency specific summating potentials (SP) but not when using the click evoked summating potential versus action potential ratio (SP/AP).
Intratympanic Corticosteroids in the Treatment of Sudden Sensorineural Hearing Loss
George Hicks, MD

Objective

To evaluate the efficacy of intratympanic administration of corticosteroids for sudden sensorineural hearing loss (SNHL) of varying etiologies.

Methods

Sixty-eight patients ranging in age from 23-90 years of age were treated from 1996-2008 with intratympanic dexamethasone (IT-Dex) of varying concentrations or methylprednisolone. All patients presented with sudden SNHL defined as a rapid decline in hearing over three days or less affecting three or more frequencies by 30 dB or greater. All patients received pre- and post-treatment audiograms including pure-tone average (PTA) and speech reception thresholds (SRT). Variables related to recovery included patient age, time to onset of treatment, presence of systemic illness, severity of hearing loss, and presence of vertigo. The primary corticosteroid delivered was dexamethasone (24mg/ml) via a delivery system consisting of a Venturi ventilation tube (lumen diameter of 1.4 mm) and a Silverstein MicroWick™ (lumen diameter of 1 mm) which was advanced to the round window niche. For three weeks patients received dexamethasone otic solution (24 mg/ml), administered three to four drops three times a day together with an evening administration of CIPRODEX® otic suspension of three to four drops. The patient’s hearing was measured weekly for three weeks after which the wick and tube were removed and medication stopped. The average follow up time was 3.9 years.

Results

A successful outcome was measured as a PTA improvement of ten dB and an SRT improvement 15 percent greater than the pre-treatment audiogram. Of the 68 patients treated, these successful criteria were attained in 42 of the 68 patients (61.7 percent). Of the various delivery systems, the most successful was that of the ventilation tube plus the Silverstein micro wick in 35 of 42 patients (83 percent). The most successful medication was dexamethasone (24 mg) in 33 of 48 patients (68.7 percent). Methylprednisolone, although used less, was successful in three of four patients. The least successful medication was standard, stock dexamethasone, four mg/ml. Less successful delivery systems were injections (6 of 14), round window gelfoam (one) and a micro-catheter (0 of one). The time between hearing loss and treatment initiation favored early intervention. Of the 42 successes, the average time from symptom onset to treatment was 37.6 days. Thirty-one of the 42 successes (74 percent) seen and treated had an average time to treatment of 16.3 days. Vertigo presence reduced the success (6 of 12 failed). Overall, patients with idiopathic sudden SNHL did best with early intervention. The only complication was a tympanic membrane perforation in three patients. No treatment caused a worsening of the hearing loss.

Conclusion

Overall, this study evaluates the use of intratympanic corticosteroids as a safe and effective treatment for sudden sensorineural hearing loss caused by varying inner ear disorders. The results suggest that a higher concentration of a corticosteroid with a delivery system over a prolonged period of time may be more successful than a lower concentration, intermittent administration of any type of steroid in the treatment of sudden sensorineural hearing loss.
Jeremy Hornibrook, MD

Christchurch, New Zealand

Title: Vasopressin and HSP-70 Antibodies in Clinically Certain Meniere’s disease

Objectives: To test the claims by Japanese and American investigators that a significant proportion of Meniere’s disease patients have (1) a raised vasopressin level (particularly around the time of a vertigo attack), supporting a long-held notion that emotional stress is an important trigger, and (2) HSP-70 antibodies, possibly supporting an autoimmune basis.

Methods: Ethical approval was obtained. Serum samples were taken from 80 subjects electrocochleographic proof of hydrops with tone burst stimuli at varying times after the last vertigo attack. Each subject was asked (yes/no) if they believed stress triggers their attacks. Vasopressin was measured by a standard radioimmunoassay. For HSP-70 autoantibodies the commercial “OTOblot” Anti-68kD Western Blot assay was used. Samples from 86 sex and age-matched donors were used as controls.

Results: (1) Vasopressin. The community mean for vasopressin is 2.2 pmol/L (SD=2.4). In the 80 Meniere’s patients the mean vasopressin concentration was 2.1 pmol/L (SD=1.6), 2.3 pmol/L (SD=1.4) in those whose last attack was within a week, 2.8 pmol/L (SD=0.9) in those whose last attack was within a day, and 1.8 pmol/L (SD=0.9) in those who believed stress is a trigger. The only significant difference was (Mann-Whitney test, p<0.05) was a mildly elevated concentration when the last attack was within a day. (2) HSP-70. In 80 Meniere’s patients 14 were positive or equivocal; in 86 controls 10 were positive or equivocal. There was no significant difference (p=0.8229).

Conclusions: Patients with an unequivocal diagnosis of Meniere’s disease do not have a raised incidence of HSP-70 antibodies or a raised vasopressin concentration, except when the last attack was within a day of their last vertigo attack. There was no correlation between “yes to stress” and vasopressin. The most likely cause of raised vasopressin is nausea which is the most potent trigger for vasopressin release.
Title: Ocular (o-VEMPs) and Cervical (c-VEMPS) VEMPS in Patients with Clinically Certain Ménière’s Disease

Objectives: To compare c-VEMPS and o-VEMPs in patients with a certain diagnosis of Ménière’s disease and in controls to see if they could detect saccular hydrops and improve the ability to stage the disorder.

Methods: Ethical approval was obtained. 22 control subjects and 19 subjects with Clinically Certain Ménière’s disease (AAO-HNS Criteria plus electrocochleographic confirmation of cochlear endolymphatic hydrops) were tested. The stage (AAOHNS) of Ménière’s disease was at the time of the VEMP testing. Custom-written evoked potential averaging software on a laptop was used to evoke and record c-VEMPS and o-VEMPS. Recording of multiple channels at once and self-monitoring by the patient with a response light ensured recording of optimum EMG activity, reducing the likelihood of inactivity or over-exertion. Interleaving stimuli at different intensities aided the accuracy of threshold detection. c-VEMP P1, N1 and P2 peaks and o-VEMP N1, P1, N2, P2, N3 and P3 peaks were analysed with respect to amplitude, latency and threshold. Subjects were asked to indicate on a linear scale (difficult → easy) the degree of difficulty they experienced flexing the neck for c-VEMPS or gazing upward for o-VEMPS.

Results: Threshold: There was no significant difference between Ménière’s ears and controls for c-VEMPS or o-VEMPS. Amplitude and inter-peak amplitudes: For ipsilateral c-VEMPS there was a significant reduction in the P1/N1 inter-peak amplitude for late-stage Ménière’s (stages 3 and 4); for contralateral o-VEMPS Ménière’s subjects had significant amplitude reduction for N1, P1, N2 and N3. Latency: for c-VEMPS there was no difference from controls; for o-VEMP there was a significant increase in P2 latency in subjects with late-stage Ménière’s disease. The majority (67%) of participants would prefer having the o-VEMP test rather than the c-VEMP test.

Conclusions: This small study of VEMPS in Clinically Certain Ménière’s disease has produced negative findings at variance with other published studies in regard to threshold. It suggests a new finding: that for o-VEMP a P2 latency increase detects late-stage Ménière’s disease. For amplitude both c-VEMPS and o-VEMPS can reliably detect late-stage Ménière’s disease, but that for o-VEMPS an N2 amplitude reduction detects both early and late stages. Overall both o-VEMPS and c-VEMPS reliably detect late-stage Ménière’s disease. The majority of tested subjects favoured the o-VEMP over the c-VEMP test.
Jeremy Hornibrook, MD
Christchurch, New Zealand

Title: So if it isn’t Meniere’s disease what is it? The case for microvascular compression as a cause of vertigo.

Objectives: It is now established that microvascular compression of the fifth, ninth and seventh cranial nerves is the cause of trigeminal neuralgia, glossopharyngeal neuralgia and hemifacial spasm. Amazingly, there remains widespread scepticism that the same mechanism could cause cochleovestibular symptoms. The most common cause of recurrent vertigo attacks is Meniere’s disease. The AAOHNS Equilibrium Committee definition is based on symptoms and makes no allowance for a “Certain” diagnosis based on any in vivo test. Refinements in transtympanic electrocochleography (EcochG) have made it a sensitive and reliable test to imply the presence (or absence) of endolymphatic hydrops. Now MRI inner ear imaging can show the hydrops, or the absence of hydrops.

Methods: (1) To describe three patients with recurrent vertigo attacks suggestive of Meniere’s who had at least two EcochGs which did not diagnose hydrops. In each case MRI scanning showed an AICA vessel obviously in contact or close to the 8th cranial nerve and they were offered and underwent microvascular decompression. Operative videos will be shown. (2) To present a new patient with proven spontaneous vertigo attacks, a hearing loss in one ear with two normal toneburst EcochGs and normal MRI inner ear imaging (intratympanic gadolinium) and 3D “virtual endoscopy” suggesting a compressing vessel as the cause.

Results: (1) In all three subjects (two followed now > 10 years) the vertigo attacks ceased. (2) This subject represents what will be an increasing common therapeutic challenge.

Conclusion: The rapidly evolving combination of EcochG and MRI inner ear imaging is likely to show that some patients who might have Meniere’s disease do not. Microvascular 8th nerve compression is an alternative possible cause. 3D MRI “virtual endoscopy” can show more clearly the vessel/nerve relationships. Increasing acceptance of in vivo tests for Meniere’s disease is an urgent priority, so that when the diagnosis is reliably excluded an alternative cause for symptoms can be sought and treated.
Title: The sideways stepping test for perilymph fistula.

Objectives: To explain why since the discovery of the superior canal dehiscence syndrome (SCDS) perilymph fistula (PLF) has almost gone ‘underground’, in contrast with its controversial heyday in the 1980s. In 1992 John Shea wrote “the ‘myth’ of spontaneous perilymph fistula has become a ‘cancer’ eating at the very credibility of otolaryngology…..no characteristic signs, symptoms and diagnostic test exist……” The objective is to demonstrate that PLF patients have a unique combination of symptoms and a balance instability which can be demonstrated with a simple logical refinement of Singleton’s eyes-closed turning test.

Methods: To illustrate with video recordings the unique balance instability of patients presenting with constant disequilibrium, motion intolerance and nausea (one for twelve years). Five had no identifiable trauma history.

Results: Each subject exhibited a dramatic unilateral instability in stepping sideways (or jogging on the spot) with eyes closed, which was abolished after surgical closure (video documentation) of a window PLF.

Conclusion: PLF is a more common and far more disabling inner ear condition than SCDS, and it should be of concern that awareness of its existence, seriousness and prevalence have diminished. Its symptoms and the unilateral balance instability imply a chronic otolith organ dysfunction, for which the sideways stepping test appears to be both sensitive and specific.
Dexamethasone therapy and methods to control the effects of trauma in cochlear implant design

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The use of superflexible and soft electrodes, inserted through the round window membrane, does not completely suppress the risk of residual hearing loss in cochlear implant patients. Complete or partial loss of residual hearing can decrease the finite neural reserve of the inner ear, a fact which is particularly unacceptable for young children and infants facing the possibility of a number of re-implantations during their lifetimes. It is postulated that an acute or semi-chronic pharmacological approach at the time of electrode insertion has the potential to further reduce the risk of hearing loss. Indirect mechanisms of hearing loss after electrode insertion are in part associated with the release of inflammatory mediators, such as the TNF alpha cytokine, from lateral wall fibrocytes, due to either cochleostomy and puncturing of the spiral ligament or friction of the electrode against the lateral wall. Dexamethasone is an anti-inflammatory and anti-apoptotic drug which can protect hair cells against TNFalpha ototoxic effects in animal models (Haake et al 2009). Techniques to incorporate and deliver dexamethasone to the inner ear intra and/or post operatively are being developed and tested. The most promising technique uses the natural elution of dexamethasone crystal from the electrode silicone after mixing 2% to 10% of the corticosteroid with the elastomer. Sub microgram/day elution along the length of the electrode increases hair cell survival during electrode trauma in animal models, as measured with CAP or ABR. Another approach is being tested to evaluate long term hair cell protection when a single bolus of dexamethasone is slowly and precisely injected in a specific location of the scala tympani prior to electrode insertion. Method and devices will be presented and results of animal studies will be discussed.

1: Hear Res. 2009 May 12. Dexamethasone protects auditory hair cells against TNFalpha-initiated apoptosis via activation of PI3K/Akt and NFkappaB signaling. Haake SM, Dinh CT, Chen S, Eshraghi AA, Van De Water TR.
Title: Can tinnitus be cured by brain stimulation?

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Abstract

The pathophysiology of tinnitus remains incompletely understood and treatment is elusive. Recent neurophysiological and neuroimaging data suggest that tinnitus is associated with synchronized hyperactivity in the auditory cortex. Therefore targeted modulation of tinnitus-related cortical hyperactivity has been considered as a new promising treatment strategy. Repetitive transcranial magnetic stimulation (rTMS) is a non-invasive method for modifying neural activity at the stimulated area and at a distance along functional anatomical connections. The technique can be applied in two different ways in diagnosing and treating tinnitus patients. One approach uses single sessions of high-frequency rTMS applied to the temporal cortex. This method has shown to be successful in suppressing tinnitus transiently during the time of stimulation. Low-frequency rTMS is an efficient method to selectively reduce the abnormally increased activity in cortical areas. Several small controlled studies demonstrated beneficial effects in tinnitus patients after repeated sessions of low-frequency rTMS. In some patients consistent treatment effects could outlast the stimulation period for up to one year. However, results of available studies show high inter-individual variability of treatment effects and only moderate effect sizes. Therefore enhancement strategies are essential before this technique can be considered as a routine procedure in tinnitus therapy. If rTMS is capable of suppressing tinnitus transiently, the effect might be maintained by implanting electrodes over the area of electrophysiological signal abnormality on the auditory cortex for direct electrical stimulation. The results of the first patients treated worldwide demonstrated inconsistent results. A subgroup of patients with unilateral pure tone tinnitus showed statistically significant suppression with this technique. Hence, non-invasive and invasive auditory cortex stimulation could become a physiologically guided treatment for a selected group of tinnitus patients. At this time it is far too early to demand a complete tinnitus relief of brain stimulation for the majority of tinnitus patients.
Brain activity in verticality perception

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The ascending projections from the otolithic organs to the central nervous system are not yet fully understood in humans. In patients with unilateral vestibular deafferentation such as vestibular schwannoma (VS), verticality (gravity) perception is sometimes affected and patients with VS show abnormal tilts of subjective visual vertical (SVV). Although this is assumed to be caused by a dysfunction in the otolithic organs and graviceptive pathways, it is also unknown which cerebral cortex areas participate in the graviceptive pathways from the otolithic organs. In the present study, using multi-channel functional near-infrared spectroscopy (fNIRS), the brain activation in the SVV tests was investigated in both 7 healthy subjects and 7 post-operative patients with vestibular schwannoma (VS). In the healthy subjects, activation was observed in the superior temporal gyrus, and the supramarginal gyrus of the both cerebral hemispheres. These areas are similar to the cortical areas activated by caloric or galvanic stimulus. Although the active areas in the patients with VS were similar to those in the healthy subjects, these were observed in the contralateral hemisphere predominantly. The cortical processing mechanism in the cerebral hemispheres likely plays an important role in verticality (gravity) perception.
Surgical results and pathological findings of the endolymphatic sac in Meniere’s disease

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Endolymphatic surgery has been frequently recommended as the first-choice operation for medically refractory Meniere's disease (MD). However, the efficiency of endolymphatic surgery (ELS) is still controversial. Although a small endolymphatic sac, perisaccular fibrosis, degeneration of the epithelium, and decrease of vessels were observed as histopathological findings of the endolymphatic sac (ES) in Meniere’s disease. However, whether the findings are an essential causative factor is controversial. Up to now, there is no study investigating the relationships between surgical results of ELS and ultrastructural findings of the ES. We electron-microscopically observed 20 ESs obtained from autopsy cases without ear disease, 22 ESs obtained from patients with vestibular schwannoma (VS), and 36 ESs obtained from definite cases with MD. The surgical results of ELS and the ultrastructural findings of the ES were also analyzed. Overall, 86.3% of the MD cases responded favorably to ELS, according to the functional level and class categories as defined by the American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) 1995 guidelines for control of vertigo. Patients having abnormal findings such as degeneration of the epithelium and perisaccular fibrosis significantly showed good surgical results compared to patients having normal ES. In most cases with MD, abnormalities of the ES were assumed to be responsible. In addition, results of intraoperative observation of the ES by a narrow-band imaging (NBI) endoscope and measurements of endolymphatic sac potential (ESP) are presented.
A mathematical model utilising prestin for establishing cochlear homeostasis in the presence of summating pressures in scala media.

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We present a mathematical model for the role of outer hair cell (OHC) activity (LePage and Olofsson, Mechanics of Hearing, Portland OR, 2005). The model displays key features of the cochlear amplifier, including sharpening of the tuning curve and distortion product generation. This implementation is extended to deal with zero-frequency, i.e. it takes account of not just sound pressures, but also static pressures in scala media. Rise in static pressure is assumed to increase basilar membrane stiffness. Somatic motility is incorporated as a prerequisite for homeostasis via dc-feedback to stabilise the OHC operating point (OP), coping with bias displacements caused by loud sound (Flock, Hear.Res. 2000; Salt, JARO, 2004) or manifest as diurnal variation (LePage, Acoustics Aust., April 2006; Kemp, Mechanics of Hearing, Keele, UK, 2008). Summating increase of net static pressure in scala media is an inherent property of the model which mimics loud-sound-invoked summating displacements of the basilar membrane seen in guinea pigs (LePage, Hear.Res., 1989). The conditional stability of the feedback model suggests that delayed endolymphatic hydrops, and rupture of the vessel, could arise due to failure of OHC-regulated homeostasis. Thus, a primary role for prestin may be to maintain OHC OP, by tracking dynamic changes in mechanical offset due to normal hydropic variation.
Ocular and cervical vestibular-evoked myogenic potentials to bone conducted vibration in Ménière's Disease

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Bone conducted vibration (BCV) of the head causes linear acceleration stimulation of both inner ears and this linear acceleration is an effective way of selectively activating otolithic afferent neurons. Single neuron studies in animals have shown that semicircular canal neurons are rarely activated by levels of bone conducted vibration which generate vigorous firing in otolithic irregular neurons and result in a variety of vestibulo-spinal and vestibulo-ocular responses, and one of the latter is the focus of this review. BCV delivered at the midline of the forehead at the hairline (Fz) causes simultaneous and approximately equal amplitude linear acceleration stimulation at both mastoids and results in ocular evoked myogenic potentials (oVEMP) beneath both eyes. The first component of this myogenic potential at a latency to peak of about 10ms is a negative potential and is called n10 and in healthy subjects is equal in amplitude beneath both eyes, but after unilateral vestibular loss the n10 potential beneath the eye opposite to the lesioned ear is greatly reduced or absent altogether. n10 is due to a crossed otolith-ocular pathway. In patients with Meniere’s Disease tested at both attack and quiescent phases showed an increased amplitude of n10 of the oVEMP during the attack but with no detectable change in p13 of the cVEMP. 16 healthy control subjects tested at comparable intervals showed no systematic change in either oVEMPs or cVEMPs.

In conclusion during an MD attack dynamic utricular function is enhanced whereas dynamic saccular function is not similarly affected. These results are to signify that MD attack affects different otolithic regions differentially. A mechanical process rather than an ionic change in endolymph may be responsible for the MD attack.
Ocular vestibular-evoked myogenic potentials to Fz Bone Conducted Vibrations in Superior Semicircular Canal Dehiscence show enhanced utricular function.

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Abstract

Objective: To explore vestibular responses by Bone Conducted Vibration – BCV – at forehead (Fz) Ocular Vestibular Evoked Myogenic Potentials (oVEMPs) in patient affected by superior canal dehiscence syndrome. To provide evidence that the responses depend on the utricular macula function.

Methods: An hand – held 4810 Bruel & Kjaer, Mini-shaker, was used to provide adequate BCV stimulation at the forehead in the midline at the hairline (Fz) and so to test 22 (twenty-two) Superior Semicircular Canal Dehiscence patients compared with 50 healthy subjects to quantify the differences in terms of amplitude of the n-10 component.

Results: the n-10 evoked response showed substantial differences in amplitude between healthy subjects, but is repeatable within healthy subjects. n10 is of equal magnitude in both eyes whereas in SSCD patients showed a significant increase in amplitude.

Conclusion: An analysis and comparison of amplitude of n-10 (oVEMPs), recently proposed, to study transmission of excitatory stimuli to the vestibular end organ by bone conduction vibration between healthy and SSCD patients, may be appropriate for underlie the enhanced utricular macula function due to altered immittance caused by superior semicircular canal dehiscence (SSCD). This promises to be an interesting new field of research.
Ocular and cervical vestibular-evoked myogenic potentials to bone conducted vibration in Ménière's Disease

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Bone conducted vibration (BCV) of the head causes linear acceleration stimulation of both inner ears and this linear acceleration is an effective way of selectively activating otolithic afferent neurons. Single neuron studies in animals have shown that semicircular canal neurons are rarely activated by levels of bone conducted vibration which generate vigorous firing in otolithic irregular neurons and result in a variety of vestibulo-spinal and vestibulo-ocular responses, and one of the latter is the focus of this review. BCV delivered at the midline of the forehead at the hairline (Fz) causes simultaneous and approximately equal amplitude linear acceleration stimulation at both mastoids and results in ocular evoked myogenic potentials (oVEMPs) beneath both eyes. The first component of this myogenic potential at a latency to peak of about 10ms is a negative potential and is called n10 and in healthy subjects is equal in amplitude beneath both eyes, but after unilateral vestibular loss the n10 potential beneath the eye opposite to the lesioned ear is greatly reduced or absent altogether. n10 is due to a crossed otolith-ocular pathway. In patients with Meniere’s Disease tested at both attack and quiescent phases showed an increased amplitude of n10 of the oVEMP during the attack but with no detectable change in p13 of the cVEMP. 16 healthy control subjects tested at comparable intervals showed no systematic change in either oVEMPs or cVEMPs.

In conclusion during an MD attack dynamic utricular function is enhanced whereas dynamic saccular function is not similarly affected. These results are to signify that MD attack affects different otolithic regions differentially. A mechanical process rather than an ionic change in endolymph may be responsible for the MD attack.
Diagnosis and treatment of tinnitus

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Abstract

Tinnitus is the medical term for the auditory perception of sounds in the absence of surrounding sounds. Tinnitus may be the only or most important symptom, or it may be a component of an otovestibular complaint (impaired hearing, distortion of sound, recruitment, sensation of pressure or pain in the ear, vertigo, instability or blurred vision). Tinnitus can be accompanied by unpleasant sensations and be associated with anxiety and depression. Anatomical and physiological evidence provides the substrate for somatosensory influences on both the generation and modulation of tinnitus. Tinnitus can no longer be considered an exclusive disorder of the auditory system, but it is rather an expression of neural plasticity encompassing reactions of multisensory neurons to changes in their external environment. There are different and new methods of testing the tinnitus, including psycho physiological ones. The treatment of this symptom is very difficult. There is no specific therapy, but it should be etiologically defined and complex.
An overview on FMT placements and audiological outcomes after Vibroplasty

R. Mlynski, K. Rak, Wafaa Shehata-Dieler, J. Müller, R. Hagen

The extended implantation criteria for the Vibrant Soundbrige® (VSB) in patients with conductive and mixed hearing loss led to a variety of surgical strategies for the placement of the floating mass transducer (FMT). In the present study, a range of placement sites of the FMT are demonstrated depending on the middle ear pathology. The audiological outcomes were analysed depending on the position of the FMT at the round window, oval niche, in combination with middle ear prostheses or remnants of the ossicular chain.

A patient group with conductive and mixed hearing loss underwent revision middle ear surgery combined with the implantation of a VSB and placement of the FMT at the round window (n=13), oval niche (n=6), modified middle ear and stapes prostheses (n=6) as well as at the stapes (n=4). The follow up was 6 to 32 month. Audiological testing included threshold measurements as well as speech audiometry.

Postoperative wobble thresholds were in the overall population 35 dB (61 dB unaided). Threshold data was independent from the stimulation of the cochlea through the round window or the oval window pathway (FMT in the oval niche, stapes attachment or in combination with middle ear prostheses). The 50% perception threshold (OLSA) lay at 44 dB (60 dB unaided) in the entire group. The perception level by stimulation through the oval window was at 43 dB. The group implanted at the round window reached levels of 45 dB. Again, there was no significant difference in the variety of groups.

These results show that the active middle ear implant VSB can be used in a variety of middle ear conditions previously hard to access for hearing rehabilitation. The audiological outcomes appear to be independent from the stimulation site of the FMT. Further follow up will reveal favourable FMT placement sites for long term stability.
Cochlear Implants in Unilateral Deaf Patients?

J. Mueller, St. Brill, P. Schleich, R. Hagen, J. Helms

**Introduction:**
Unilateral deaf patients complain about the loss of binaural hearing abilities, resulting in a deterioration in speech understanding in noisy environments and in a missing ability to localize sounds.

**Materials and Method:**
A remarkable improvement of binaural hearing abilities is known for more than a decade now from bilateral cochlear implantation. In an attempt to at least partly restore binaural hearing in single sided deaf patients, we started to implant selected unilateral deaf patients. At the time of writing, 5 subjects have been implanted. To evaluate the benefit of bilateral implantation, a series of studies has been conducted to provide a broad image on binaural hearing abilities in unilateral deaf patients.

**Results:**
All patients implanted so far with a CI did not benefit from other options (i.e. bone anchored hearing aid, CROSS-HA) tested prior to implantation. They wear the implant in daily life conditions. Speech understanding in difficult, noisy situations is improved. Directional hearing is restored to variable degree. No major surgical complications have been observed.

**Conclusions:**
From our results we conclude that cochlear implantation in unilateral deaf patients provides a significant benefit in speech understanding in noise. Unilateral deaf patients using a CI in addition to their normal ear seem to benefit from restored spatial hearing. Performance increases over time.

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Performance with the OPUS 2 processor remains uncompromised in roving-level speech


Introduction and objectives: As performance with cochlear implants improves, and as the expectations of cochlear implant users increase, it becomes increasingly important to assess performance under more realistic and challenging conditions than in state-of-the-art speech tests. Based on the results of a study [Haumann et al., 2008] by the Medical University of Hannover, we performed speech tests aiming at testing speech at variable presentation levels.

Materials and methods: Seven subjects were tested using a modified version of the Oldenburg sentence test where speech was presented at three levels (50 dB, 65 dB, 80 dB) and the noise level was adaptively varied to obtain speech reception threshold. In one test, the three levels were interleaved so that level varied from sentence to sentence, and in additional tests, each level was tested individually.

Results: Results do not show a significant effect of the roving level method on test outcomes.

Conclusion: Results show that performance with the OPUS 2 processor remains uncompromised at fixed levels ranging from soft to loud, and even in speech fluctuating between soft and loud, without the need of processor adjustments.
How to interpret findings of vestibular function tests at compensated stage in patients with vestibular neuritis

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Objectives: Most patients complaining of dizziness seek medical services in the interictal period, which is thought to be a compensated stage. Thus, we wanted to investigate the results of vestibular function tests (VFTs) at a compensated stage in patients with vestibular neuritis.

Methods: We analyze the results of VFTs in 38 patients with vestibular neuritis observed at around 2 months after the onset of vertigo.

Results: Thirty-seven (97%) showed pathologic results in at least 1 test. In 29 patients with pathologic CP, pathologic results, based on SN, VIN, HSN, and SVV tests, were observed in 16 (55%), 20 (69%), 26 (90%), and 13 patients (45%). Three (10%) of 29 patients showed pathologic VIN or HSN, indicating that the intact side is pathologic. There was no patient with pathologic CP on the intact side. In 9 patients with normalized CP, pathologic results, based on SN, VIN, HSN, and SVV tests, were observed in 4 (44%), 4, 7 (78%), and 2 patients (22%). Five (56%) of 9 patients showed pathologic results on the intact side at least in 1 test, and the pathologic sides by each test were not the same.

Conclusion: Our findings suggest that we can detect vestibular imbalance in patients with unilateral vestibular hypofunction through a set of VFTs even when CP is normal at a compensated stage. The CP side indicated by caloric test was the real affected side when CP was pathologic, even if the results of other tests were normal or rarely indicated that the intact side was pathologic. If CP was within reference range, other tests can show the previous presence of vestibular imbalance; however, they could not predict the side of the vestibular hypofunction.

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For more than ten years, the Vibrant Soundbridge middle ear implant was aimed to patients with pure sensorineural hearing loss. These last years, different centers have demonstrated good surgical and audiological results in patients with conductive and mixed hearing losses, particularly when the FMT is placed on the round window. We present the preliminary results of a prospective multicenter study comparing the results of the VSB placed on the round window with BAH and conventional hearing aid.

Materials and methods: ten patients whose pathologies were mainly chronic otitis (9 cases) and otosclerosis (1 case) were implanted with a VSB middle ear implant. The surgical approaches used consisted in the classical approach (FMT on long process of the incus) in one case, in placement of the FMT on the stapes in one case, and in placement of the FMT on the round window in eight cases. Thresholds in air condition, bone conduction, speech understanding and speech understanding in noise were measured at 1, 3, 6, and 12 months, and compared with preoperative measurements with numeric conventional hearing aid and head set BAHA.

Results: No surgical complications were reported. Two patients expressed a lack of hearing improvement and the FMT and replaced under local anesthesia. There was no change in bone conduction hearing thresholds and all patients are showing significant gain with VSB and improvement 17 dB above the bone conduction thresholds in average. Speech understanding was better for VSB than BAHA and hearing aids in all cases.

Conclusion: Preliminary results have shown that the VSB middle ear implant can be a good alternative for the rehabilitation of mixed hearing losses.
Intraoperative monitoring of residual hearing in EAS surgery


Hearing preservation is of increasing interest since the indication criteria for cochlear implantation has shifted to patients with functional residual hearing. However, complete hearing preservation is not achieved in every patient in spite of identical surgical procedures. The underlying mechanisms are not clearly revealed until now, but may include direct traumatization and delayed effects of intrascalar tissue formation or immune response. Intraoperative frequency specific monitoring may be a reasonable tool to assess critical points for hearing preservation during surgery. Presented is a monitoring technique based on the recording of cochlear microphonics that allow for a quick and frequency specific intraoperative determination of the inner ear function. Using this technique, we were able to specify the extent and time point of the intraoperative threshold deterioration in EAS patients. Comparing the results with postoperative audiograms revealed that a significant part of the hearing losses observed did not occur immediately during surgery. Intraoperative frequency-specific monitoring of the residual hearing may be a valuable tool for scientific studies dealing with preservation of hearing function during cochlear implantation.
Low-Frequency Sensitivity of the Ear and Meniere’s disease

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The lowest perceivable sound frequency is approximately 30 Hz in humans and 50 Hz in guinea pigs. Yet large cochlear microphonics (CM) (up to 20 mV) can be recorded from the endolymphatic space of guinea pigs with infrasonic stimuli as low as 1 Hz, demonstrating that these stimuli are effectively transduced by the cochlea. One explanation for the hearing loss exhibited by patients with Meniere’s disease is that it is caused by mechanical displacement of the organ of Corti by endolymphatic hydrops. Some Meniere’s patients report sensitivity to very low frequencies, such as windmills and pressure changes associated with weather fronts. In addition, the Menielt is a therapeutic device that uses static and infrasonic pressure changes as a form of treatment for patients with the disease. Understanding the relationships between sustained (DC) movements of the cochlear partition, responses to infrasonic stimuli, and sensitivity across the hearing frequency range may therefore be important to understand the disease. We recently found that sustained, controlled displacements of the organ of Corti could be achieved experimentally by slow injections of viscous, hyaluronate gel into the cochlear apex. In response to such injections, electrical responses from the basal turn show a dramatic increase of asymmetry of the CM waveform, a major increase in summing potential and moderate (20-30 dB) elevation of AP thresholds. The CM changes are in close accordance with those predicted by computer models of the cochlear transducer. During displacements of the organ of Corti towards scala tympani by gel injection, the endocochlear potential (EP) rises far more than can be accounted for by transducer current decrease. This EP increase may partially counteract the reduction of current through the hair cells due to the mechanical displacement. It leads to the possibility that the voltage changes in scala media produced by low frequency stimulation may play a part in an active cancellation of responses to infrasonic stimuli at the level of the inner hair cell. In addition, following the occlusion of the helicotrema with gel, the cochlea becomes highly sensitive to infrasonic stimulation. An increased sensitivity to low frequency bias tones was similarly observed in animals with surgically-induced endolymphatic hydrops. The occlusion of the perilymphatic communication through the helicotrema by hydrops would also be expected to increase the sensitivity of Meniere’s patients to externally generated infrasonic stimuli.

This study was supported by research grant RO1 DC01368 from NIDCD (ANS) and BMBF grant 0313844B (SKP).
Cochlear drug gradients and functional changes with sustained intratympanic dexamethasone delivery.

Alec Salt and Jared Hartsock

Local delivery of drugs to the cochlea by intratympanic (IT) application is gaining popularity both for clinical and research purposes. However, a limitation of IT application is that drugs are rapidly cleared from the middle ear by multiple mechanisms, one of which is the loss of drug volume down the Eustachian tube. In the present study a dexamethasone (Dex) formulation using a poloxamer hydrogel has been evaluated. The gel is liquid at room temperature, allowing IT injection, but transitions to a gel at body temperature, providing a prolonged residence time in the middle ear. A 50 μL volume of control or Dex-containing gel was injected through the tympanic membrane. Cochlear function was assessed by first calibrating the sound field in the external ear canal followed by measurement of cochlear action potential (CAP) thresholds (1 to 22 kHz in ¼ octave steps, 10 μV criterion) and by acoustic emission (2f₁-f₂) thresholds (0.6 to 9.6 kHz in ¼ octave steps). Function was assessed either immediately after, or 24 hours after, IT gel injection. After 24 hours treatment with Dex-gel, perilymph from scala tympani was sampled by taking 8 successive samples from the cochlear apex, allowing the drug gradient along the scala to be derived. A single endolymph sample was also taken from the basal turn. Immediately after control gel injection, the sound field calibration and functional measures showed small changes with low frequency stimuli, consistent with a disturbance of mechanical function of the middle ear by the gel. After 24 hours with control gel, measurements returned to normal. Following 24 hours treatment with Dex-gel, low frequency changes remained as the gel was retained better in the middle ear. There was no indication of high frequency loss, indicating no apparent toxic effect of Dex in the basal turn. Perilymph sample data showed that Dex gradients were substantially lower than those measured previously with shorter application times. However, the initial perilymph sample (originating from the apical turns) was slightly elevated relative to the second sample in most animals. This suggests that some Dex may have entered through the thin bone in the apical regions, even though the apical region was observed to be clear of gel in most of them. Endolymph levels of Dex remained lower than those in perilymph. The study confirms that this gel-based Dex formulation provides an effective method for a prolonged delivery of drug to the cochlea.

Disclosure
This work was supported by research grant DC01368 from NIDCD, NIH. The drug formulation used in this study was provided by Otonomy, Inc. Dr. Salt is a member of the Scientific Advisory Board of Otonomy and may receive income based on equity holdings. Otonomy did not financially support this study.
Semicircular canal dehiscence syndrome – a radiographic study

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Since Minor et al. identified a new syndrome related to bony dehiscence of semicircular canals, this new entity has been increasingly recognized among patients with auditory and vestibular dysfunctions. In patients with typical clinical symptoms, high-resolution radiographic imaging with CT and MRI scans may reveal the anatomical correlate. The prevalence of dehiscence is currently not known, nor do we know the number of patients with anatomical dehiscence who suffer from clinical symptoms. In a radiographic study using high-resolution MRI and CT scans, two groups of patients were investigated. The relationship of the semicircular canals to the intracranial space was differentiated by a 3-point scale, with grade 0=clear bony coverage, grade 1=canal attached to the dura with no radiographic sign of bony coverage, and grade 2=part of the lumen of the semicircular canal is located outside the bone. Two cohorts of patients were investigated: those with acoustic neuroma (n=79) and those with CT and MRI scans of the skull base - performed for different reasons (n=400). In the first group, a grade 2 dehiscence was found in 2.1% of patients, and a grade 1 dehiscence was found in 11.3%. In two-thirds of the patients, the anterior, and in one-third, the posterior semicircular canal was affected. Among the second cohort, 20 patients could be identified who had dehiscence of the semicircular canals. In 12 patients, a grade 1 dehiscence was recognized; in 7 patients more than one canal was affected. The prevalence for grade 2 dehiscence in this cohort was 5% related to the number of patients and 2.9% related to the number of temporal bones. The prevalence for grade 1 dehiscence was 4.8% and 3.3%. Because patients with acoustic neuroma suffer from vestibular symptoms, correlation with clinical symptoms was not possible. In the 20 patients from the second (control) cohort with a grade 2 dehiscence, 4 had symptoms that may have been related to their uncovered semicircular canals. We conclude that the correlation of anatomically detected dehiscence and clinical symptoms remains unclear and grade 2 dehiscence may not be clinically evident.

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Hearing Preservation through Elution of Dexamethasone from the Electrode Array.

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Protection of the cochlea during implantation is likely to have benefits for most CI candidates, either through hearing preservation or through increased protection of the status of the auditory nerve. Furthermore as greater success is achieved, audiological boundaries will be pushed, and hearing preservation will be explored with greater insertion depths and greater degrees of residual hearing. These issues are particularly relevant to children, for whom the results of an intervention need to be maintained for many decades, and for potential future regenerative therapies. A number of authors have demonstrated the potential and actual therapeutic effects of steroids against the inflammatory response of the cochlea to implantation [1-4]. The invasive nature of CI electrode insertion itself provides both an opportunity for accurate local drug delivery and a platform for the development of a delivery device. Farahmand et al (US patent publication no.2007/0213799A1) have demonstrated that pharmaceutical grade micronized dexamethasone can be homogeneously mixed with the medical grade silicone elastomer used in the cochlear implant electrode array, and that the resulting combination product will elute dexamethasone into physiological saline in a predictable manner. Depending on the drug percentage loading and the geometry of the eluting silicone, the release rate and duration can be pre-determined according to the desired treatment regime.

We investigated the efficacy of dexamethasone elution in reducing hearing loss after cochleostomy and insertion of rods of implant grade silicone 3-4mm into guinea pig cochleas. Rods of dexamethasone-eluting silicone were created, 0.6mm in diamater, with drug loadings of 2% and 10%. In the animal model, in-vivo measurements of drug concentration were made at sacrifice using apical fluid sampling of 10 microlitres at selected intervals after implantation of dexamethasone-eluting electrodes. Higher dosing was achieved with higher drug loading for the same geometry. A burst release was followed by a relatively stable concentration during the first week. After this time, the rapid clearance from the cochlea combined with the small sample volume brought the concentration below the detection limit of the HPLC system used. Importantly, there was no evidence of accumulation of drug in the perilymph at the doses used. In the same model, the degree of hearing loss after implantation of eluting and control (non-eluting) silicone rods was evaluated (n=18/group). Auditory thresholds were established using tone-burst BERA and Distortion Product Otoacoustic Emissions. At 6 months post-intervention there was a significantly lower threshold shift, at mid to high frequencies, after implantation with dexamethasone-eluting rods than in animals implanted with control rods. This difference (approximately 15dB) was maintained for the duration of the experiment (24 weeks).

This positive outcome has allowed further development of a very promising device by demonstrating positive, lasting results using a low drug dose and a convenient mode of application. Ongoing safety studies are now evaluating the potential effects of steroid elution on infection risk.
Electric Acoustic Stimulation and tinnitus

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Background: Electric Acoustic Stimulation (EAS) is a treatment for patients with severe to profound high frequency sensorineural hearing loss and functional low frequency hearing. This type of hearing loss is often accompanied by subjective tinnitus, and can even be the main complaint of the patient. Research on cochlear implantation as tinnitus treatment (Van de Heyning et al., 2008) suggests that EAS may also be a viable tinnitus treatment in patients with severe high frequency hearing loss. The working mechanisms are explained and a case study is discussed.

Methods: A 22 year old male presented at the University Hospital Antwerp with a main complaint of severe subjective tinnitus and a secondary complaint of reduced speech recognition, especially in noise. This patient had bilateral profound high frequency hearing loss and tinnitus due to ototoxic medication. A MED-EL SonataTI100 FlexEAS electrode was implanted and combined with a DUET speech processor. Assessment of tinnitus consisted of a) tinnitus frequency determination, b) tinnitus loudness assessment, c) residual inhibition possibilities, d) subjective loudness on a Visual Analogue Scale (VAS), and e) Tinnitus Questionnaire (TQ). Hearing was assessed with unaided pure tone audiometry with insert earphones, speech recognition of monosyllables and sentences in quiet (at 70 dB SPL) and sentences in noise (10 dB SNR) in Free Field. The patient was tested preoperatively, 1, 3 and 12 months after first fitting.

Results: Pre-operatively this patient suffered from bilateral subjective tinnitus at 6000 Hz of 10 dB Sensation Level (SL) in the right ear and 20 dB SL in the left ear. Masking of tinnitus was possible, but residual inhibition was negative. The subjective tinnitus loudness on the VAS was 10/10 for both ears. Tinnitus was present for 6 years and remained intractable over time. The total score on the TQ was 69/72, which reflects a degree 4, decompensated tinnitus. With EAS tinnitus was reduced bilaterally to 3/10 after 3 months and to 0/10 after 12 months. Without EAS, tinnitus was 2/10 on the VAS.

Conclusions: Electric Acoustic Stimulation can significantly reduce tinnitus in patients suffering from tinnitus and profound high frequency hearing loss. Restored auditory input with EAS can reverse the deafferentation process causing tinnitus. Although EAS was implemented unilaterally, bilateral tinnitus suppression was obtained.
Incapacitating tinnitus in single-sided deafness treated with cochlear implantation

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Background: Tinnitus following single-sided deafness (SSD) may be experienced as very loud and may affect quality of life in a significant way. This phantom type of tinnitus may be irresponsive to cognitive treatments (eg. TRT) and cannot be influenced by hearing aids.

Objectives: To assess the effectiveness of cochlear implantation to reduce tinnitus loudness and tinnitus suffering of patients in whom unilateral profound hearing loss provoked incapacitating tinnitus.

Methods: 22 patients were selected for cochlear implantation in the deaf ear in which the tinnitus was perceived. Patients were implanted with a COMBI 40+ M-implant or a PULSARCI¹⁰ FLEXsoft implant, with the electrode fully inserted in the scala tympani. Tinnitus was assessed using a comprehensive tinnitus assessment schedule comprising tinnitus characterization, pitch sensation, sensation level, visual analogue scale (VAS) for loudness, and the tinnitus questionnaire (TQ) following Hallam, which is a tinnitus specific quality of life questionnaire. Spatial speech-in-noise tests were performed to assess binaural hearing after cochlear implantation. Evaluation was performed preoperatively, 1, 3, 6, 12, 18, 24 and 48 months post fitting.

Results: All 22 patients used their cochlear implant every day and the whole day. With the implant activated, a significant tinnitus reduction was realized in all patients, regarding the loudness perception (VAS from 8.45 to 2.45) and the TQ self-assessed quality of life (raw score from 58 to 32/80). The result obtained was stable during the 4 years of evaluation. A significant improvement in hearing using the CI was found for summation effect (3.3 dB), squelch effect (5.2 dB) and combined with head shadow (6.4 dB) effect at 36 months.

Conclusions: The results of these 22 cochlear implantations in SSD demonstrate the effectiveness of CI in reducing or even abolishing unilateral continuous tinnitus in a single-sided deaf ear. CI proved to be an adequate treatment for this type of incapacitating tinnitus. There was no conflict between the hearing with CI and the hearing in the opposite ear and many patients experienced an improvement of their auditory capabilities. The improvement was obtained within 3 months after fitting, and the achieved effect on tinnitus was stable during the 48 months of follow-up. These results support the hypothesis that tinnitus is a deafferentiation type of sensation in these patients and that this physiopathological mechanism is partially reversible.

SSD with incapacitating tinnitus is a new indication for CI.

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Bilateral Electric Acoustic Stimulation and hearing preservation after deep cochlear electrode insertion

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Background: Electric Acoustic Stimulation (EAS) is a treatment for patients with severe to profound high frequency sensorineural hearing loss and functional low frequency hearing in the low frequencies. The aims were to assess the benefit of bilateral EAS compared to unilateral EAS and to assess the amount of hearing preservation after deep electrode insertion. A comparison was also made between EAS using partial and deep electrode insertion in terms of hearing preservation and speech perception results.

Methods: A patient with bilateral severe, sloping, high-frequency hearing loss was implanted bilaterally for EAS. A Med-El COMBI 40+ M electrode array was implanted and a partial insertion (18mm) of the electrode was performed on the right side; Contralaterally, the patient received a Med-EL PulsarCT100 FLEXsoft electrode array 39 months later. A deep insertion of the electrode was performed, with an insertion depth of 30 mm. Hearing thresholds and speech reception outcomes were measured preoperatively and up to 48 months after implantation using fixed speech in noise and speech in quiet tests for unilateral and bilateral EAS use. The benefit of EAS in daily life was assessed with the APHAB questionnaire.

Results: Hearing preservation after EAS surgery was achieved bilaterally, even after deep electrode insertion. Bilateral EAS was especially beneficial for speech recognition in noise compared to unilateral EAS. A head shadow effect of 3.4 dB, binaural squelch effect of 1.2 dB and binaural summation effect of 0.5 dB were measured. APHAB scores improved after both first and second EAS treatment.

Conclusion: Bilateral EAS was successfully implemented in this patient providing better speech recognition in noise compared to unilateral EAS. Bilateral EAS resulted in improved spatial hearing. Hearing preservation is possible after deep insertion of a FLEXsoft electrode array.


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Title: Review of cases in which gentamicin perfusion did NOT go as planned—What I learned

Objectives:
1. Discuss gentamicin perfusion for treatment of Meniere’s Disease (MD).
2. Review cases where the perfusion did not go as planned.
3. Lessons learned.

Methods:

The Silverstein Microwick was used for gentamicin perfusion. Patients had the wick placed in the middle ear under local or general anesthesia. Patients were sent home to use a solution of gentamicin (10mg/cc) with a dosing schedule of 3 drops TID. Patients returned for weekly audio and ENG air calorics. Treatment was stopped when there was a severe drop in hearing or when the ENG showed no response in the treated ear.

Results

In the selected cases the perfusion did not go as planned. There were unexpected outcomes in the hearing and balance results. These unique cases will be presented and discussed.

Conclusions:

Not all cases of gentamicin perfusion proceed as planned. Variations in treatment outcomes are instructional for future cases.