PROGRAM and ABSTRACTS

of the

One Hundred Thirty-Seventh
Annual Meeting

AMERICAN OTOLOGICAL SOCIETY, INC.

May 1-2, 2004

J. W. Marriott Desert Ridge Resort & Spa
Phoenix, AZ

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The American Otological Society is accredited by the Accreditation Council for Continuing Medical Education to sponsor continuing medical education for physicians.

This Continuing Medical Education offering meets the criteria for eight (8) credit hours in Category One (1) of the Physician's Recognition Award of the American Medical Association.

An unrestricted educational grant was received from Medtronics and Gyrus ENT in support for this program.

SATURDAY, May 1, 2004

REGISTRATION – 12:00 Noon

BUSINESS MEETING – 12:30 pm
ROOM: Grand Sonoran Salon E
(Restricted to Members)

Minutes of the Annual Meeting 2003

Introduction of New Members

Election of Nominating Committee

Report of the Secretary-Treasurer

Report of the Editor-Librarian

SCIENTIFIC PROGRAM – 1:00 pm
ROOM: Grand Sonoran Salon E
(Open to Non-Members)
*Speaker

1:00 pm	Remarks by the President **Jeffrey P. Harris, MD, PhD**
1:05 pm	Presidential Citation **Elizabeth M. Keithley, PhD** **Allen F. Ryan, PhD**

Session: Skull Base Surgery

1:10 pm	Introduction of the Guest of Honor **Ugo Fisch, MD**
1:15 pm	Surgical Management of Temporal Para-gangliomas (glomus jugulare tumors): A Long Term Review **Guest of Honor: Ugo Fisch, MD**
1:45 pm	A Meta-Analysis of Cerebrospinal Fluid Leakage after Vestibular Schwannoma Surgery **Jeffrey C. Liu, MD** **Samuel H. Selesnick, MD*** **Albert Jen, MD** **Jason Newman, MD**
1:55 pm	Four Channel Electromyography of the Facial Nerve in Vestibular Schwannoma Surgery: Sensitivity and Prognostic Value **Olivier Sterkers, MD, PhD*** **Alexis Bozorg Grayeli, MD, PhD** **Michel Kalamarides, MD** **Rey A, MD**

NOTES

Session: Temporal Bone Pathology and Meniere's Disease

2:05 pm	Audiometric Long-term Follow-up in Enlarged Vestibular Aqueduct Syndrome **Salvatore Iurato, MD*** **Giuseppe Bux, MAu** **Salvatore Mevoli, MAu**
2:15 pm	Pathophysiology of Meniere's Syndrome: Are Symptoms Caused by Endolymphatic Hydrops? **Saumil N. Merchant, MD*** **Joe C. Adams, PhD** **Joseph B. Nadol Jr., MD**
2:25 pm	ABRs to Clicks and High-Pass Noise Masking Clearly Distinguish Patients Diagnosed with Meniere's Disease **Manuel Don, PhD*** **Betty Kwong** **Chiemi Tanaka** **Michael Waring**
2:35 pm	Evaluation of Pupillometry in Distinguishing Meniere's Disease from Vestibular Migraine **Rebecca L. Duke, MD*** **Robert J. Toohill, MD** **P. Ashley Wackym, MD** **David R. Friedland, MD, PhD**
2:45 pm	**DISCUSSION**
2:55 pm	Break with Exhibitors

Session: Meniere's Disease (continued)

3:15 pm	Meniett Device for the Treatment of Meniere's Disease
Moderator:	**Jeffrey P. Harris, MD, PhD**
Panel:	**Barbara Densert, MD** **Alec N. Salt, PhD** **Jens C. Thomsen, MD** **Olivier Sterkers, MD, PhD** **George A. Gates, MD**
4:05 pm	**DISCUSSION**

NOTES

Session: Cochlear Implantation

4:15 pm	Minimally-Invasive, Image-Guided Facial Recess Approach to the Middle Ear **Robert F. Labadie, MD, PhD*** **David S. Haynes, MD** **Rohan J. Shah** **Steven S. Harris** **Robert L. Galloway, PhD** **J. Michael Fitzpatrick, PhD**
4:25 pm	More Challenging Speech Perception Tasks Demonstrate Binaural Benefit in Bilateral Cochlear Implant Users **P. Ashley Wackym, MD*** **Jill B. Firszt, PhD** **Christina L. Runge-Samuelson, PhD** **Wolfgang Gaggl, MSE** **Farah Mohd Alkaf, MA** **Linda Burg, AuD**
4:35 pm	Cochlear Implant Failures **Amy Anne Donatelli, MD*** **Teresa A. Zwolan, PhD** **Steven A. Telian, MD**
4:45 pm	Bacterial Biofilms May Contribute to Cochlear Implant Infection **Patrick J. Antonelli, MD*** **James C. Lee, BS** **Robert A. Burne, PhD**
4:55 pm	Multielectrode Cochlear Implantation in the Scala Vestibuli **Karen Lin, MD*** **Michelle S. Marrinan, MD** **Susan B. Waltzman, PhD** **J. Thomas Roland, Jr., MD**
5:05 pm	**DISCUSSION**
5:15 pm	**Adjourn**
5:20 pm	**Group Photograph (Members Only)** Location to be announced

NOTES

Sunday, May 2, 2004

REGISTRATION – 7:00 am

BUSINESS MEETING – 7:00 am
ROOM: Grand Sonoran Salons A-D
(Restricted to Members)

REPORT OF THE

A. Board of Trustees of the Research Fund
B. American Board of Otolaryngology
C. Award of Merit Committee
D. American College of Surgeons
E. American Academy of Otolaryngology-Head and Neck Surgery

Report of the Audit Committee

Report of the Membership Development Committee

Report of the Nominating Committee

Unfinished Business

New Business

SCIENTIFIC PROGRAM – 7:30 am
ROOM: Grand Sonoran Salons A-D
(Open to Non-Members)
*Speaker

7:30 am	Retrograde Mastoidectomy with Canal Wall Reconstruction: A Follow-up Report **John L. Dornhoffer, MD***
7:40 am	Window Shade Tympanoplasty for Anterior Marginal Perforations **Scott A. Schraff, MD*** **Barry Strasnick, MD**
7:50 am	Self-Adjusting Ossicular Replacement Prostheses—Studies in a Temporal Bone Model **Richard L. Goode, MD*** **Nobumitsu Honda, MD** **Toshiki Maetani, MD**

NOTES

Session: Etiology and Interventions in Sensorineural Hearing Loss

8:00 am — Improved Diagnostic Effectiveness with a Sequential Diagnostic Paradigm in Idiopathic Pediatric Sensorineural Hearing Loss
Diego A. Preciado, MD*
Colm Madden, MD
David Myer, BS
Chris Ngo, BS
John K. Bradshaw, MD
Daniel I. Choo, MD
John H. Greinwald Jr, MD

8:10 am — Serial Audiometry in a Multicenter Clinical Trial of AIED Treatment
John K. Niparko, MD*
Gregory B. Russell, PhD
Mark A. Espeland, PhD
June J. Pierce, PhD
Nae-Yuh Wang, PhD
Stephen Bowditch, MS
A. Julianna Gulya, MD
Bruce J. Gantz, MD
Jeffrey P. Harris, MD, PhD
The AIED Study Group

8:20 am — Topical Application of Mitomycin-C to the Middle Ear is Ototoxic in the Gerbil
Marcus W. Moody, MD*
Hainan Lang, MD, PhD
Adam C. Spiess, MD
Richard A. Schmiedt, PhD

8:30 am — Role of Tumor Necrosis Factor Alpha in Sensorineural Hearing Loss Following Bacterial Meningitis
Shervin Aminpour, BS*
Steven P. Tinling, MA
Hilary A. Brodie, MD, PhD

8:40 am — Antioxidant Prevention of Cisplatin Ototoxicity
Kay W. Chang, MD
Won-Taek Choe, MD*
Nina Chinosornvatana, BS

8:50 am — Cochlear Microperfusion: Experimental Evaluation of a Potential New Therapy for Profound Hearing Loss Due to Inflammation
Gregory C. Barkdull*
Cong Vu
Elizabeth M. Keithley, PhD
Jeffrey P. Harris, MD, PhD

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9:00 am **DISCUSSION**

Session: Inner Ear

9:10 am Frontiers in Hair Cell and Neural Regeneration
Moderator: **Allen F. Ryan, PhD**
Panel: **Allen F. Ryan, PhD**
Stefan Heller, PhD
Yehoash Raphael, PhD

9:45 am **DISCUSSION**

9:55 am Break With Exhibitors

Session: Middle Ear Implants, Ossicular Reconstruction and Otosclerosis

10:15 am Ferro-Magnetic Properties of Middle Ear Implants and Stapes Prostheses in a 3 Tesla Magnetic Resonance Field
Michael H. Fritsch, MD*
Jason J. Gutt, MD

10:25 am The SOUNDTEC Semi-implantable Hearing Aid
Herbert Silverstein, MD*
James Atkins, MD
Nancy Gilman, MS
Neil E. Brown, MD

10:35 am A Novel Genetic Locus for Otosclerosis
X. Cindy Li, MD
Austin Chen
Derald E. Brackmann, MD
Rick A. Friedman, MD, PhD*

10:45 am The Effects and Diagnosis of Malleus Fixation
Hideko H. Nakajima, MD, PhD*
Michael E. Ravicz, MS
John J. Rosowski, PhD
William T. Peake, ScD
Saumil N. Merchant, MD

10:55 am **DISCUSSION**

Session: Otosclerosis and Stapedectomy

11:05 am Contemporary Topics in Stapedectomy
Moderator: **Antonio De La Cruz, MD**
Panel: **Joseph B. Nadol, Jr., MD**
William H. Lippy, MD
Jeffrey P. Harris, MD, PhD
Ugo Fisch, MD

2004 Program Advisory Committee

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COSM 2005
138th AOS Annual Meeting
May 14-15, 2005
Boca Raton Resort & Club
Boca Raton, Florida

Abstract Deadline: October 15, 2004

Abstract form available from
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11:55 am	**DISCUSSION**
12:05 pm	Introduction of New President **Sam E. Kinney, MD**
12:10 pm	**Adjourn**
6:30 pm	**President's Reception (Members and Invited Guests Only)**
7:30 pm	**President's Banquet (Members and Invited Guests Only)**

AMERICAN OTOLOGICAL SOCIETY, INC.

MISSION STATEMENT

The mission of the American Otological Society, Inc., shall be

- to advance and promote medical and surgical otology including the rehabilitation of the hearing and balance impaired.
- to encourage, promote, and sponsor research in otology and related disciplines.
- to conduct an annual meeting of the members for the presentation and discussion of scientific papers and the transaction of business affairs of the Society.
- to publish the peer reviewed papers and discussions presented during the scientific program and the proceedings of the business meetings.

EDUCATIONAL MISSION STATEMENT

The Educational Mission of the American Otological Society is to foster dialog on, and dissemination of, information pertaining to advances in the understanding and management of otologic and neurotologic disorders. It is expected that the CME program of the AOS will enhance the competency of the participant in otology and neurotology.

After attending this meeting, the participant will be informed about new aspects of otology and neurotology in their practice including:

- The apparent value of the Meniett device as to the treatment of patients with Meniere's Disease.
- Controversial areas in the performance of Stapedectomy for otosclerosis.
- The use of imaging and newer technologies for surgery of the ear.
- The current state of the art for nerve and hair cell regeneration.
- Inner ear and temporal bone pathology and new interventions.

Author's signature on the following statements were required on all papers submitted to the American Otological Society. Each author was advised that the submitted paper becomes the property of ***Otology & Neurotology*** and cannot be reprinted without permission of the Journal.

CONFLICT OF INTEREST DISCLOSURE FORM

I, as senior author, am confirming that I/we have no real or apparent conflict of interest related to my/our participation in the American Otological Society's Annual Spring Meeting to be held May 1-2, 2004. In this regard, please be advised that I am disclosing below any publication, public positions, or memberships, as well as any personal financial interests (including equity positions, consulting agreements or employment arrangements) related to the proposed conference topic.

____I have no financial interests or advocacy positions related to the issues under discussion.

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PUBLICATION STATEMENT

The material in this abstract, ____(Name of Abstract)_____, has not been submitted for publication, published, nor presented previously at another national or international meeting and is not under any consideration for presentation at another national or international meeting. The penalty for duplicate presentation/publication is prohibition of the author and co-authors from presenting at a COSM society meeting for a period of three years.

Submitting Author's Signature (required): _____

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1.

A Meta-Analysis of Cerebrospinal Fluid Leakage after Vestibular Schwannoma Surgery

Jeffrey C. Liu, MD, Samuel H. Selesnick, MD
Albert Jen, MD, Jason Newman, MD

Objective: To review the incidence of cerebrospinal fluid (CSF) leak after vestibular schwannoma removal reported in the literature.

Data Sources: MEDLINE and PUBMED literature search using the terms *Acoustic Neuroma* or *Vestibular Schwannoma,* and *cerebrospinal fluid leak* or *cerebrospinal fluid fistula* covering the period from 1985 to present in English. A review of bibliographies of these studies was also performed.

Study Selection: Criteria for inclusion in this meta-analysis consisted of the availability of extractable data from studies presenting a defined group of patients who had undergone primary vestibular schwannoma removal and for whom the presence and absence of CSF leakage was reported. Studies reporting combined approaches were excluded. No duplications of patient populations were included. Twenty-five studies met the inclusion criteria.

Data Extraction: Quality of the studies was determined by the design of each study and the ability to combine the data with the results of other studies. All of the studies were biased by their retrospective, non-randomized nature.
Data Synthesis: Significance ($p<0.05$) was determined using the chi-squared test.

Conclusions: CSF leak occurred in 10.6% of 2273 retrosigmoid surgeries, 9.5% of 3118 translabyrinthine surgeries, and 10.6% of 573 middle fossa surgeries. The type of CSF leak was not associated with surgical approach. Meningitis was significantly associated with CSF leak ($p<0.05$). Age and tumor size were not associated with CSF leak.

2.

Four Channel Electromyography of the Facial Nerve in Vestibular Schwannoma Surgery: Sensitivity and Prognostic Value

Olivier Sterkers, MD, PhD, Alexis Bozorg Grayeli, MD, PhD
Michel Kalamarides, MD, Rey A, MD

Objective: To evaluate the facial prognostic value of a four channel facial electromyographic (EMG) device in vestibular schwannome (VS) surgery.

Study Design: Among 95 VS operated on and intraoperatively monitored by a four channel facial EMG (NIM response, Xomed Medtronics, France) between October 2002 and September 2003, 84 patients were included in this prospective study. Detection was performed in frontal, orbicularis oculi, orbicularis oris and plathysma muscles.

Main Outcome Measure: Facial function (House and Brackmann classification)

Setting: Tertiary referral centre.

Results: The postoperative facial function at days 8 and 60 was related to the intraoperative stimuli thresholds (ST, range: 0.01 to 3 mA for a response > 100 μV) at the proximal region of the nerve after the tumour removal. At day 8, facial function grades 1 and 2 were obtained in 83% for ST at 0.01-0.04 mA, in 67% for ST at 0.05 mA, in 69% for ST from 0.1 to 0.25 mA, and in 7% for ST > 0.3 mA. At day 60 (n=77), 58% grade 1, 20% grade 2, 5% grade 3, 9% grade 4, and 8% grade 5 were achieved with a mean ST at 0.05 ± 0.007, 0.069 ± 0.016, 0.28 ± 0.136, 1.01 ± 0.374, and 1 ± 0.416 respectively. The maximal EMG response was detected in the frontal muscle or the plathysma in 29 % of cases, and in orbicular muscles in 71%.

Conclusion: A four channel device may enhance the EMG sensitivity. Determination of ST below 0.05 mA yields facial prognostic information.

3.

Audiometric Long-term Follow-up in Enlarged Vestibular Aqueduct Syndrome

Salvatore Iurato, MD, Giuseppe Bux, M.Au
Salvatore Mevoli, M.Au

Objective: To study the audiometric long-term follow-up of patients with enlarged vestibular aqueducts (EVA).

Design: Retrospective review.

Setting: A tertiary referral center.

Patients: Subjects were included for study with a CT scan or MRI diagnosis of EVA in at least one ear.

Main Outcome Measures: Longitudinal audiometric analysis of the hearing threshold data over the years. Progression was called significant if it could be linked to correlation coefficients. Tympanometry and caloric tests were performed at various ages.

Results: Twelve patients with an EVA (6 males and 6 females; age range at detection = 3-36 years; mean age 20 years) were followed for a mean of 12.5 years (range 2-31 years). Hearing loss was bilateral in all patients. The mean PTA was 42.8 dB (SD 18.2 dB) for the better ear and 77.0 dB (SD 26 dB) for the worse ear. Two patients out of 12 showed a mixed type of hearing loss in one ear despite a normal middle ear. Hearing aids were used in the rehabilitation of the patients. Audiometric thresholds remained stable over time in 11 patients. In one patient followed over 31 years (8 audiograms; age range, 3-34 years) there were two slight drops in hearing both after mild head trauma. Head trauma was present in the far history of two other patients.

Conclusions: Hearing threshold remained stable over time in most patients. Mild head trauma may cause deterioration of hearing in EVA patients.

4.

Pathophysiology of Meniere's Syndrome: Are Symptoms Caused by Endolymphatic Hydrops?

Saumil N. Merchant, MD, Joe C. Adams, PhD
Joseph B. Nadol Jr., MD

Background: The association of Meniere's syndrome with endolymphatic hydrops has led to the formation of a central dogma: many possible etiologic factors lead to hydrops, and hydrops in turn, generates the symptoms. However, this central dogma of hydrops as being the final common pathway has not been proven conclusively.

Specific aims: To examine human and animal data with respect to the role of hydrops in causing symptoms in Meniere's syndrome. If the central. dogma were true, then every case of Meniere's syndrome should have hydrops and every case of hydrops should show the typical symptoms.

Methods: 1) Review of 79 archival temporal bone cases with a clinical diagnosis of Meniere's syndrome or an otopathological diagnosis of hydrops. 2) Review of experimental blockage of the endolymphatic duct in 14 guinea pigs followed by examination of the inner ear by immunostaining in the early post-surgical time period. 3) Review of literature.

Results: 1) Human data: Seven cases showed idiopathic hydrops with intact sensory and neural structures but the patients did not have symptoms of Meniere's syndrome during life. Conversely, 1 patient with fluctuating, low frequency, sensorineural hearing loss (SNHL) and 1 patient with episodic vertigo did not show any hydrops in either ear on histology. Review of literature revealed cases with asymptomatic hydrops as well as cases where symptoms of Meniere's existed during life but no hydrops was observed on histology. 2) Experimental data: obstruction of endolymphatic duct in guinea pigs resulted in change in immunostaining for taurine, NaK2Cl cotransporter and C-Jun-N-terminal kinase within type I fibrocytes of spiral ligament before development of hydrops. This result is consistent with the hypothesis that hydrops resulted from disordered fluid regulation due to disruption of regulatory elements within the spiral ligament.

Conclusion: Endolymphatic hydrops is an epiphenomenon of Meniere's syndrome rather than being directly responsible for its symptoms.

ABRs to Clicks and High-Pass Noise Masking Clearly Distinguish Patients Diagnosed with Meniere's Disease

Manuel Don, PhD, Betty Kwong, Chiemi Tanaka
Michael Waring

Meniere's disease is defined as the idiopathic syndrome of endolymphatic hydrops. The syndrome is characterized by episodic vertigo, tinnitus, fluctuating hearing loss, and the sensation of fullness or pressure. However, these symptoms are not always evident, especially at the onset of the disease. Histopathological studies *(e.g. Schuknecht; 1968,1974)* indicate that in Meniere's patients, hair cells usually appear normal. Therapeutic approaches (both surgical and pharmaceutical) assume involvement of cochlear hydrops. A vast amount of literature documents attempts to diagnose Meniere's disease and cochlear hydrops with various measures of evoked electrical activity, particularly electrocochleography (ECochG).

In cochlear hydrops, a reasonable assumption is that the increase in endolymphatic pressure could increase the stiffness of the basilar membrane (*Tonndorf, 1957; Tonndorf, 1983; Flottorp, 1980*). The possible changes in the physical properties of the basilar membrane due to hydrops appear to alter the effect of high-pass masking noise on the ABRs. In a study of 20 patients diagnosed with Meniere's disease and still symptomatic at the time of testing, and 40 non-Meniere's ears, ABRs to clicks presented with high-pass masking noise were recorded. All of the Meniere's ears showed a clear undermasking of wave V. Measurements of the undermasked Wave V in Meniere's ears were completely separate from the non-Meniere's ears yielding 100% sensitivity and 100% specificity for these two populations. There is strong evidence that these measures can be used to identify the presence of hydrops that accompanies Meniere's disease.

6.

Evaluation of Pupillometry in Distinguishing Meniere's Disease from Vestibular Migraine

Rebecca L. Duke, MD, Robert J. Toohill, MD
P. Ashley Wackym, MD, David R. Friedland, MD, PhD

Objective: To determine whether measures of pupillary function can distinguish patients with Meniere's disease from vestibular migraine.

Design: Prospective, controlled, cross-sectional study with correlation of objective and subjective measures.

Setting: Multi-subspecialty otolaryngology practice in a tertiary referral center.

Patients: Adults suffering from Meniere's disease (n=16) and vestibular migraine (n=20) in acute and interval states with recruitment of control population (n=30). Intervention: Use of a portable pupillometer to measure sympathetic and parasympathetic control of the ocular light response. Correlation of these results with diagnosis, Dizziness Handicap Inventory and objective measures of disease severity.

Main Outcome Measure: Maximum and minimum pupil aperture, constriction and dilation rates and latency of light response in subject and controls as stratified by side, diagnosis and disease severity.

Results: Patients with vestibular migraine demonstrated abnormalities in both minimum and maximum apertures following an initial stimulation of the contralateral eye ($p < .0015$, Bonferroni/Dunn post-hoc ANOVA) when compared to controls. Patients with Meniere's disease had a significant difference between their eyes with regards to latency measures when stratified by affected ear ($p < 0.05$, Student's t-test). Trends toward significant differences were seen between Meniere's and vestibular migraine patients in latency of response, minimum aperture and aperture ratios ($p < 0.10$, ANOVA).

Conclusions: Pupil responses to light are under sympathetic and parasympathetic control. The finding of abnormalities in patients with Meniere's disease and vestibular migraine suggest a systemic autonomic imbalance that may advise additional therapeutic interventions and provide a means to better distinguish between Meniere's disease and migraine variants.

IRB Number: FMLH 03-115; HRRC 244-03

7.

Minimally-Invasive, Image-Guided Facial Recess Approach to the Middle Ear

Robert F. Labadie, MD, PhD, David S. Haynes, MD
Rohan J. Shah, Steven S. Harris, Robert L. Galloway, PhD
J. Michael Fitzpatrick, PhD

Hypothesis: Image-guided surgery (IGS) will permit accurate access to the middle ear via the facial recess using a single drill hole from the lateral aspect of the mastoid cortex.

Background: The widespread use of IGS in otologic surgery has been limited by the need for a system which achieves the necessary level of accuracy with an easy-to-use, non-invasive fiducial marker system. We have developed and recently reported such a system with accuracy within the temporal bone of 0.76±0.23 mm (n=234 measurements). With this system, accurate image-guided otologic surgery is feasible.

Methods: A human skull fit with our fiducial marker system was CT scanned using standard temporal bone algorithms. Using an infrared tracking system to track an otologic drill, an image-guided facial recess approach was performed using a single pass of the drill. To confirm the path of the drill, a traditional mastoidectomy was then performed.

Results: A split-screen video of the image-guided facial recess surgery and the concurrent computer tracking of the drill will be shown. Following this, a video of the traditional mastoidectomy showing the path of the image-guided drilling will be shown. An accurate path through the facial recess into the middle ear without injury to the facial nerve, horizontal semicircular canal, or posterior external auditory canal wall is demonstrated.

Conclusions: Image-guided otologic surgery provides accurate access to the middle ear via the facial recess in a minimally invasive fashion. This system also has use in retrofacial dissection, approaches to the petrous apex, and robot-assisted mastoidectomy.

Acknowledgements: This work is supported by the National Institute of Health - National Institute of Biomedical Imaging and Bioengineering (R21 EB02886-01)

8.

More Challenging Speech Perception Tasks Demonstrate Binaural Benefit in Bilateral Cochlear Implant Users

P. Ashley Wackym, MD, Jill B. Firszt, PhD
Christina L. Runge-Samuelson, PhD
Wolfgang Gaggl, MSE, Farah Mohd Alkaf, MA
Linda Burg, AuD

Objective: Preliminary studies show that bilateral cochlear implantation improves speech recognition ability in most subjects; however, the magnitude of this improvement has been variable. The objective of our research was to explore means to better differentiate the binaural benefit that all patients who receive bilateral cochlear implants (CIs) describe.

Study Design/Patients: Prospective clinical study. Subjects were adult cochlear implant recipients. Three device manufacturers were represented (Advanced Bionics Corporation, Cochlear Corporation, and the Med-El Corporation) and three patients received simultaneous implantation, while the other three received sequential CIs.

Setting: Comprehensive Cochlear Implant Program / Tertiary Referral Center.

Main Outcome Measures: All subjects completed the Ontario Health Utility Index (revised for CI users) and the Abbreviated Profile of Hearing Aid Benefit (APHAB). Word and sentence recognition tests were administered in the unilateral and bilateral conditions, with and without noise and at three presentation levels.

Results: All subjects preferred the binaural listening condition. Measured improvement in the quality of life was seen. Speech perception testing at lower presentation levels and more challenging listening environments demonstrated the strongest binaural benefit for each subject.

Conclusions: Preliminary study findings suggest that the outcomes of subjects with bilateral CIs increases the quality of life and the speech recognition ability, when compared to the unilateral hearing condition. Based on the outcome of our studies, there should be a structured hierarchical approach in testing the binaural benefit of CIs that takes into account the varied performance of CI recipients that has been demonstrated in unilateral subjects.

9.

Cochlear Implant Failures

Amy Anne Donatelli, MD, Teresa A. Zwolan, PhD
Steven A. Telian, MD

Objective: To review our experience with cochlear implant failures and reimplantation, with attention to cause of failure of primary implant.

Study Design: Retrospective case review.

Setting: Cochlear implant program in a tertiary referral center with 1000 total implant recipients.

Patients: All adults and children who underwent explantation of a cochlear implant, for a total of 59 patients.

Intervention: Explantation of failed cochlear implants and reimplantation when indicated. Assessment of implant function and speech perception results pre / post-operatively.

Main Outcome Measures: Device type, time from implantation to explantation, cause of failure, performance with initial cochlear implant versus reimplant, surgical techniques / operative challenges related to reimplantation.

Results: 47 recipients from this program were reimplanted, for failure rate of 4.7%. 12 additional patients implanted elsewhere were treated for device related problems. Average time from implantation to explantation / reimplantation was 57 months. Performance remained comparable or improved in the majority of patients. Reasons for explantation / reimplantation were: complete device failure - 25 patients, partial device failure - 5 patients, scalp flap complications including infection - 5 patients and exposure - 8 patients, decreased performance cause unknown - 7 patients, technology upgrade - 5 patients, electrode extrusion - 2 patients, cholesteatoma - 2 patients.

Conclusions: Clinical experience suggests that device failures and revision surgery are becoming increasingly important issues in cochlear implant programs. Failures are not limited to device malfunction, and may be influenced by multiple factors including ossification, cochlear malformation, infection, and design characteristics of the implant.

10.

Bacterial Biofilms May Contribute to Cochlear Implant Infection

Patrick J. Antonelli, MD, James C. Lee, BS

Objectives: To determine if bacterial biofilms are present on the surface of extruding or persistently infected cochlear implants.

Study design: Prospective, case-controlled, non-randomized.

Setting: Academic, tertiary referral center.

Patients: Cochlear implant recipients undergoing explantation for persistent infection or device failure.

Intervention(s): Cochlear implant removal.

Main outcome measures: Scanning electron microscopy of removed cochlear stimulator-receivers examined for the presence of bacterial biofilms.

Results: The presence of microorganisms and amorphous extracellular debris was detected on the surface of both infected cochlear implants. Small foci of amorphous material and microbes were also found on the two implants removed due to device failure. Two never-implanted controls demonstrated microbial contamination without exopolymeric material.

Conclusion: Bacterial biofilm formation may play a role in recalcitrant cochlear implant infections. This may have profound implications for the treatment of cochlear implant infections.

11.

Multielectrode Cochlear Implantation in the Scala Vestibuli

Karen Lin, MD, Michelle S. Marrinan, MD
Susan B. Waltzman, PhD, J. Thomas Roland, Jr., MD

Objective: Sensorineural hearing loss resulting from otosclerosis, meningitis, chronic otitis media, autoimmune ear disease, and trauma can be associated with partial or total obstruction of the cochlear scalae. Multichannel cochlear implantation may be difficult or impossible in a cochlea with an obstructed scala tympani. The purpose of this study is to determine the safety and efficacy of scala vestibuli electrode insertion.

Study Design: Retrospective chart review.

Setting: Academic medical center.

Patients: Eight children and adults with profound sensorineural hearing loss who underwent cochlear implantation with known scala vestibuli electrode array insertion were subjects for this study.

Interventions: Eight study subjects were implanted, five with the Nucleus 24RCS (Contour) device and three with the Nucleus 24M device.

Outcome Measures: Imaging findings, operative findings, and age appropriate speech perception testing.

Results: All patients had full electrode insertion. Various obstructive patterns on CT and MRI imaging were found, and there was a range of speech perception results. All patients improved based on age appropriate monosyllabic word and sentence tests.

Conclusion: Scala vestibuli multielectrode insertion is a viable alternative when scala tympani insertion is not possible due to abnormal anatomy or anatomical changes secondary to disease or prior implantation. We will also present an algorithm of options for decision making for implantation when encountering cochlear obstruction and difficult electrode insertion.

12.

Retrograde Mastoidectomy with Canal Wall Reconstruction: A Follow-up Report

John L. Dornhoffer, MD

Objective: To evaluate long-term results of retrograde mastoidectomy with canal wall reconstruction as a single-stage technique for cholesteatoma removal.

Study Design: Retrospective case review.

Setting: Tertiary referral center.

Patients: Forty-six patients, representing 50 ears (20 pediatric, 30 adult), who had undergone surgery for cholesteatoma removal with said technique and had an average follow-up of 7.8 years.

Interventions: Temporary removal of the upper canal wall, in association with a retrograde-type mastoidectomy, for full exposure and extirpation of the disease, followed by reconstruction of the canal defect using Cymba cartilage.

Main Outcome Measures: Pre-operative and short- and long-term postoperative audiogram, obtained as four-frequency pure tone average air-bone gap (PTA-ABG). Complications, including presence of recurrent or residual cholesteatoma, need for tube insertion, perforation, and poor hearing requiring revision surgery were also reported and correlated with patient's tobacco use.

Results: The average pre-, short-term post-, and long-term post-operative PTA-ABG was 25.6 ± 11.2 dB; 11.0 ± 5.7 dB; and 12.4 ± 6.4 dB, respectively. There were significant differences between the pre- and postoperative values ($p<0.5$), but there was no significant difference between short- and long-term hearing results. Recurrent cholesteatomas were seen in 8 ears (16%); pressure equalizing tube insertion was performed post-surgery in 9 ears (18%); a perforation was seen in 1 ear (2%); and 2 ears (4%) had a poor hearing results requiring second-look surgery. The long-term complication rate of smokers was 79% (15/19), compared to 13% (4/31) for non-smokers.

Conclusions: This single-stage technique for cholesteatoma removal and canal wall reconstruction showed acceptable long-term results, but tobacco use was associated with a higher long-term complication rate.

13.
Window Shade Tympanoplasty for Anterior Marginal PerforationsSco

Scott A. Schraff, MD, Barry Strasnick, MD

Objective: Retrospective analysis of the success of "window shade" tympanoplasty.

Study Design: Retrospective case review from July 1, 1994 to July 1, 2003.

Setting: Tertiary referral center.

Patients: Patients with anterior marginal perforation undergoing tympanoplasty repair.

Intervention: Therapeutic.

Main Outcome Measured: Anterior marginal perforations of the tympanic membrane often present a reconstructive challenge to the otolaryngologist. Poor surgical outcomes are often due to inadequate exposure, a lack of residual tympanic membrane, impaired vascularity and delayed healing. In this study, we report on the success of the "window shade" technique, combining aspects of both the traditional undersurface and overlay tympanoplasty techniques, for the management of anterior marginal tympanic membrane perforations.

Results: We identified 164 patients who underwent "window shade" tympanoplasty during the study period. The overall success rate for tympanic membrane repair was 94%. There were no cases of tympanic membrane lateralization or significant blunting. The average healing time was four weeks. The surgical technique will be described in detail. Conclusions: The "window shade" tympanoplasty is an excellent surgical option for repair of anterior marginal perforations of the tympanic membrane.

14.

Self-Adjusting Ossicular Replacement Prostheses- Studies in a Temporal Bone Model

Richard L. Goode, MD, Nobumitsu Honda, MD
Toshiki Maetani, MD

Hypothesis: Middle ear ossicular replacement prostheses whose length can adjust to changes in middle ear dimensions following insertion may have acoustic advantages over conventional prostheses.

Background: Optimal tension appears to be an important factor in the acoustic performance of incus and incus-stapes replacement prostheses. Length is the primary determinant of post-insertion tension with conventional, rigid prostheses. Post-operative changes in prosthesis tension may occur over time due to retraction of the tympanic membrane (TM) leading to a worsening of post-operative hearing thresholds.

Methods: Testing of four experimental self-adjusting prostheses containing an internal spring was performed in eight fresh human temporal bones using a previously described method. Sound input into the ear canal of the temporal bone model was from 0.1 to 10 kHz at 80 dB SPL. Stapes footplate displacement was measured in response to this input using a laser Doppler vibrometer before and after incus removal and prosthesis insertion. Measurement of stapes displacement was performed at 0, -50 and –100 daPa middle ear pressure before and after inactivation of the internal spring. Malleus neck to stapes head, malleus neck to footplate, TM to stapes head and TM to footplate prostheses were evaluated.

Results: The self-adjusting prostheses performed significantly better below 2.0 kHz at all pressures, compared to the same prosthesis with spring inactivated. Prostheses that contacted the malleus performed slightly better than those that contacted the TM.

Conclusions: Self-adjusting middle ear prostheses appear to have acoustic advantages in a temporal bone model. Clinical correlation is needed.

15.

Improved Diagnostic Effectiveness with a Sequential Diagnostic Paradigm in Idiopathic Pediatric Sensorineural Hearing Loss

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David Myer, BS, Chris Ngo, BS, John K. Bradshaw, MD
Daniel I. Choo, MD, John H. Greinwald Jr, MD

Objectives: To determine if a stepwise diagnostic paradigm is more diagnostically efficient and cost-effective than the more commonly used simultaneous testing approach in idiopathic pediatric SNHL.

Design: Prospective longitudinal case series.

Setting: Tertiary referral children's hospital.

Patients: Children (n=85) presenting with idiopathic SNHL in the last 2 years.

Interventions: All children were evaluated with full diagnostic evaluations including *GJB2* screens, temporal bone CT scans, and laboratory investigations.

Main Outcome Measures: 1) Diagnostic yields of *GJB2* screens, imaging, and laboratory results per SNHL category, 2) Cost analysis comparing a sequential vs. a simultaneous testing approach.

Results: Patients had either unilateral or bilateral SNHL, with the latter classified as either mild to moderate, moderately severe, or severe to profound. Laboratory testing did not reveal the SNHL etiology in any patient. Patients with unilateral SNHL had a significantly higher imaging yield than those with bilateral SNHL. The diagnostic yield of *GJB2* screening was significantly higher in patients with severe to profound SNHL than in all other groups. Only 1 patient with a positive *GJB2* screen also had a positive imaging study. While maintaining diagnostic accuracy, significant cost savings were inferred by utilizing a sequential diagnostic algorithm.

Conclusions: A stepwise diagnostic paradigm in which children with bilateral SNHL first undergo *GJB2* screening, followed by imaging only if the *GJB2* screen is negative, and in which children with unilateral SNHL are only investigated with imaging, is more diagnostically efficient and cost effective than the more commonly used full, simultaneous testing approach. Laboratory investigation should not be routine, but based on clinical history.

16.

Serial Audiometry in a Multicenter Clinical Trial of AIED Treatment

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A. Julianna Gulya, MD, Bruce J. Gantz, MD
The AIED Study Group, Jeffrey P. Harris, MD, PhD

Objective: Despite their perceived clinical utility, puretone and speech audiometry have received little study of their value in predicting response to medical therapy. We analyzed audiometric results in a study of treatment results in subjects with autoimmune inner ear disease (AIED). We sought to identify audiometric predictors of steroid response.
Study Design & Setting: Initial phase of a prospective, double-blind, randomized trial conducted in 10 tertiary care centers in the United States.
Patients: Adult participants demonstrated established criteria for AIED and no contraindications to steroid treatment. Eligible participants had active AIED as defined by air conduction thresholds beyond 30 dB at one of more frequencies-AU, and progression of the hearing loss within 3 months with threshold shifts of >15dB @ 1 frequency, or >10dB @ 2 consecutive frequencies.
Interventions: We evaluated patients audiometrically at baseline and at closeout, after 4 weeks of oral treatment with pharmacologic doses of prednisone.
Main Outcome Measures: We determined six-frequency (.25, .5, 1, 2, 4, & 8 KHz) puretone thresholds to air-conducted pulses using established bracketing and masking procedures. Word identification scoring (WIS) testing used NU-6 50-word lists under headphones. We examined WIS scores at closeout with regressions on baseline puretone frequency thresholds.
Results: Overall (n=116) mean pure tone averages improved from baseline to closeout of prednisone treatment: 47.3 to 43.7 dB [p=0.0001]. Mean WIS improved: 71.4 to 78.1% [p=0.0001]. Of all pure tone measures, only the baseline 4- & 6-frequency averages (in the better hearing ear) correlated significantly with changes in WIS, with higher thresholds associated with greater responsiveness. Individual frequencies at baseline showed no significant relationship with change in WIS. Of individual frequencies, 1 KHz thresholds showed the greatest variance. WIS improved in 69 (59%) of 116 subjects (range: 2% to 80%). In this group, baseline 4- and 6-frequency averages correlated significantly and positively with improvement in WIS, as did puretone thresholds at 2 K Hz and below.
Conclusions: Four- and 6-frequency averages prior to treatment best predict outcome with respect to improvement in WIS in AIED suspects treated with steroids. Explicit criteria for subject enrollment and defining "clinically significant" change in the audiogram in future protocols can be guided by these observations.

This study was supported by grant 5 U01 DC03209 from the NIH/ NIDCD and the AAO-HNS Foundation Inc.

17.

Topical Application of Mitomycin-C to the Middle Ear is Ototoxic in the Gerbil

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Hypothesis: Mitomycin-C is ototoxic when applied topically to the structures of the middle ear. **Background**: Mitomycin-C is a topically applied medication widely used in a variety of surgical procedures to prevent excessive scar tissue formation. Its safety for use during otologic procedures has not been evaluated.

Methods: A laboratory study was undertaken using the Mongolian gerbil as an animal model. Both acute and chronic effects on cochlear function of mitomycin-C were assessed with measurements of compound action potential (CAP) thresholds of the auditory nerve, CAP input-output (I/O) functions, distortion product otoacoustic emissions (DPOAEs) and endocochlear potentials (EP). Morphologic changes were assessed with light microscopy using H&E staining.

Results: Five-minute applications of mitomycin-C to the entire surface of the middle ear adversely affected CAP thresholds, I/O functions, DPOAEs and the endocochlear potential. Ninety-minute exposures of mitomycin-C solely to the round window produced similar changes. Histologic evaluation of animals one week after treatment showed damage to cochlear hair cells, the stria vascularis and spiral ganglion neurons when compared to controls.

Conclusions: Mitomycin-C can produce substantial sensorineural hearing loss when applied topically to the gerbil middle ear for even brief periods of time. Consequently, its safety for topical use in the human middle ear is highly questionable.

18.

Role of Tumor Necrosis Factor Alpha in Sensorineural Hearing Loss Following Bacterial Meningitis

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Hypothesis: To identify the effects of cytokine blockade on intracochlear fibrosis, ossification, and hearing loss associated with meningogenic labyrinthitis.

Background: Inflammatory mediators play a significant role in the morbidity associated with bacterial meningitis including hearing loss. Previous studies have shown the attenuation of hearing loss by the non-specific blockade of such pathways.

Methods: Thirty-five Mongolian gerbils were divided into 3 groups. Auditory brainstem response testing (ABR) was conducted to measure hearing thresholds. Streptococcus pneumoniae meningitis was induced in groups 1 and 2. Group 2 was then given daily intraperitoneal injections of tumor necrosis factor alpha (TNF-alpha) antibody while group 1 received normal saline. Uninfected animals in group 3 were implanted with osmotic pumps that delivered a continuous 7 day intrathecal flow of TNF-alpha. After 6 weeks, ABR testing was repeated. The cochleas were harvested and analyzed histomorphometrically.

Results: Group 2 animals receiving cytokine blockade developed significantly less hearing loss than group 1 controls. The difference in hearing loss at 4, 8, 16, and 32 kHz was 26.5%, 20.9%, 27.8%, and 39.7% respectively ($p<.0001$). Furthermore, histomorphometric analysis showed significantly less damage to the organ of corti, spiral ganglion, spiral ligament, and stria vascularis in group 2. Conversely, cytokine induced meningitis animals showed increased hearing loss from their pre-treatment control thresholds ($p<.0001$).

Conclusions: TNF-alpha plays an important role in cochlear injury following bacterial meningitis. Blockade of TNF-alpha reduces post-meningitic hearing loss and cochlear injury. Induction of meningitis with intrathecal TNF-alpha also resulted in hearing loss and cochlear injury similar to bacterial meningitis.

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19.

Antioxidant Prevention of Cisplatin Ototoxicity

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Hypothesis: Simultaneous transtympanic delivery of the antioxidant N-acetylcysteine (N-Ac) will mitigate the cochleotoxic effects of systemically administered cisplatin in the guinea pig model.

Background: Cochlear ototoxicity is a well known side effect of cisplatin administration, with the mechanism of damage thought to rest in oxidative damage to the Organ of Corti. Accordingly, various preventive strategies have been devised for the delivery of antioxidants into the inner ear. We have found that the simple transtympanic delivery of dilute N-Ac effectively counteracts cisplatin cochleotoxicity in the guinea pig model.

Methods: Hartley guinea pigs were housed and fed under standard conditions, and anesthesia obtained with ketamine and xylazine. Baseline DPOAE measurements were performed. On days 1, 2 and 3, animals were hydrated with 12cc normal saline subcutaneously and their middle ear cavities were filled with either 10% Floxin solution (control) or 2% N-Ac / 10% Floxin solution (treatment group) via anterosuperior quadrant myringotomies. The animals received 4 mg/kg of cisplatin intraperitoneally on these days for a cumulative dose of 12 mg/kg. Post-treatment DPOAEs were obtained on day 5.

Results: Animals receiving the control 10% Floxin solution demonstrated consistent obliteration of DPOAEs, while those receiving the treatment 2% N-Ac / 10% Floxin solution demonstrated consistent preservation at near pre-treatment levels with minimal mucosal toxicity.

Conclusions: We have demonstrated the efficacy and safety of transtympanic N-Ac in the prevention of cisplatin ototoxicity using a guinea pig model. Our model also allows other candidate antioxidants to be tested readily.

Cochlear Microperfusion: Experimental Evaluation of a Potential New Therapy for Profound Hearing Loss Due to Inflammation

Gregory C. Barkdull, Cong Vu, Elizabeth M. Keithley, PhD
Jeffrey P. Harris, MD, PhD

This investigation was undertaken to develop and evaluate a potential new treatment for profound sensorineural hearing loss due to inner ear inflammation.

Inflammation is triggered by viruses, bacteria, or autoimmune processes. Hearing loss during the acute phase is associated with elevations in cytokines, nitrous oxide, cellular infiltrates and the breakdown of the blood-labyrinthine barrier. The chronic phase leads to irreversible ossification of the labyrinth.

We developed cochlear microperfusion to facilitate removal of inflammatory cells and their mediators during the acute phase of inflammation. Using a ventral approach to the guinea pig cochlea, we displaced resident perilymph by delivering perfusate into the scala vestibuli and collecting the efflux from the scala tympani. The safety of this procedure was assessed in healthy controls and then tested in animals with profound hearing loss due to experimentally generated sterile labyrinthitis.

Healthy controls undergoing cochlear microperfusion with phosphate buffered saline incurred a mean hearing loss of 15 dB (n=4). This hearing loss was associated with the creation of cochleostomy holes and not the perfusion itself. Sterile labyrinthitis generated by perfusion of the cochlea with antigen consistently produced hearing loss of 65 dB (n=6). Cochlear microperfusion, performed in animals with profound deafness secondary to acute inflammation, restored 30 dB of hearing (n=3).

We conclude that cochlear microperfusion is a promising new technique for treating profound deafness due to inflammatory processes. It will be interesting to see if combining this treatment modality with drug delivery enhances the benefit.

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21.

Ferro-Magnetic Properties of Middle Ear Implants and Stapes Prostheses in a 3 Tesla Magnetic Resonance Field

Michael H. Fritsch, MD, Jason J. Gutt, MD

Magnetic Resonance Imaging (MRI) technology continues to increase its magnet strength to improve visualization. Previous studies have delineated the safety and compatibility of middle ear implants and stapes prostheses for 1.5 Tesla (T) magnetic resonance (MR) fields. Our study explored the in-vitro effects on prostheses by a more powerful 3 Tesla MR field. We hypothesized that the 3 Tesla MR field may cause displacement or motion of middle ear implants or prostheses different from studies using 1.5 T magnets. Eighteen different middle ear implants and stapes prostheses from multiple manufacturers were studied within an enclosed Petri dish. The implants were placed on a .25mm grid surface and exposed to the 3 T magnetic field in each of 2 positions for 15 seconds. Any translational and/or rotational movement was recorded. The same study was repeated in a 1.5 T field for comparison with earlier studies. Dramatic prosthesis motion was observed in three different implants in the 3 T field. No movement was seen in any prostheses in the 1.5 T field. The forces and movement generated by 3 T magnets in-vitro were great enough to cause concern about in-vivo displacement or injury. Concerns are raised about MR safety data for 1.5 T fields being applied to 3 T scanners. Our data and discussion provide valuable information to the otologic surgeon for selecting an appropriate middle ear implant or stapes prosthesis, and to manufacturers for selecting materials and shapes for prostheses.

22.

The SOUNDTEC Semi-implantable Hearing Aid

Herbert Silverstein, MD, James Atkins, MD
Nancy Gilman, MS, Neil E. Brown, MD

Objective: To assess the efficacy, morbidity, and patient satisfaction of the SOUNDTEC semi-implantable hearing Aid.

Study design: Retrospective case review.

Setting: Tertiary Referral Center.

Patients: Eighty-five patients with bilateral moderately severe sensorineural hearing loss: Seventy-eight of the patients had worn conventional hearing aids were dissatisfied and wanted better hearing. Nine patients had not previously worn hearing aids.

Intervention(s): After separating the incudo-stapedial joint, a magnet encased in a titanium canister with a ring was introduced onto the stapes neck. Gel foam and adipose tissue were used to stabilize the magnet. After three months the external electromagnetic driver was placed in the external auditory canal and adjusted for the patient's hearing loss.

Main Outcome Measure(s): At one month audiometric testing in quiet and in noise was performed. At three months a questionnaire was sent to the patients.

Results: The results of the questionnaire indicated that patients below the age of seventy had perceived better results than those older than seventy. Twenty-four patients complained of sound produced by the implant during head motion, which was eliminated in 70% when the external processor was worn. Audiometric data will be presented. Sixty percent were pleased with their hearing, and noted the lack of occlusion effect and feedback.

Conclusions: The SOUNDTEC Direct device is well tolerated in the majority of patients with a significant increase in functional gain, especially for the high frequencies. Magnet instability was the most frequent complaint, which is being corrected. This electromagnetic semi-implantable hearing aid represents a significant advance over conventional hearing aids.

23.

A Novel Genetic Locus for Otosclerosis

X. Cindy Li, MD, PhD, Austin Chen
Derald E. Brackmann, MD, Rick A. Friedman, MD, PhD

Objective: To describe the clinical and genetic mapping data a multi-generational family segregating a novel gene for otosclerosis.

Study Design: Human genetics: Ascertainment and genetic mapping.

Setting: Tertiary referral center and research institute.

Patients: Patients derived from a multi-generational family segregating a gene for otosclerosis.

Intervention: Blood draw and buccal swabs for DNA, audiometrical evaluations and whole genome scan for genetic mapping.

Main Outcome Measures: Genetic map location including calculation of statistical significance (LOD).

Results: We have identified a novel gene locus for otosclerosis on human chromosome 16p.13.

Conclusions: A novel locus for otosclerosis has been identified. We are currently analyzing candidate genes in this interval. Genetic studies of otosclerosis will ultimately identify the mechanisms underlying this common form of hearing loss.

24.

The Effects and Diagnosis of Malleus Fixation

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John J. Rosowski, PhD, William T. Peake, ScD
Saumil N. Merchant, MD

Background: Preoperative clinical diagnosis of malleus fixation can be difficult. "Fixation" of the malleus may result from a variety of pathologies: fibrous tissue, bony spurs and neo-osteogenesis around the malleus head or stiffening of the anterior malleal ligament (AML). The conductive hearing loss produced by these pathologies has not been well characterized.

Goals: 1) Determine effects of various types of malleus fixation using a cadaveric temporal bone preparation. 2) Investigate clinical utility of umbo velocity measurements in the preoperative diagnosis of malleus fixation and its differentiation from stapes fixation.

Methods: Umbo and stapes velocity were measured in 10 fresh human temporal bones with laser vibrometry, before and after controlled application of glues and cements to the malleus and stapes. Experimental results were compared to clinical measurements of umbo velocity in surgically confirmed cases of malleus (n=4) or stapes fixation (n=27).

Results and Conclusions: 1) Experimental. Each simulated pathology produced a specific degree of loss in stapes velocity: stiffening of AML, 0-5 dB; fibrous tissue around malleus head, 5-10 dB; bony spur to malleus head, 10-20 dB; extensive neo-osteogenesis around malleus head, > 30 dB. Thus, stiffening of the AML produced insignificant reductions in stapes velocity, while the other pathologies produced more substantial reductions. Furthermore, the simulated malleus fixations produced similar reductions in both umbo and stapes velocity. Stapes fixation reduced stapes velocity with little change in umbo velocity. Thus, measurements of umbo velocity can differentiate malleus fixation from stapes fixation. 2) Clinical. Umbo velocity was significantly lower than normal in all 4 cases of fixed malleus, and within the normal range in all 27 cases of stapes fixation. The clinical and experimental data match well; thus, preoperative diagnosis of malleus fixation is possible by measurements of umbo velocity.

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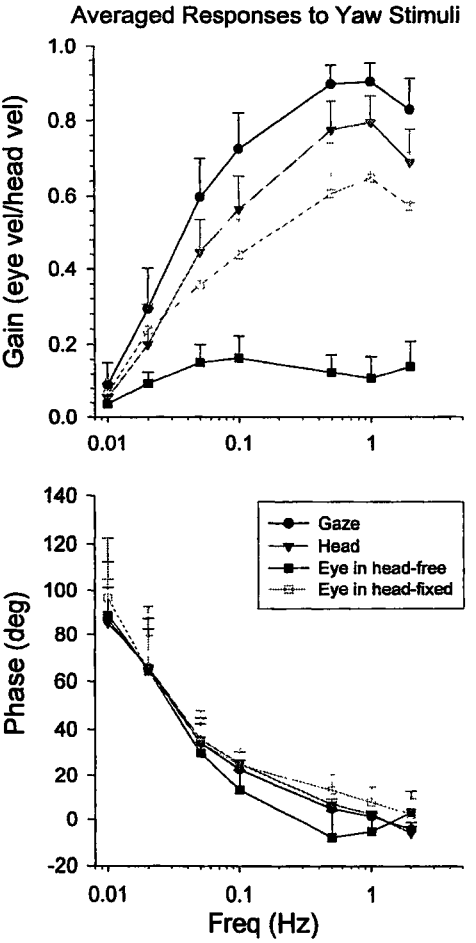
AOS Research Grantee Progress Report

Progress Report for Asim Haque
AOS Research Training Fellow

The specific aim of this project is to quantitatively characterize vestibular gaze behavior in normal animals and after Ménière's treatment regimens involving either aminoglycosides or histaminergics. Although there have been some animal model studies exploring intratympanic aminoglycoside and oral betahistine administration, to our knowledge, none have evaluated the effects of these treatments upon vestibular function in normal subjects using accurate three-dimensional (3D) eye and head movement measures. Our first major finding to date has been that pigeons, unlike primates who have 'heavier' heads, rely more on head movement contributions to maintain steady gaze. Thus, any disturbance in vestibular afferent input will affect not only eye movements, but also head movements. This capacity compensates for the low VOR gains seen in lateral-eyed animals.

Experiments designed to characterize the normal gaze responses under head-fixed and head-free conditions have recently been completed, with a manuscript currently in preparation. A thorough battery of rotational testing in the animal's yaw, pitch, and roll planes in the dark was performed at frequencies ranging from 0.01Hz – 10Hz at 20°/s stimulus velocity. These control experiments examined the differences in gaze stabilization due to the vestibulo-ocular reflex (VOR, head-fixed) and combined vestibulocollic (VCR), cervicocollic (CCR), cervico-ocular (COR) reflexes, and head inertia (altogether combined under head-free). Results from 7 different animals, and their complex average, dynamic response bode plots for yaw stimuli are shown in the figure (error bars represent standard deviations calculated via the error-propagation formula). As stated above, the pigeon VOR response is under-compensatory in head-fixed, dark conditions (see green trace/open squares). However, with the head free to move in order to stabilize gaze, near unity gains were recorded (black trace/circles). Additionally, we observed that the contribution from the eye when the head is free to move (blue trace/closed squares) is significantly less than that observed under head-fixed conditions (the head bears the burden under 'natural' stimuli conditions, red trace/triangles). With the normal control study nearing completion, efforts for the remainder of the funding period will now shift to characterizing behavior using intratympanic streptomycin injections as well as orally administered betahistine.


Averaged Responses to Yaw Stimuli
Gain (eye vel/head vel)
1.0
0.8
0.6
0.4
0.2
0.0
0.01
0.1
1
Phase (deg)
140
120
100
80
60
40
20
0
-20
Gaze
Head
Eye in head-free
Eye in head-fixed
Freq (Hz)

AOS Research Grantee Progress Report

Response Dynamics of Vestibular Afferents in Hydropic Guinea Pigs

Larry Hoffman
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January 2004

Abstract

Though the symptoms and functional anomalies of Meniere's disease are idiopathic, the histopathologic condition of endolymphatic hydrops is believed to be its principal precipitating factor (Honrubia, 1999). Because endolymphatic hydrops remains so preeminently associated with Meniere's, the animal model of experimental hydrops has been extensively utilized as a research tool for studies of vestibular pathophysiology resulting from the condition. However, it remains unresolved at this time how endolymphatic hydrops alters the function of the peripheral vestibular receptors. In this application we propose experiments that will elucidate whether endolymphatic hydrops results in alterations in the dynamic response characteristics of vestibular primary afferent neurons. This will be achieved through single-neuron electrophysiologic recordings conducted in guinea pigs in which endolymphatic hydrops is surgically induced through obliteration of the endolymphatic sac. These data from a population of afferent neurons will be compared to a similar population recorded from normal guinea pigs. Endolymphatic hydrops will be confirmed through auditory testing, MRI evaluation, and temporal bone histology.

Research Progress

This project was delayed in its start due to late notification from the Research Fund. This had significant ramifications on the progress to date, as it resulted in concomitant delays in personnel recruitment and institutional animal care and use approval.

Despite these temporary delays, this project has advanced on three critical fronts.

a. *Surgical induction of endolymphatic hydrops in guinea pigs.* We have successfully conducted the preparations to induce hydrops in the first set of guinea pigs. These animals are in the postoperative stage, during which time the endolymphatic hydrops condition develops.

b. *Electrophysiologic recording from vestibular afferent neurons.* The research design calls for maintaining an intact labyrinth and cranium to achieve single neuron recordings from vestibular primary afferents. Therefore, we are devoting considerable effort to the

development of the surgical approach to the superior vestibular nerve via the middle ear. This is a challenge in view of the guinea pig's temporal bone anatomy. Furthermore, we have had to develop a new anesthesia protocol for this animal model, and are conducting trials using modified anesthetic agents. We are also conducting trials using gaseous isoflurane. This may require the development of a miniature vaporizer that can fit on our stimulus turntable.

c. *Imaging the temporal bone for confirmation of endolymphatic hydrops.* Due to unforeseen developments in UCLA's Department of Radiological Sciences, it may be not be in the best interest of the present study to conduct *in vivo* MR imaging of the guinea pig temporal bones. Therefore, we have established a new collaboration with Dr. Arne Voie (Spencer Technologies; Seattle, WA), who has developed a novel imaging modality known as *orthogonal-plane fluorescence optical sectioning microscopy* (Voie, Hear. Res 171:119-128, 2002). We are developing a collaborative arrangement for conducting such imaging on guinea pig temporal bones that harbor the condition of endolymphatic hydrops. We have conducted trials using mouse specimens, which illustrate the exquisite morphology resulting from this processing and imaging modality. An example is shown below in Fig. 1

Figure 1. *Image of mouse temporal bone using OPFOS.* This imaging modality allows temporal bone specimens to be imaged *in situ*, obviating the need for time-consuming histologic processing. The processing that is required for OPFOS is very similar to the presectioning procedures (i.e. mild decalcification) required for traditional temporal bone histology. Abbreviations: *sv*, scala vestibuli; *sm*, scala media; *st*, scala tympani; *RM*, Reissner's membrane.

AOS Research Grantee Progress Report

Role of Glutamate Receptors in NOS1-Mediated Bone Resorption in the Ear

Brian T. Faddis, PI

We are interested in the cellular and molecular mechanisms that mediate bone remodeling in the otic capsule. Recently we have more specifically started to investigate the role of nitric oxide as an activator of osteoclasts. We recently showed that the neuronal isoform of nitric oxide synthase (NOS1) is important for osteoclast development and activation, both *in vitro* and in a model of particle induced osteolysis *in vivo*. This grant from the American Otological Society seeks to further those observations by examining the role of the glutamate receptor as the mediator of NOS1 activation. The funds provided by AOS were used to purchase a calcium imaging system, including imaging software, light source, and intensified camera. This equipment was months delayed due to governmental constraints placed on the distribution of intensifiers during the war. Therefore, we are still in the process of learning how best to use this equipment with our cultures. However it remains the primary goal of this project to examine, in real time, nitric oxide production and calcium flux in response to glutamate receptor stimulation in our cultured osteoclasts. This report will detail progress we have made on other aspects of our studies which will also be important in describing the role of the glutamate receptor in bone remodeling.

Osteoclast cultures We previously cultured osteoclasts using whole marrow extracted from the long bones of mice. While this method consistently produced osteoclasts from these marrow precursors, the cultures were often inconsistent in the density of osteoclasts produced and contained a large population of non-osteoclastic cells. We now use a procedure that selects monocytic osteoclast precursors from whole marrow and yields cultures that are more densely populated with osteoclasts and contaminated with fewer non-osteoclastic cells. This will be most useful for our imaging studies as well as for harvesting RNA to assess NOS expression.

Autologous Dermal Implants Our old method of inducing osteoclast activation *in vivo* relied on the placement of keratin particles to the calvaria of mice. Keratin induced significant osteoclast recruitment within 4-5 days, but this method was marred by considerable variability due to variation in clearing and movement of the keratin particles. We now take a 5mm biopsy punch from the pinna and place it on the calvaria. By tacking the punch to the bone with a tiny drop of cyanoacrylate glue (VetBond) at one edge, we can guarantee the punch will remain in place. This method also induces osteoclast

recruitment within 5 days and has the advantage of not only providing a better simulation of cholesteatoma-induced bone resorption (for other studies), but also defines a precise area of bone for quantification. We have recently implanted a number of wild type: knockout littermate pairs (males) using mice with targeted deletions of NOS1, NOS2 and NOS3. We have also implanted a number of mice with miniosmotic pumps to deliver MK-801, a glutamate receptor antagonist, at the time of dermal implant. These mice will be used to assess the role of the glutamate receptor in osteoclast activation. These tissues are currently being sectioned for further analysis.

NOS1 Splice Variants Our lab previously identified splice variants of NOS1 that may be present and active in our cultured osteoclasts. We recently used primers designed to detect the known β and γ NOS1 splice variants in brain tissue from both wildtype and NOS1 knockout mice. These variants may provide some level of NOS1 activity even in our knockout and therefore need to be fully characterized. We are currently probing extracts from osteoclast cultures for these variants and will also assess their potential for upregulated expression following inflammatory cytokine stimulation.

AOS Research Grantee Progress Report

Genetic Analysis of Meniere's Disease

Jeffrey T. Vrabec, M.D.

Hypothesis: The etiology of Meniere's Disease (MD) remains obscure despite a century of research. Disease development likely requires a combination of genetic and environment influences.

Background: The theories for pathogenesis of MD include vascular disease, viral reactivation, autoimmune disease, metabolic dysfunction, and allergy. Each theory is sustained by a varying degree of evidence. A genetic basis for the disease is suggested by racial predilection and familial cases that display an autosomal dominant mode of transmission. The development of more efficient techniques for genetic analysis provides a new opportunity for deciphering the underlying physiology of complex diseases.

Single nucleotide polymorphisms (SNPs) occur frequently across the entire human genome. These markers can be used to compare population samples for genotype differences, either using SNPs dispersed across the entire genome or concentrated in specific genes. This preliminary investigation employs a candidate gene approach in a case-control format.

Methods: Real-time fluorescence PCR is carried out using commercially available SNP assays. The assays include two different reporter taqman probes containing the major and minor alleles at the SNP site. SNPs that display significantly different genotypes in MD patients versus controls are sought. Initial genes selected for study represent cellular factors associated with herpes simplex virus (HSV) susceptibility and reactivation.

Another gene of interest is COCH, which has been associated with familial cases of vestibular dysfunction. It is postulated that the vestibular dysfunction is consistent with MD. There are five known mutations of the gene, all presumed to alter function of the inner ear specific cochlin protein. The prevalence of these mutations in sporadic cases of MD has not been defined. In addition to examining several SNP sites in this gene, a second objective is to sequence DNA from patients with MD to determine prevalence of the known COCH mutations.

Results: To date, 25 SNPs have been evaluated in 10 candidate genes. Five of the SNPS are suggestive of an association (genotype difference $p<0.08$). These five SNPs are concentrated in three genes with a putative role in reactivation of HSV. However, the power of this observation is limited by the current sample size. More patient samples are required to confirm or refute these tentative associations. None of the known COCH mutations were identified in patient DNA sequenced to date.

Conclusions: Our investigation has identified some tentative associations between genes involved in HSV reactivation and individuals with MD, and demonstrates a lack of association between the COCH gene and sporadic cases of MD. These observations require additional study for confirmation. Specifically, a larger population sample of affected patients and controls is required to minimize the possibility of a false positive association. In the remainder of the funding period, we plan to obtain additional samples for analysis and will investigate more genes involved in HSV reactivation and candidate genes based on other theories of pathogenesis (e.g. migraine).

AOS Research Grantee Progress Report

Role of Noggin in Ear Development

Margaret I. Lomax, Ph.D.

Several autosomal dominant human syndromes are known to cause conductive hearing loss due to stapes ankylosis, the fusion of the middle-ear ossicle to the oval window of the cochlea. These syndromes include proximal symphalangism (SYM1) and multiple synostosis (SYNS1) syndromes, whose principal features are multiple joint fusions and conductive hearing loss caused by stapes ankylosis. Dominant missense mutations in the human *NOGGIN* gene (*NOG*) have been identified in several unrelated families with either SYM1 or SYNS1. Noggin is one of the most powerful antagonists of bone morphogenetic proteins (BMPs) and decreased noggin levels would be expected to affect development of joints, the skeleton, and the bony structures of the ear. Dr. Lesperance and her colleagues identified chain termination mutations in the *NOG* gene two families with conductive hearing (Brown et al., 2002, 2003). The clinical features of affected family members indicated that the conductive hearing loss was only one feature of a syndrome that includes congenital stapes ankylosis, broad thumbs and toes, hyperopia and skeletal anomalies (SABTH), but did not involve symphalangism. They identified a chain termination (nonsense) mutation in the *NOG* gene in Family 16 and an insertion mutation that leads to premature chain termination in another family (Family G). Thus human *NOG* mutations can cause at least three different syndromes involving skeletal abnormalities, underscoring the role of noggin in development of joints, the skeleton, and the bony structures of the ear. As a first step in understanding how noggin affects BMP signaling and subsequent development of bony structures of the ear, including the stapes and otic capsule, we have begun to examine expression of the mouse *Nog* gene during normal ear development by in situ hybridization (ISH). Using a DIG-labeled riboprobe to mouse *Nog*, we performed ISH on parasagittal sections of embryonic day 13.5 (E13.5) mouse embryos. We detected expression of *Nog* in the developing ribs and in Meckel's cartilage. We also performed ISH on sections through the head region at a later stage (E15.5). At E15.5, we observed low level expression of Nog in Meckel's cartilage, strong expression in the stapes, and also the outer wall of the cochlea. Additional ISH studies will include Bmp4 and other genes that affect development of the stapes and otic capsule, such as *Brn4*. These studies are the first to demonstrate the sites of expression of Nog in the branchial arches and developing ossicles. We also want to understand the structure-function relationships between the mutations in the human *NOG* gene and the effects of these chain terminating

mutations on Noggin protein. The initial experiments were designed to test the stability of the truncated NOG proteins. We transfected both wild-type and mutant NOG cDNAs, subcloned into the eukaryotic expression vector pcDNA3.1-V5-His, into COS7 cells. We have not been able to detect either the wild-type or mutant epitope-tagged Nog proteins on Western blots. These results are inconclusive, since we know that the wild-type NOG protein should be stably expressed. We are continuing to test the stability of the truncated Nog proteins by cloning into different expression vectors. If the truncated Nog proteins prove to be unstable, this would support a model of haploinsufficiency for the human NOG STABTH syndrome.

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Died: Date of death unknown

Howard P. House, MD
Active 1947
Senior 1975
Died: 8/1/2003

Franklin M. Rizer, MD
Active 1999
Died: 3/20/2003

Jack Pulec, MD
Active 1969
Died: 12/20/2003

William W. Montgomery, MD
Active 1975
Senior 1997
Died: 11/7/2003

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