PROGRAM and ABSTRACTS

of the

One Hundred Thirty-Ninth
Annual Meeting

AMERICAN OTOLOGICAL SOCIETY, INC.

May 20-21, 2006

The Hyatt Regency Hotel
Chicago, Illinois

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JULY 1, 2005- JUNE 30, 2006

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Credit Statement:
The American Otological Society designates this educational activity for a maximum of 8 AMA PRA Category 1 Credit(s)™. Physicians should only claim credit commensurate with the extent of their participation in the activity.

Certificate of Attendance will be issued at the close of the meeting upon completion of the questionnaire required by us for the certifying organizations.

AMERICAN OTOLOGICAL SOCIETY, INC.

MISSION STATEMENT

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

- to advance and promote medical and surgical otology/neurotology including the rehabilitation of the hearing and balance impaired.
- to encourage, promote, and sponsor research in otology/neurotology 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.

Goals & Objectives: The overall goal of this course is to provide up-to-date information pertaining to advances in the understanding and management of otologic and neurotologic disorders. The **target audiences** are otologists, neurotologists, and otolaryngologists with specific interests in otologic and neurotologic disorders.

After attending this meeting, the attendees will have a better understanding of

- sensorineural hearing loss (SNHL) and its effects on speech recognition and music appreciation.
- the challenges of SNHL rehabilitation.
- surgical options in managing otosclerosis.
- advances in imaging the temporal bone and cerebellopontine angle in detecting pathology involvement of neurovascular structures.

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

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In accordance with the ACCME Essential Areas and Policies, it is the policy of the American Otological Society to ensure balance, independence, objectivity and scientific rigor in all of its educational activities. All faculty participating in the American Otological Society's sponsored activities are expected to disclose to the audience the existence of any significant financial or other relationships with the manufacturer(s) of any commercial product(s) or provider(s) of any commercial service(s) discussed in an educational presentation. The purpose of this form is to identify and resolve all potential conflicts of interests that arise from financial relationships with any commercial or proprietary entity that produces healthcare-related products and/or services relevant to the content you are planning, developing, or presenting for this activity. This includes any financial relationships within the last twelve months, as well as known financial relationships of your spouse or partner. The intent of this policy is not to discourage speakers who have relationships with commercial entities from presenting, but to identify these relationships to the listeners so that they may form their own judgments. It remains for the audience to determine whether the speaker's outside interest may reflect a possible bias in either the exposition or the conclusions presented. **Failure to disclose this information on submission forms, or failure to return this disclosure form will result in exclusion from this activity and from future CME activities for up to two years.** The American Otological Society is committed to the non-promotional advancement of knowledge and science and to a free exchange of medical education in otology and neurotology.

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)

FACULTY DISCLOSURES

The following faculty disclose

Thomas J. Balkany, MD—Cochlear Americas - Consultant, Advanced Bionics Corp - Research Support, Med El Corporation - Research Support
Jill B. Firszt, PhD—Advanced Bionics Corp - Advisory Board Member, Research grant recipient; Cochlear Corp - Advisory Board Member
Charles M. Luetje, MD—Cochlear Americas - Medical Advisory Board
Michael J. McKenna, MD– Gyrus ENT-Royalty-Prosthesis
Joseph B. Nadol, Jr., MD- Gyrus ENT Content Royalty-Prosthesis

The following faculty have nothing to disclose

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John P. Carey, MD
Matthew J. Carfrae, MD
Arthur M. Castilho, MD
Robert J. Caughey, MD
Dylan K. Chan, PhD
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Michael McKenna, MD
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Marcus W. Moody, MD
Luc G. Morris, MD
John M. Ryzenman, MD
Masafumi Sakagami, MD, PhD
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John W. Seibert, MS, MD
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Karen B. Teufert, MD
Haruo Takahashi, MD
Keith Trimble, MD
Neel Varma, MD
Frank M. Warren, MD

The following faculty did not disclose at time of publication
Douglas E. Mattox, MD
Beverly Wright, PhD

NOTES

SATURDAY, May 20, 2006

REGISTRATION – 12:00 Noon

BUSINESS MEETING – 12:30 pm
ROOM: Grand Ballroom AB
(Restricted to Members)

Minutes of the Annual Meeting 2005

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 Ballroom AB
(Open to Non-Members)

1:00 pm **Remarks by the President**
John K. Niparko, MD

Presidential Citation
Malcolm D. Graham, MD
Paul R. Kileny, PhD

1:10 pm **Introduction of Guest of Honor**
Richard A. Chole, MD, PhD

Bacterial Biofilms: The Source of Tissue Destruction in Cholesteatomas?
Richard A. Chole, MD, PhD

Chronic Suppurative Otitis Media Surgery

Moderators: *Edwin M. Monsell, MD, PhD*
Leonard P. Rybak, MD, PhD

1:22 pm **Simple Underlay Myringoplasty Which Is Commonly Performed in Japan**
Masafumi Sakagami, MD, PhD
Ryo Yuasa, MD
Yu Yuasa, MD

1:31 pm **Incidence of Dehiscence of the Facial Nerve in Cholesteatoma**
Marcus W. Moody, MD
Paul R. Lambert, MD

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1:40 pm **Mastoid Obliteration Combined with Soft-wall Reconstruction of Posterior Ear Canal**
Haruo Takahashi, MD
Tetsu Iwanaga, MD
Satoru Kaieda, MD
Tomomi Fukuda, MD
Hidetaka Kumagami, MD
Kenji Takasaki, MD

Novel Therapies in Otology

1:49 pm **Botulinum Toxin Injection and Surgical Intervention for Treatment of Middle Ear and Palatal Myoclonus**
John M. Ryzenman, MD
Richard J. Wiet, MD
Timothy C. Hain, MD

1:58 pm **Ototoxicity in the Guinea Pig Associated with the Oral Administration of Hydrocodone/ Acetaminophen**
Rita M. Schuman, MD
Neena Agarwal, MD
Agnes Oplatek
Michael Raffin, PhD
Sam Marzo, MD
Gregory Matz, MD

2:07 pm **The Effects of Floxin and Ciprodex on Tympanic Membrane Perforation Healing**
Jeffrey A. Buyten, MD
Matthew Ryan, MD

2:16 pm **Protection Against Cisplatin-Induced Ototoxicity by AAV-Mediated Delivery of the X-linked Inhibitor of Apoptosis (XIAP)**
Dylan K. Chan, PhD
David M. Lieberman, BA
Sergei Musatov, PhD
Samuel H. Selesnick, MD
Michael G. Kaplitt, MD, PhD

2:25 pm **Percutaneous Cochlear Access Using Bone-Mounted, Customized Drill Guides: Demonstration of Concept In Vitro**
Frank M. Warren, MD
Robert L. Labadie, MD, PhD
J. Michael Fitzpatrick, PhD

NOTES

2:34 pm Discussion

2:45 pm Break with Exhibitors

Otosclerosis Surgery

Moderators: *Sujana S. Chandrasekhar, MD*
D. Bradley Welling, MD, PhD

3:15 pm **Stapedectomy: Demographics in 2005**
Robert J. Caughey, MD
Geoffrey B. Pitzer, BS
Bradley W. Kesser, MD

3:24 pm **Current Otologic Opinion on theTreatment of Hearing Loss in Patients with Intermittent Disequilibrium**
John W. Seibert, MS, MD
Christopher J. Danner, MD
John L. Dornhoffer, MD
Jeffrey P. Harris, MD, PhD

3:33 pm **Magnetic Properties of Middle Ear and Stapes Implants in a 9.4 Tesla Magnetic Resonance Field**
Michael H. Fritsch, MD
Jason J. Gutt, MD
Ilke Naumann, MD

3:42 pm **Panel**: **Challenges in Stapes Surgery**
Moderator: *Michael J. McKenna, MD*
Participants:
Joseph B. Nadol, Jr., MD
Sujana S. Chandrasekhar, MD
Moises A. Arriaga,MD
D. Bradley Welling, MD, PhD
Antonio De La Cruz, MD

Advances in the Assessment & Management of Vestibular Disorders

4:18 pm **Significance of Bilateral Caloric Loss**
Neel Varma, MD
Brian W. Blakley, MD, PhD, FRCSC

4:27 pm **Semicircular Canal Function before and after Surgery for Superior Canal Dehiscence**
John P. Carey, MD
Americo A. Migliaccio, PhD
Lloyd B. Minor, MD

NOTES

4:36 pm	**Transmastoid-Translabyrinthine Labyrinthectomy versus Translabyrinthine Vestibular Nerve Section: Patient Survey of Postoperative Vertigo and Imbalance** *Karen B. Teufert, MD* *Antonio De la Cruz, MD* *Karen I. Berliner, PhD*
4:45 pm	**Survey of Meniere's Disease in a Subspecialty Referral Practice** *Lawrence M. Simon, MD* *Jeffrey T. Vrabec, MD* *Newton J. Coker, MD*
4:54 pm	Discussion
5:00 pm	Adjournment
5:10 pm	Group Photograph (AOS Members) *Location to be announced*

Sunday, May 21, 2006

REGISTRATION – 7:00 am

BUSINESS MEETING – 7:00 am
ROOM: Grand Ballroom AB
(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-HNS

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 Ballroom AB

Moderators: *Herman A. Jenkins, MD*
Seth Rosenberg, MD

Advances in Prosthetic Approaches to Hearing Loss

7:30 am **Results from the Nucleus® Freedom Clinical Trial**
Thomas J. Balkany, MD
Christine Menapace, MS, CCC-A
Annelle V. Hodges, PhD, CCC-A
Stacy L. Payne, AuD
Linda A. Hazard, MS, CCC-A
Fred F. Telischi, MEE, MD

7:39 am **Current Steering and Spectral Resolution in the Advanced Bionics Cochlear Implant**
Jill B. Firszt, PhD
Dawn B. Koch, PhD
Mark Downing, PhD
Leonid Litvak, PhD

7:48 am **Hybrid Cochlear Implantation—Preliminary Clinical Results**
Charles M. Luetje, MD
Bradley S. Thedinger, MD
Lisa R. Buckler, MA, CCC-A
Kristen L. Dawson, MA, CCC-A
Kristin L. Lisbona, MA, CCC-A

7:57 am **Outcomes in Speech Perception Following Left and Right-Sided Cochlear Implantation**
Luc G. Morris, MD
Pavan S. Mallur, MD
J. Thomas Roland, Jr., MD
Susan B. Waltzman, PhD
Anil K. Lalwani, MD

8:06 am **Morphological Changes Following Partial Cochlear Implantation in the Animal Model**
Arthur M. Castilho, MD
Ricardo F. Bento, MD, PhD
Raimar Weber, MD

8:15 am **Intracranial Complications Following Cochlear Implantation**
Kelley M. Dodson, MD
Patrick G. Maiberger, BA
Aristides Sismanis, MD

8:24 am **Anatomical Vibration Considerations in Fully Implantable Microphones**
Herman A. Jenkins, MD
James Kasic, MS
Nicholas Pergola, MS

8:33 am **Bone-Anchored Hearing Aids: Incidence and Management of Postoperative Complications**
J. Walter Kutz, Jr., MD
John W. House, MD

Basic Science Seminar

Audition: Peripheral & Central Mechanisms

8:42 am **How We Hear, How We Listen Participants**
Bradford J. May, PhD
Beverly Wright, PhD
Charles Limb, MD

9:36 am Discussion

9:45 am Break with Exhibitors

Advances in Imaging

Moderators: *Lloyd B. Minor, MD*
Samuel H. Selesnick, MD

10:15 am **3-D Virtual Model of the Human Temporal Bone: A Stand-Alone, Down-Loadable Teaching Tool**
Saumil N. Merchant, MD
Haobing Wang, MA
Clarinda Northrop, BS
Barbara Burgess, BS
M. Charles Liberman, PhD

10:24 am **3 Tesla MRI Evaluation of Meniere's Disease**
Matthew J. Carfrae, MD
Steven M. Parnes, MD
Adrian Holtzman, MD
Fred Eames, MD
Allison Lupinetti, MD

10:33 am **Sigmoid Sinus Diverticulum Causing Pulsatile Tinnitus: A Novel Radiologic Finding and Proposed Surgical Treatment**
Douglas E. Mattox, MD
Kristen J. Otto, MD

10:42 am **CT and/or MRI before Pediatric Cochlear Implantation? Developing an Investigative Strategy**
Keith Trimble, MB, FRCS
Adrian James, MA, FRCS
Susan Blaser, MD, FRCPC
Blake Papsin, MD, MSc, FRCSC

10:51 am **Guest Speaker: Advances in High Resolution CT & MR Imaging of the Temporal Bone & Cerebellopontine Angle**
H. Ric Harnsberger, MD

Advances in the Treatment of Skull Base Neoplasms

11:36 am **Intracranial Schwannomas of the Lower Cranial Nerves**
John P. Leonetti, MD
Douglas A. Anderson, MD
Sam J. Marzo, MD
Thomas C. Origitano, MD, PhD
Mobeen Shirazi, MD

11:45 am	**Prevention and Treatment of Cerebrospinal Fluid Leak Following Translabyrinthine Acoustic Tumor Removal** *Jose N. Fayad, MD* *Marc S. Schwartz, MD* *Derald E Brackmann, MD* *William H. Slattery, MD*
11:54 am	Discussion
12:00 pm	Introduction of Incoming AOS President Antonio De La Cruz, MD
6:30 pm	President's Reception & Banquet (Members and Invited Guests Only)

2006 Program Advisory Committee

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COSM 2007
140th AOS Annual Meeting
April 27-28, 2007
Manchester Grand Hyatt
San Diego, CA

Abstract Deadline: October 15, 2006

Abstract submission form
Website—www.americanotologicalsociety.org
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Journal Requirements
All abstract submissions must meet Journal requirements. To see those requirements, please consult "Instructions for Authors" in the printed Journal or online at www.otology-neurotology.org

Manuscripts must be submitted electronically to the Journal no later than two weeks before the presentation. One copy of the manuscript is to be submitted electronically or mail CD to the AOS Administrative Office.

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Simple Underlay Myringoplasty Which Is Commonly Performed In Japan

Masafumi Sakagami, MD, PhD
Ryo Yuasa, MD, Yu Yuasa, MD

Objective: To introduce simple underlay myringoplasty (SUM) which is commonly performed in Japan.

Study design: retrospective

Settings: tertiary referral center

Patients: 423 ears with perforated ear drum underwent SUM at Sendai Ear Surgicenter from 2000 to 2004. They aged from 4 to 87 years (mean: 46.0 years). The surgical indications were for cases without cholesteatoma, with hearing gain in a paper patch test, and with no shadow in the tympanic cavity on CT.

Interventions: Through the ear canal, the margin of the perforation was removed with a fine pick under local anesthesia. A connective tissue obtained from the retroauricular region was inserted through perforation. The stretched graft was gently lifted to make a reliable contact with the edge of the perforation, and a few drops of fibrin glue were applied to the contact area. There was no packing in the external canal. If the perforation was left, re-closure was attempted at the office by using the patient's frozen material.

Main outcome measures: rate of closure of perforation
Results: Overall rate of closure was 341/423 (80.6%), and that after re-closure was finally 404/423 (95.5%). In 82 ears with failure of closure, the initial size of perforation was small in 46 ears, middle in 26 ears, large in 9 ears, and multiple in 1 ear.

Conclusions: SUM has been spread into all over Japan for the last 10 years because it was a simple procedure with fibrin glue and showed a high closure rate of the ear drum.

Incidence of Dehiscence of the Facial Nerve in Cholesteatoma

Marcus W. Moody, MD; Paul R. Lambert, MD

Objective: To determine the incidence and location of dehiscence of the facial nerve in patients with cholesteatoma.

Study Design: Retrospective case series.

Setting: Tertiary referral centers.

Patients: Charts and operative details from 1287 chronic ear cases performed by a single surgeon were reviewed for anatomic details regarding the facial nerve. The study group was limited to 376 ears in which cholesteatoma was confirmed at the time of surgery.

Main Outcomes Measure: Facial nerve dehiscence was graded as present or absent for both the tympanic and the mastoid segments; the location of dehiscence in the tympanic segment was further characterized as above the oval window, anterior to the oval window, posterior to the oval window or entirely dehiscent. Adherence of cholesteatoma to any area of dehiscence was noted.

Results: There were no cases of mastoid segment dehiscence. The tympanic segment was dehiscent in 25% of patients in the study group. Of those, 18% were dehiscent anterior to the oval window, 27% above the oval window, 14% posterior to the oval window, and 41% were entirely dehiscent. Cholesteatoma was directly adherent to the facial nerve in 21% of these cases.

Conclusions: This study represents the largest group of patients evaluated to date for dehiscence of the facial nerve in the setting of cholesteatoma. The most common variant found was complete dehiscence of the entire tympanic segment, followed by dehiscence above the oval window.

Mastoid Obliteration Combined with Soft-wall Reconstruction of Posterior Ear Canal

Haruo Takahashi, MD; Tetsu Iwanaga, MD
Satoru Kaieda, MD; Tomomi Fukuda, MD
Hidetaka Kumagami, MD; Kenji Takasaki, MD

Objective: To determine the clinical efficacy of the combined procedure of mastoid obliteration and soft-wall reconstruction of the posterior ear canal.

Study design: retrospective case review was done.

Setting: Tertiary referral centers

Patients: Ninety six patients (98 ears) with their age ranging from 5 to 82 (average 51.3), including 62 ears with chronic otitis media (COM) with cholesteatoma, 18 ears with non-cholesteatomatous COM, 14 ears with postoperative cavity problem, and 4 ears with adhesive-type COM

Intervention(s): all the patients had soft-wall reconstruction of the posterior ear canal and mastoid obliteration using mainly bone powder following mastoidectomy, and were followed more than an year.

Main outcome measure(s): Clean and dry condition was defined as success, and any of the following conditions including pocket formation, accumulation of debris or excessive crust, persistent wet condition, exposure of obliterated material was defined as failure.

Results: Overall success rate was 76.5% (75/98), and fresh cases showed better success rate (84.8%) than those with multiple surgeries (69.2%). Among unsuccessful cases, crust accumulation and persistent wet condition were observed most (7 ears each) followed by exposure of the obliterated material (5 ears), while only 2 ears showed pocket formation. Success rate showed no difference according to whether artificial material (apatite ceramics chip) was used in addition to bone powder or not. In 60 ears on which postoperative hearing was assessed, 41.7% showed less than 15 dB of air-bone gap (ABG), and 61.7% showed less than 20 dB of ABG.

Conclusions: Mastoid obliteration with bone powder in combination with soft-wall reconstruction of the posterior ear canal appeared a useful method for obliterating mastoidectomized cavity especially for prevention of postoperative pocket formation.

Botulinum Toxin Injection and Surgical Intervention for Treatment of Middle Ear and Palatal Myoclonus

John M. Ryzenman MD, Richard J. Wiet MD
Timothy C. Hain MD

Objectives: To report on the use and present video documentation of Botox and surgical therapy for the management of objective tinnitus due to middle ear and palatal myoclonus.

Study Design: Retrospective case review

Setting: Tertiary neurotologic private practice

Patients: A retrospective chart review was performed for patients evaluated from 2002 to 2005 for tinnitus. Of 626 patients, 5 patients (one female and four males, ages 13-52 years) were diagnosed with non-pulsatile objective tinnitus, often described as a "clicking sound". Bilateral symptoms were present in three patients.

Interventions: Three patients were diagnosed with palatal myoclonus, of these one had obvious tympanic membranes contractions and levator palatini muscles spasms. Two patients had middle ear myoclonus (stapedial or tensor tympani myoclonus). All patients with palatal myoclonus underwent bilateral injections of the soft palate with Botox A (10-20 units each side). One patient underwent staged sectioning of the tensor tympani tendon followed by sectioning of the stapedial tendon. One patient was managed conservatively.

Results: All patients who received Botox injections reported complete relief for 3-5 months within 10 days. One of these patients experienced transient velo-palatal insufficiency. The surgically treated patient experienced 70% relief of symptoms following sectioning of the tensor tympani tendon, with complete resolution after sectioning of the stapedius tendon. The conservatively managed patient has persistent symptoms.

Conclusion: Middle ear and palatal myoclonus are well known etiologies of objective tinnitus that are frequently under diagnosed. These patients can be successfully treated with either office-based Botox injections or a stepwise surgical approach.

Ototoxicity in the Guinea Pig Associated with the Oral Administration of Hydrocodone/Acetaminophen

Rita M. Schuman, MD; Neena Agarwal, MD
Agnes Oplatek; Michael Raffin, PhD
Sam Marzo, MD; Gregory Matz, MD

Hypothesis: This prospective study intended to investigate and confirm that the daily oral administration of high doses of hydrocodone/acetaminophen caused ototoxicity in the guinea pig.

Background: Hydrocodone and acetaminophen taken in combination is a frequently prescribed and well tolerated analgesic. However, case reports have recently been published demonstrating a rapidly progressive sensorineural hearing loss associated with overuse or abuse of this medication. Currently, there are no published animal studies confirming this. This animal study intended to further investigate and confirm this hypothesis.

Methods: 30 female Hartley guinea pigs were randomly assigned to 2 groups of 15. The experimental group was given daily oral doses of hydrocodone/acetaminophen and the control group a daily placebo. All 30 guinea pigs were tested with baseline ABRs on day 0, and post drug/ placebo administration on day 30 and 60.

Results: There was no significant difference between the control and experimental baseline ABR thresholds with mean hearing thresholds of 11.0 dB and 12.6 dB respectively. The experimental group had average ABR threshold of 25 dB at day 30 and 28.3 dB at day 60. The control group had average ABR threshold of 18.6 dB at day 30 and 21.4 dB at day 60. The experimental group demonstrated a greater significant average threshold shift as compared to the control group with a p value < 0.02.

Conclusion: Oral administration of hydrocodone/ acetaminophen in the guinea pig caused a significant hearing threshold shift as compared to normal controls.

The Effects of Floxin and Ciprodex on Tympanic Membrane Perforation Healing

Jeffrey A. Buyten, MD; Matthew Ryan, MD

Hypothesis: Exposure to Ciprodex, but not Floxin, prolongs tympanic membrane (TM) healing.?

Background: Exposure to hydrocortisone has been shown to delay TM wound healing. No published studies have compared the effects of Ciprodex and Floxin on TM healing.

Methods: Non-infected tympanic membrane perforations were created in thirty rats. The rats were split into three groups and Ciprodex, Floxin or normal saline drops were instilled for seven days. Tympanic membrane healing was determined at specified intervals using photographic documentation and blinded observers.

Results: The normal saline control and Floxin exposed TMs healed at similar rates. There was a statistically significant delay in TM healing in the Ciprodex exposed TMs by post-operative day 10. However, All TM perforations were healed by postoperative day 20.

Conclusion: Ciprodex delays healing of experimental tympanic membrane perforations, but the brief exposure in this study did not cause persistent perforation.

Protection Against Cisplatin-Induced Ototoxicity by AAV-Mediated Delivery of the X-linked Inhibitor of Apoptosis (XIAP)

Dylan K. Chan, PhD; David M. Lieberman, BA
Sergei Musatov, PhD; Samuel H. Selesnick, MD
Michael G. Kaplitt, MD, PhD

Cisplatin, an effective chemotherapeutic agent, is limited clinically owing to ototoxicity associated with the apoptosis of cells in the inner ear.

In this study, we assessed the role of the X-linked inhibitor of apoptosis protein (XIAP) in regulating and preventing cisplatin-mediated hearing loss and outer-hair-cell death in rats. We administered unilaterally through the round-window membrane adeno-associated viruses (AAV) harboring genes encoding wild-type XIAP, YFP, or either of two XIAP mutants— one deficient in caspase inhibition, and the other additionally deficient in the binding of the upstream pro-apoptotic factors Smac and Omi. After a three-day systemic course of cisplatin, the uninjected ears of all animals demonstrated significant hearing loss, as measured by auditory-brainstem response (ABR) thresholds, and outer-hair-cell loss, as detected by staining of hair bundles and cuticular plates.

By both measures, ototoxicity was most profound at high frequencies. Whereas injection of AAV harboring YFP had no effect, ears injected with wild-type XIAP exhibited 68% less ABR threshold elevation at 32 kHz and 50% less basal-turn outer-hair-cell loss compared to the contralateral, untreated ears, demonstrating that XIAP can protect against cisplatin-mediated ototoxicity. Furthermore, the XIAP mutant lacking both anti-caspase and Smac/Omi binding activity showed no protection, whereas the mutant lacking only anti-caspase activity, but retaining the ability to bind Smac/Omi, significantly protected against hearing loss and hair-cell death, shedding light on the basic mechanism by which Smac and XIAP regulate apoptosis in the inner ear.

These results suggest that gene therapy with XIAP may be effective to protect against cisplatin-mediated ototoxicity.

8.

Percutaneous Cochlear Access Using Bone-Mounted, Customized Drill Guides: Demonstration of Concept In Vitro

Frank M. Warren, MD; Robert L. Labadie, MD, PhD
J. Michael Fitzpatrick, PhD

Hypothesis: Percutaneous cochlear access can be performed using bone-mounted drill guides custom made based on pre-intervention CT scans.

Background: We have previously demonstrated the ability to use image guidance to obtain percutaneous cochlear access in vitro (Otology & Neurotology 2005; 26:557-562). A simpler approach that has far less room for application error is to constrict the path of the drill to pass in a pre-determined trajectory using a drill guide.

Methods: Cadaveric temporal bone specimens (n=8) were affixed with three bone-implanted fiducial markers. Temporal bone CT scans were obtained and used in planning a straight trajectory from the mastoid surface to the cochlea without violating the facial nerve, horizontal semicircular canal, external auditory canal, or tegmen. These surgical plans were used in rapid prototyping customized drill guides (FHC Inc.; Bowdoinham, ME) to mount onto anchor pins previously used to mount the fiducial markers. Specimens then underwent traditional mastoidectomy with facial recess. The drill guide was mounted and a 2mm drill bit was passed through the guide across the mastoid and facial recess. The course of the drill bit and its relationship to the aforementioned vital structures were photo documented.

Results: Eight cadaveric specimens underwent the study protocol. For all specimens, the drill bit trajectory was accurate; it passed from the lateral cortex to the cochleostomy site without compromise of any critical structures.

Conclusions: Our study demonstrates the ability to obtain percutaneous cochlear access in vitro using customized drill guides manufactured based on pre-intervention radiographic studies.

Stapedectomy -Changing Practice Patterns

Michael J. Ruckenstein MD, MSc; Alexandra Tuluca BA
Jeffery P. Staab MD, MS

Objectives: To demonstrate that (1) Recent graduates of training programs in OTO-HNS are less likely to recommend/perform stapedectomy than more senior otolaryngologists. (2) When surgery is recommended, referral is most commonly made to an otologist/ neurotologist.

Study Design: Survey of 500 regional otolaryngologists pertaining to their treatment of patients with hearing loss secondary to otosclerosis.

Results: Data were obtained from 179 general otolaryngologists treating adults and children in solo or group private practices in the Pennsylvania and New Jersey. The majority (66%) diagnosed 1 – 5 new cases/ year. Ten percent of surgeons graduating in the 1970's, 25% graduating in the 1980's, 50% graduating in the 1990's, and 90% of graduates in 2000's never performed stapedectomy as part of their practices ($p < 0.001$). Similarly, a significant number of surgeons who formerly performed stapedectomies no longer do this surgery. A trend toward greater use of hearing aids for the treatment of otosclerosis was seen in more recent graduates ($p > 0.08$). When surgery was recommended, otologists/neurotologists received the majority of referrals from the practitioners surveyed.

Conclusions: Stapedectomy is performed and recommended less often by more recent graduates of otolaryngology training programs. Given that the majority of referrals for stapedectomy are made to otologists/neurotologists, current fellowship requirements should likely include stapedectomy as a component of training.

Current Otologic Opinion on theTreatment of Hearing Loss in Patients with Intermittent Disequilibrium

John W. Seibert, MS, MD; Christopher J. Danner, MD
John L. Dornhoffer, MD; Jeffrey P. Harris, MD, PhD

Objective: There is a general unease in the otologic community when presented with a patient who has probable otosclerosis and symptoms of vertigo. Considering possible complications, otologists fall into one of three different camps: refuse to perform stapes surgery on anyone who has symptoms of vertigo, proceed with surgery only if certain criteria are met (normal ENG, quiescent period free of vertigo, etc), or perform stapedotomy regardless of vertigo symptoms.

Study Design: Survey

Methods: Our survey mailed in the spring of 2005 when out to 250 members of the American Otologic Society. A one sentence case study was presented to the respondents which described a 45 year old with history of balance problems and hearing loss suggestive otosclerosis. Participants were given the option of immediately proceeding with stapedectomy/stapedotomy or further management and work up.

Results: Sixteen (22%) of respondents said that they would proceed with stapedectomy after assuring that the presence of a balance disorder in the study patient was not due to a retrocochlear cause. Forty-nine (69%) recommended further work up or treatment that could included a diuretic trial, electrocochleography, trial of fluoride, electronystagmongraphy, and/or computed tomography scan. Looking at overall initial management, 31 (44%) would consider diuretics an initial management. Twenty-two (31%) agreed with using some form of fluoride prior to intervention. Thirty-one (43%) chose electronystagmongraphy. Twenty (28%) choose to perform electrocochleography.

Conclusions: Although opinions will differ, current standards of practice can be brought forth from these series of questions.

Magnetic Properties of Middle Ear and Stapes Implants in a 9.4 Tesla Magnetic Resonance Field

Michael H. Fritsch, MD
Jason J. Gutt, MD; Ilke Naumann, MD

Hypothesis: A 9.4 Tesla (T) Magnetic Resonance (MR) field may cause motion displacements of ME and stapes implants not previously seen with 1.5 and 3.0 T magnets.

Background: Publications have described the safety limitations of some otologic implants in 1.5, 3.0, and 4.7 T fields and resulted in several company-wide patient safety related recalls. To date, no studies have been reported for otologic implants in a 9.4 T MR field, nor have comparisons been made with 1.5, 3.0, or 4.7 T field strengths.

Methods: 23 ME and stapes prostheses were selected and exposed to 1.5, 3.0, and 9.4 T MR fields in vitro within Petri dishes and 8 of the 23 implants were further studied ex-corpus in temporal bones (TB). IRB approved.

Results: 8 prostheses grossly displaced in Petri dishes at 9.4 T, 3 of which had not previously moved in either the 1.5 or 3.0 T magnets. The 8 TB preparations showed no avulsions or motion indicators after exposures at 9.4 T.

Conclusions: ME and stapes implants can move dramatically in Petri dishes at 9.4 T, more so than at 1.5 and 3.0 T. Finding no avulsions in the TB group strongly suggests that the surgical means used to fixate ME implants to ME structures successfully overcomes the magnetic moment produced at 9.4 T. MR usage is not contraindicated by this study's findings.

12.

Significance of Bilateral Caloric Loss

Neel Varma, MD; Brian W. Blakley, MD, PhD FRCSC

Objective: To study the presentation and prognosis of persons with bilaterally reduced caloric responses.

Study Design: Retrospective database review.

Setting: Tertiary Referral Center

Methods: Data from the charts was obtained for forty-two patients who met the criteria for bilaterally reduced caloric response on ENG from 1999-2002. These patients were then followed by means of a questionnaire in 2004.

Intervention: Neither rehabilitation or antidepressant therapy was effective.

Results: Twenty-two patients presented essentially with spinning vertigo, 1 with mild turning, 21 with imbalance and 1 with pre-syncope (3 patients reported more than one type of symptom). Contrary to expectations, 32 (76%) patients reported that their dizziness was episodic or occurred in spells rather than constant dizziness. Only 50% of the patients reported some improvement that occurred after 11 +/- 12 (mean +/- s.d.) months. The patients were seen 40+/-105 months after onset of symptoms. Differences in the improvement rate for men vs. women or the presenting symptoms were not statistically significant. Neither rehabilitation treatment, antidepressants or other treatment was associated with improvement different from untreated cases.

Conclusion: Bilateral caloric loss is usually associated with prolonged impairment and is refractory to treatment. It is a significant cause of disability that otolaryngologists are in the most appropriate position to evaluate.

13.

Semicircular Canal Function Before and After Surgery or Superior Canal Dehiscence

John P. Carey, MD; Americo A. Migliaccio, PhD
Lloyd B. Minor, MD

Objective: To characterize semicircular canal function before and after surgery for superior semicircular canal dehiscence syndrome.

Study Design: Retrospective case review

Setting: Tertiary referral center

Patients: Patients with superior semicircular canal dehiscence (SCD) syndrome documented by history, sound- or pressure-evoked eye movements, vestibular evoked myogenic potential testing, and high-resolution multiplanar CT scans.

Intervention: Nine subjects with SCD had quantitative measurements of their angular vestibulo-ocular reflexes (AVOR) in response to rapid rotary head thrusts measured by magnetic search coil technique before and after middle fossa approach and repair of the dehiscence. In 7 subjects the dehiscence was plugged, and in 2 it was resurfaced.

Main Outcome Measures: AVOR gains (eye velocity/ head velocity) for excitation of each of the semicircular canals

Results: Vertigo resulting from pressure or loud sounds resolved in each case. Before surgery AVOR gains were normal (horizontal canals: 0.74 to 1.06; vertical canals: 0.64 to 0.96, 95% CIs) for all semicircular canals except for the affected superior canals (SCs) of 2 subjects in whom the dehiscences were = 5 mm long. AVOR gains decreased by 32% for the operated SCs (from 0.73 ± 0.17 pre-surgery to 0.50 ± 0.19 post-surgery, $p = 0.01$). Gains decreased by the same proportion after resurfacing as after plugging. AVOR gains did not change for any of the other canals.

Conclusions: Middle fossa craniotomy and repair of SCD reduces the function of the operated SC whether it is plugged or resurfaced. The surgery does not typically affect the function of the other semicircular canals.

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14.

Panel: Challenges in Stapes Surgery

Moderator: Michael J. McKenna, MD
Participants: Joseph B. Nadol, Jr., MD
Sujana S. Chandrasekhar, MD
Moises A. Arriaga,MD;
D. Bradley Welling, MD, PhD
Antonio De La Cruz, MD

Our ability to surgically restore hearing in otosclerosis calls for an understanding of the underlying pathology, anatomic variations that can hamper access, and technical aspects of footplate and prosthesis management. This panel will examine challenges to successful hearing results after stapes surgery through case presentations. Intraoperative findings and surgical options will be discussed, and the AOS audience will participate through response feedback.

15.

Transmastoid-Translabyrinthine Labyrinthectomy Versus Translabyrinthine Vestibular Nerve Section: Patient Survey of Postoperative Vertigo and Imbalance

Karen B. Teufert MD; Antonio De La Cruz MD
Karen I. Berliner PhD

Objectives: Determine frequencies and the difference in postoperative outcomes between labyrinthectomy with and without vestibular nerve section, including characteristics of postsurgical symptoms, and time course for improvement.
Study Design: Database review and patient survey.
Setting: Tertiary referral neurotologic private practice.
Patients: 292 translabyrinthine vestibular nerve sections (TLVNS) and 97 transmastoid labyrinthectomies for treatment of vertigo.
Intervention: Surgery for vertigo.
Main Outcome Measures: All patients undergoing TLVNS and transmastoid labyrinthectomy from 1974 through 2004 were identified. Frequency and relative prevalence of procedure was determined by decade. A mail questionnaire assessed frequency, severity and disability for vertigo and imbalance before and after surgery as well as the time course of improvements.
Results: Transmastoid labyrinthectomy comprised 2.7% of all surgeries for vertigo and TLVNS 8.0%. Through the decades, use of TLVNS decreased while use of labyrinthectomy increased. In preliminary analyses, no differences between groups achieved statistical significance. However, the AAO-HNS functional disability rating showed improvement for all TLVNS subjects but was not improved in 33.3% of the labyrinthectomy group. The labyrinthectomy group was more likely to rate current imbalance as extremely or quite severe (23.1% vs. 9.1%) and to rate imbalance as interfering more often (38.5% vs. 20.0%) than the TLVNS group. Class A vertigo treatment results were obtained in 84.6% and 81.8% of the two groups, respectively.
Conclusions: Both transmastoid labyrinthectomy and TLVNS provide complete control of vertigo spells in the majority (>80%) of patients. However, patients undergoing TLVNS were more likely to show improvement in functional disability and less likely to rate their current imbalance as extremely or quite severe or to have imbalance interfere in daily activities.

Survey of Meniere's Disease in a Subspecialty Referral Practice

Lawrence M. Simon, MD; Jeffrey T. Vrabec, MD
Newton J. Coker, MD

Objectives: We sought to define the prevalence of definite Meniere's Disease (MD) in a tertiary care otology practice among patients presenting with Meniere like symptoms.

Study Design: Retrospective case review.

Setting: Academic tertiary referral practice.

Patients: Patient visits using ICD-9 codes for Meniere's disease (386.0-386.04) were retrospectively reviewed. The 1995 AAO-HNS Committee on Hearing and Equilibrium guidelines were used for classification.

Main Outcome Measures: Data extracted included duration of disease, gender, laterality, comorbid conditions, and treatment administered.

Results: The prevalence of definite MD in this population was 62%. The next largest classification was cochlear hydrops (18%), consisting of patients with only cochlear symptoms. Those classified as probable are often reclassified as definite with extended follow-up. Of those with definite MD, the mean duration of disease at presentation was 4 years, 54% were female, 17% had bilateral disease, and 30% required surgical management for vertigo. Coexisting autoimmune disease and migraine were less common than in other reports. A treatment algorithm for medical and surgical management is presented.

Conclusions: The AAO-HNS guidelines produce stratification of cases according to certainty of diagnosis and severity of disease. Individuals presenting with typical symptoms frequently lack all of the criteria necessary to assign classification to the definite category. Application of consistent diagnostic criteria is essential for epidemiological, genetic, or outcomes studies of Meniere's disease.

Results from the Nucleus® Freedom Clinical Trial

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Christine Menapace, MS, CCC-A
Annelle V. Hodges, PhD, CCC-A; Stacy L. Payne, AuD
Linda A. Hazard, MS, CCC-A
Fred F. Telischi, MEE, MD

Objective: To evaluate the effects of stimulation rate and input processing on performance using measures of speech perception and subjective preference.

Study Design: Randomized, prospective, single-blind clinical study.

Setting: 14 academic and private tertiary referral centers in the U.S. and Canada.

Patients: 73 severely to profoundly hearing impaired adults.

Interventions: Subjects received a Nucleus Freedom cochlear implant (CI) and were randomly programmed at two different sets of rate: standard ACE (500Hz, 900Hz, 1200Hz) and a higher rate ACE RE (1800Hz, 2400Hz, 3500Hz) using an ABAB study design.. Subjects were blinded to the order and the stimulation rates they received as well as three input processing strategies they ranked in quiet and noise.

Main Outcome Measures: Auditory function was evaluated using the Hearing in Noise Test (HINT) sentences administered in quiet and in noise, CUNY Sentences and the Consonant Nucleus Consonant (CNC) monosyllabic words/phonemes administered in quiet. Subjective outcomes were evaluated using the Abbreviated Profile of Hearing Aid Benefit (APHAB).
Results: Data will be reported on sixty subjects who completed their six-month data point. Preliminary outcomes suggest that speech perception scores may not improve at higher rates and most subjects expressed a preference for moderate rates of stimulation. Input processing preferences vary with stimulation rate and in noise. Overall performance is superior to that achieved with the prior generation device by the same manufacturer.

Conclusions: These data suggest that higher stimulation rates do not necessarily correlate with improved performance or patient satisfaction. No single input processing strategy is ideal for patients in all listening conditions.

Current Steering and Spectral Resolution in the Advanced Bionics Cochlear Implant

Jill B. Firszt, PhD; Dawn B. Koch, PhD
Mark Downing, PhD; Leonid Litvak, PhD

Objective: The number of spectral channels is the number of discriminable pitches that can be heard as current is delivered to distinct locations along the cochlea. This study aimed to determine whether CII and HiRes 90K implant users could hear additional spectral channels using current steering. Current steering involves simultaneous delivery of current to adjacent electrodes so that stimulation can be "steered" to sites between the contacts by varying the proportion of current delivered to each electrode of a pair. Current steering may serve to increase the number of spectral channels beyond the number of fixed electrode contacts.

Setting: Fifteen tertiary care centers in the United States and Canada.

Subjects: Postlinguistically deafened adults who use the Advanced Bionics CII or HiRes 90K cochlear implants.

Study Design/Outcome Measures: After loudness balancing and pitch ranking three electrode pairs (2-3, 8-9, 13-14), subjects identified the electrode with the higher pitch while current was varied proportionally between electrodes in each pair. The proportion yielding the smallest discriminable change in pitch was defined as the spectral resolution.

Results: Data from 90 ears indicate that the number of spectral channels averages 4.0 for the basal electrode pair, 6.3 for the mid-array pair, and 5.4 for the apical pair. Assuming the number of channels on these three electrode pairs are representative of the entire array, the total potential number of spectral channels can be calculated and ranges from 7 to 451.

Conclusions: These results indicate that additional spectral resolution can be created using current steering

Hybrid Cochlear Implantation— Preliminary Clinical Results

Charles M. Luetje, MD; Bradley S. Thedinger, M.D.
Lisa R. Buckler, M.A., CCC-A,
Kristen L. Dawson, M.A., CCC-A
Kristin L. Lisbona, M.A., CCC-A

Objective: To substantiate the benefits of Hybrid cochlear implantation in patients with residual low frequency hearing.

Study Design: Prospective study of patients within a manufacturer sponsored clinical trial. Setting: Independent 501(c)(3) referral center for cochlear implantation.

Patients: Patients include those who meet the candidacy criteria for hybrid cochlear implantation. Candidacy is defined as those who have a profound hearing loss by 1500Hz and above, who also score up to 60% on CNC words in the aided condition. As of the submission of this abstract 10 patients are implanted with three more scheduled for surgery. Intervention: Pre-operative evaluation, cochlear implantation with a Cochlear Americas Hybrid cochlear implant, subsequent programming and diagnostic testing.

Main Outcome Measures: Each patient is monitored for preservation of residual hearing and to determine the benefits of high frequency electrical stimulation from the hybrid cochlear implant as measured by speech discrimination testing at quarterly intervals per protocol requirement. Results: Preliminary data on the first six subjects who have completed at least 9 months of testing at the time of submission show a range of scores. Testing includes CNC monosyllabic word testing, BKB-SIN (sentence is noise) and conventional audiometry to confirm preservation of residual hearing. Five of six patients have maintained their residual hearing and patients show a range of scores of up to 83% on CNC words when tested in the "hybrid" mode (cochlear implant + ipsilateral hearing aid).

Conclusions: Residual hearing was preserved in all subjects. However, one patient has bilateral progressive hearing loss that is considered unrelated to the surgical procedure. Audiometric results confirm simultaneous stimulation of low pitches with the hearing aid and high pitches with the cochlear implant give the patient adequate aided gain across the frequency range. Speech testing reveals increased discrimination over pre-op scores and better discrimination in noise.

Outcomes in Speech Perception Following Left and Right-Sided Cochlear Implantation

Luc G. Morris, MD; Pavan S. Mallur, MD
J. Thomas Roland, Jr., MD,
Susan B. Waltzman, PhD; Anil K. Lalwani, MD

Objective: Emerging evidence in auditory neuroscience suggests that central auditory pathways process speech asymmetrically. In concert with left cortical specialization for speech, a "right ear advantage" in speech perception has been identified. The purpose of this study is to determine if this central asymmetry in speech processing has implications for selecting the ear for cochlear implantation.

Study Design: Retrospective chart review

Setting: Academic university medical center

Patients: Post-lingually deafened adults with bilateral severe-to-profound sensorineural hearing loss (n=101).

Intervention: Cochlear implantation with the Nucleus Contour device.

Main Outcome Measurements: Patients were divided into four groups: right handed/right ear implanted, right handed/left ear implanted, left handed/right ear implanted, and left handed/left ear implanted. Postoperative pure-tone audiograms and scores on speech perception tests (HINT, CUNY quiet and in noise, CNC words and phonemes) at one year were compared using one-way analysis of variance.

Results: The four groups were equally matched in terms of age, duration of hearing loss, duration of hearing aid use, percentage implanted in the better hearing ear, and preoperative audiologic testing. Postoperatively, there were no differences between groups in hearing outcome and improvement on speech perception tests.

Conclusion: Despite central asymmetry in speech processing, our data does not support a "right ear advantage" in speech perception outcome with cochlear implantation. Therefore, among the many factors in choosing the ear for cochlear implantation, central asymmetry in speech processing is not likely to be a significant consideration.

Morphological Changes Following Partial Cochlear Implantation in the Animal Model

Arthur M. Castilho, MD; Ricardo F. Bento, MD, PhD
Raimar Weber, MD

Objectives: The objective of this study was to describe the histology and the audiological findings created by the cochlear implant electrode array when inserted at the basal turn, using an animal model (guiena pig), and correlate these findings with previous reports.

Material and Methods: Thirty female young guinea pigs were used for this investigation. They were devided in two groups. Fifteen animals had the round window opened with no implantation (control)and fifteen animals had the round window opened and inserted with a 4mm x 0,5mm silicone tube. Auditory brainstem response (tone burst) was performed prior the procedure and 3 months after, when the animals were sacrified. The organ of Corti was removed from the cochlea second turn for analysis with immunofluorescence TRITC-phalloidin reaction.

Results: The damage caused by the silicone tube insertion on the base turn of the cochlea was greater (66,7%) when compared with the control group (33,3%) p=0,25. The hair cell cilia was preserved in 40% of the animals at control group against 6,7% of implanted animals (p=0,31). The ABR was absent in 93,7% of implanted group and 60% of the control group (p=0,31).

Conclusion: The damage caused by the silicone tube can be compared with the damage caused by the cochlear implant array. When the basal turn of the cochlea is implanted the damage extends to the second turn and is greater when compared with group that had the cochlea opened but not implanted, which is important for hearing preservation purposes.

Intracranial Complications Following Cochlear Implantation

Kelley M. Dodson, MD; Patrick G. Maiberger, BA
Aristides Sismanis, MD

Objective: To describe intracranial complications following cochlear implantation in the pediatric and adult population.

Study Design: Retrospective chart review.

Patients and Setting: A chart review of the intracranial complications and their management in 322 patients undergoing cochlear implantation at a tertiary referral center was undertaken.

Main Outcome Measures: Variables including age, gender, implant manufacturer, etiology of deafness, intraoperative findings, and intracranial complications were collected and analyzed.

Results: There were 122 Nucleus-22 devices, 50 Nucleus-24 devices, 106 Med-El devices, and 32 Advanced Bionic Corporation devices in 141 adults and 181 children. There was a 7.8% overall complication rate, with the majority (64%) being related to device failure. There were 3 intracranial complications (<1%), 2 in elderly individuals and 1 in a child. Two minor dural defects with CSF leak at the site of the receiver/ stimulator recess in Med-El devices were repaired intraoperatively with temporalis fascia. One elderly patient experienced an acute extensive subdural hematoma after Nucleus-24 implantation, which was treated successfully with immediate evacuation.

Conclusions: Intracranial complication rates associated with cochlear implantation are low although potentially very serious. Surgeons should be aware of intracranial complications, especially in older individuals, and take immediate appropriate action.

Anatomical Vibration Considerations in Fully Implantable Microphones

Herman A. Jenkins, MD; James Kasic, MS
Nicholas Pergola, MS

Hypothesis: The goal of this study was to measure tissue vibration as it pertains to totally implantable microphones.

Background: Totally Implantable Hearing Devices have been desired by the hard of heaing community for some time. However, an implanted microphone must be capable of receiving acoustic signals in the presence of undesired vibration signals. In order to design an effective microphone, the level of tissue vibrations originating from anatomical sources and the implanted transducer must be understood.

Settings: University Temporal bone laboratory and Otologics LLC engineering laboratory

Methods: Using a Laser Doppler Vibrometer, microphone, and an accelerometer, tissue vibrations were measured under the following conditions; control subjects (N=6); semi implantable hearing device wearer (N=1); and cadavers implanted with a transducer (N=4).

Results: Mastoid vibration levels measured on a patient are equivalent to that in cadavers. Vibration levels do not vary significantly with respect to location on the skull next to the pinna. Anatomical noise vibrations are 20-25 dB greater in soft tissue for frequencies below 1000 Hz than on the skull whereas vibrations due to implanted transducers are 20-25 dB greater on the skull than in soft tissue inferior to the mastoid. Chewing vibrations are 10-15 dB greater than vocalization on the mastoid.

Conclusion: The cadaver is an appropriate model for transducer skull vibration studies. The greatest anatomical vibrations that an implanted microphone must overcome are due to vocalization in the soft tissue inferior to the mastoid and chewing vibrations on the mastoid. If the implantable microphone is placed on the skull near the pinna it makes little difference where it is placed.

Bone-Anchored Hearing Aids: Incidence and Management of Postoperative Complications

J. Walter Kutz, Jr., MD; John W. House, MD

Objectives: Determine the incidence of complications associated with implantation of the bone-anchored hearing aid (BAHA) and the management of these complications.

Study design: Retrospective case review.

Setting: Tertiary referral center.

Patients: 124 consecutive patients between 10/25/01 and 6/29/05 underwent implantation of a BAHA. The majority of patients had unilateral profound sensorineural hearing loss after removal of an acoustic neuroma (59.7%) with the next most common etiology of deafness secondary to sudden sensorineural hearing loss (14.5%).

Intervention(s): Implantation of a BAHA.

Main Outcome Measure(s): Incidence of complications occurring after implantation of a BAHA.

Results: There were no intraoperative complications. Significant postoperative complications requiring intervention occurred in 18 (14.5%) patients. Problems with loosening of the titanium abutment occurred in 7 patients, with 3 requiring revision surgery. 1 patient elected not to have the device reimplanted. 5 patients developed a local wound infection requiring oral antibiotics with 1 patients requiring debridement in the operating room. Skin overgrowth of the abutment occurred in 4 patients, and all 4 patients required revision surgery. 1 patient had postoperative bleeding that was successfully treated with a pressure dressing and 1 patient developed partial flap necrosis.

Conclusions: Significant complications are uncommon after implantation of a BAHA, however, these complications may require local wound care, antibiotics, or revision surgery.

25.

How we hear, how we listen

Bradford J. May, PhD; Beverly Wright, PhD
Charles J. Limb, MD

The auditory system separates the elemental frequency and temporal components of sound into parallel processing streams to enhance the coding of perceptual attributes such as loudness, pitch, and timing. These processing streams enable a listener to establish the meaning of complex sounds such as speech and music. Sensorineural hearing loss not only lessens our sensitivity to the presence of sound, it impedes our ability to resolve the frequency changes that convey this crucial information. Consequently, an impaired listener cannot be restored to normal function by simply making sounds louder. Our presentation will begin with a review of frequency coding and auditory cortical activation patterns in the normal auditory system and discuss how these processes are altered by sensorineural hearing loss. We then will evaluate the strengths and weaknesses of current assistive devices, such as cochlear implants, from the perspective of frequency coding. Finally, we will report recent data showing the influence of training on the perception of frequency information in humans with normal hearing, and relate those results to possible therapeutic training regimens to improve the benefits of hearing aids in impaired listeners.

A Stand-Alone, Down-Loadable Teaching Tool

Saumil N. Merchant, MD; Haobing Wang MA
Clarinda Northrop BS; Barbara Burgess BS
M. Charles Liberman PhD

Objective: To develop a 3-dimensional (3-D) virtual model of a normal human temporal bone based on serial histological sections.

Background: The 3-D anatomy of the human temporal bone is complex, and learning it is a challenge for students in basic science and in clinical medicine.

Methods and Results: Every fifth histological section from a 14 year old male was digitized and imported into a general purpose 3-D rendering and analysis software package called Amira (version 3.1). The sections were aligned, and anatomical structures of interest were segmented. The 3-D model is a surface rendering of these structures of interest, which currently includes the bone and air spaces of the temporal bone, the perilymph and endolymph spaces, the sensory epithelia of the cochlear and vestibular labyrinths, the ossicles and tympanic membrane; the middle-ear muscles, the carotid artery, and the cochlear, vestibular and facial nerves. For each structure, the surface transparency can be individually controlled, thereby revealing the 3-D relations between surface landmarks and underlying structures. The 3-D surface model can also be "sliced open" at any section, and the appropriate raw histological image superimposed on the cleavage plane.

Conclusions: This model is a powerful teaching tool for learning the complex anatomy of the human temporal bone and for relating the 2-D morphology seen in a histological section to the 3-D anatomy. The model can be downloaded from our website at: <http://epl.meei.harvard.edu/~hwang/3Dviewer/3Dviewer.html>, packaged within a cross-platform freeware 3-D viewer, which allows full rotation and transparency control.

Acknowledgments: Supported by NIDCD.

27.

3 Tesla MRI Evaluation of Meniere's Disease

Matthew J. Carfrae, MD; Steven M. Parnes, MD
Adrian Holtzman, MD; Fred Eames, MD
Allison Lupinetti, MD

Objective: To determine if three tesla MRI with delayed contrast imaging will have sufficient anatomic resolution to image the intracochlear fluid spaces (i.e. the scala tympani, scala media, and scala vestibuli) of the inner ear, and identify endolymphatic hydrops in vivo.

Study Design: Prospective, nonrandomized

Setting: Tertiary medical center

Patients: Normal subjects without previous otologic history, and patients that meet the diagnostic criteria for unilateral definite Meniere's disease are included in this study.

Intervention: Normal subjects underwent serial 3T MRI scanning after the administration of gadodiamide IV contrast agent. MRI Region of Interest (ROI) signal intensity was used to determine the diffusion of gadodiamide into the perilymphatic fluid spaces over time. This data was then applied to delayed contrast imaging of subjects with unilateral Meniere's disease.

Main Outcome Measure: Post-contrast MRI signal intensity of the intracochlear fluid spaces.

Results: Perilymphatic fluid contrast enhancement was noted after the administration of contrast, allowing for the differentiation of intracochlear fluid spaces on 3T MRI. The perilymph appeared to be preferentially enhanced over the endolymph.

Conclusion: Delayed post-contrast imaging of the inner ear with 3T MRI allows for spatial resolution and differentiation of the intracochlear fluid spaces to allow for identification of endolymphatic hydrops.

Sigmoid Sinus Diverticulum Causing Pulsatile Tinnitus: A Novel Radiologic Finding and Proposed Surgical Treatment

Douglas E. Mattox, MD, Kristen J. Otto, MD

Objective: Tinnitus represents a bothersome symptom frequently encountered in an otologic practice. Tinnitus can be the harbinger of identifiable middle or inner ear pathology, but more frequently, tinnitus stands alone as a subjective symptom with no easy treatment. When a patient complains of pulsatile tinnitus, a workup to rule out vascular pathology is indicated. We report of a novel diagnostic finding and proposed surgical correction for selected patients with pulsatile tinnitus.

Study Design: Retrospective case series.

Setting: Tertiary referral center.

Patients: Three patients referred for the treatment of either unilateral or bilateral pulsatile tinnitus. All patients had normal in-office otoscopic examinations, normal audiometry, and normal tympanometric evaluations. All patients underwent computed tomographic (CT) imaging and CT-angiography of the temporal bones. Scans revealed the presence of a sigmoid sinus diverticulum in either one or both ears. Auscultation of the pinna and mastoid revealed and audible bruit in most patients.

Intervention: Two of the three patients underwent transmastoid exploration of the sigmoid sinus and successful excision of the diverticulum and repair of the sigmoid sinus.
Main Outcome Measure: Patients were evaluated clinically for presence or absence of pulsatile tinnitus following decompression surgery.

Results: The two patients who underwent surgical correction experienced complete resolution of tinnitus (mean follow-up 13 months). One patient declined surgical intervention.

Conclusions: The presence of a sigmoid sinus diverticulum represents a novel finding on CT imaging in select patients with pulsatile tinnitus. Surgical obliteration of the diverticulum has the potential to affect symptom relief for these patients.

CT and/or MRI before Pediatric Cochlear Implantation? Developing an Investigative Strategy

Keith Trimble, MB, FRCS,
Adrian James, MA, FRCS; Susan Blaser, MD, FRCPC
Blake Papsin, MD, MSc, FRCSC

Objective: To investigate and compare the utility of pre-operative magnetic resonance imaging (MRI) and high-resolution temporal bone computed tomography (HRCT) in pediatric cochlear implant candidates. To quantify the number of temporal bone anomalies in this population.

Study Design: Prospective, controlled.

Setting: Tertiary medical centre.

Patients: A consecutive sample of 100 pediatric patients with profound hearing loss of various aetiologies. Inclusion criteria were MRI, CT and cochlear implantation.

Intervention(s): All patients had pre-operative imaging of the petrous temporal bone (HRCT, T2-weighted fast spin echo, axial 3D FIESTA MRI,) and brain (FLAIR MRI). Detailed measurements of the temporal bone images were performed with Picture Archiving and Communication Software (PACS) software.

Main Outcome Measure(s): Overall prevalence of inner ear dysplasias in this population and comparison of biometry of the structures of the inner ear to normal controls.

Results: Radiological abnormalities were seen in 34% and 54% of temporal bone MRI and CTs respectively. Synchronous intracranial findings were noted in 31% and incidental paranasal sinus and mastoid pathology in 9%. Cochlear nerve aplasia was seen in 2% ears and directed side of implantation. CT was more sensitive at detecting modiolar deficiency and enlarged vestibular aqueduct.

Conclusions: MRI and CT are complimentary in predicting cochlear anomalies. Analysis of this data enabled development of an algorithm for radiological investigation prior to pediatric cochlear implantation.

Advances in High Resolution CT & MR Imaging of the Temporal Bone & Cerebellopontine Angle

H. Ric Harnsberger MD

In this session we will show how multislice-CT and thin-section, high-resolution MR images can impact modern Neurotologic practices. Multislice-CT has increased the number of normal structures that can viewed with high resolution within the temporal bone (e.g. chorda tympani nerve canal, Arnold & Jacobsen nerve canals, stapedius muscle). With such resolution, we are now able assist in the differential diagnosis of conductive hearing loss by being able to better visualize such lesions as otosclerosis & tympanosclerosis. High-resolution T2-weighted fast spin-echo MR imaging provides excellent depiction of the cisternal and intracanalicular segments of the vestibulocochlear and facial nerves. T2 high-resolution MR has thus enhanced our ability to evaluate candidacy for cochlear implantation and to evaluate lesions that may occur throughout the skull base.

Intracranial Schwannomas of the Lower Cranial Nerves

John P. Leonetti, MD; Douglas A. Anderson, MD
Sam J. Marzo, MD; Thomas C. Origitano, MD, PhD
Mobeen Shirazi, MD

Objective: To present our experience in the diagnosis and management of 39 patients with lower cranial nerve schwannomas of the posterior fossa.

Study Design: A retrospective chart review of patient medical records.

Setting: Tertiary care, academic medical center.

Patients: All patients with intracranial lower cranial nerve schwannomas treated surgically at our institution between July 1988 and July 2005.

Intervention: A retrosigmoid, transcondylar, or combined approach was employed for tumor resection.

Main Outcome Measure: The extent of tumor resection and the incidence of tumor recurrence.

Results: Thirty-nine patients underwent surgical resection with complete tumor removal in 32, near-total resection in five patients, and subtotal tumor excision in two cases. Long-term (mean of 8.2 years) MRI surveillance demonstrated recurrent tumor in two of 32 complete resections, and slow regrowth in two of seven patients with known residual disease. Only one of these four patients required re-operation.

Discussion: Intracranial schwannomas of the lower cranial nerves are relatively uncommon, and may present with subtle or no clinical symptoms. Successful surgical resection with low risk of tumor recurrence can be achieved with the retrosigmoid or transcondylar appraoch. Morbidity, in this series, was limited to isolated individual lower cranial nerve deficits.

Acknowledgments: The authors would like to thank Erin Sebastian for her work in the preparation and critique of this abstract.

Prevention and Treatment of Cerebrospinal Fluid Leak Following Translabyrinthine Acoustic Tumor Removal

Jose N. Fayad, MD; Marc S. Schwartz, MD
Derald E Brackmann, MD; William H. Slattery, MD

Objective: To determine the incidence of cerebrospinal fluid (CSF) leak following translabyrinthine acoustic tumor removal using titanium mesh cranioplasty and compare to previous series and historical controls.

Study Design: Retrospective chart review.

Setting: Tertiary referral neurotologic private practice.

Patients: The series of 388 patients who underwent titanium mesh cranioplasty after translabyrinthine tumor removal between March 2003 and July 2005. Results were compared to those in a group of 1195 translabyrinthine tumor removal patients from a previously published series.

Intervention: Cranioplasty using titanium mesh following acoustic tumor removal.

Main Outcome Measures: Rate of CSF leak for this method and previous methods of closure.

Results: 13 patients (3.3%) had CSF leaks when using the new method of titanium mesh closure. This compares to a rate of 10.9% in a series in which previous methods of closure were used ($p < .001$). The rates of CSF leak requiring reoperation were 0.8% and 2.5% for the new and older series, respectively ($p < .001$).

Conclusions: Titanium mesh cranioplasty appears to reduce the rate of CSF leaks following translabyrinthine removal of acoustic tumors in our hands. A new paradigm to treat those leaks is described which includes blind sac closure and packing of the Eustachian tube, avoiding the re-exploration of the mastoid as is traditionally proposed.

Interim Progress Report for the American Otological Society Research Grants

Effects of Low-Dose Gentamicin on Labyrinthine Structure

PI: John Carey, MD

The aims of this study are: (1) To elucidate the fate of calyceal afferent endings after low-dose IT gentamicin treatment, and (2) To elucidate the fate of stereocilia after low-dose IT gentamicin treatment. Intratympanic (IT) gentamicin treatment is an increasingly popular therapy for intractable vertigo due to Ménière's disease. Our laboratory has studied the effects of IT gentamicin treatment on the chinchilla labyrinth as a model for the human treatment. Cristae and utricles lose almost all type I hair cells and calyceal afferent endings within weeks of the lesion, but type II hair cells are not significantly reduced in density. Vestibular nerve afferents stop responding to head acceleration, but they continue to fire spontaneously. Even the most irregular units are preserved, which is surprising because such units in normal chinchillas only have calyceal endings on type I cells. These results imply that afferents must be receiving synaptic input from endings that are no longer calyceal in appearance. Thus, we are interested in further studying the fates of calyceal afferent endings after IT gentamicin treatment.

Adult chinchillas received a single unilateral intratympanic gentamicin injection; contralateral ears served as controls. Animals were euthanized at 2 periods after treatment: early (14-28 d) or late (3 mo). Semicircular canal cristae and utricular maculae were sectioned for light microscopy (LM); cristae were also sectioned for transmission electron microscopy (TEM). Hair cell counts decreased by 53% in treated cristae and 38% in treated maculae, with loss of nearly all type I hair cells but no change in type II hair cell number. Equivalent hair cell loss was seen in the three zones of the cristae. In the utricular macula, hair cell loss was greater in the striolar region. Neuroepithelial height was reduced by 21%. There was no change in afferent bouton number. Efferent bouton number decreased over time. Ribbon synapses per section were reduced by 48%, with no change in the ribbon synapse-to-hair cell ratio. By LM there was a 66% decrease in the proportion of hair cells with stereociliary bundles, from 83.8% in control cristae to 28.7% in treated cristae ($p<0.001$, χ^2-test). Upon TEM analysis, we noted that many of the remaining stereociliary bundles in gentamicin-treated cristae appeared abnormally swollen and less tightly associated.

In addition to the loss of Type I hair cells and calyx endings, gentamicin-treated cristae were noted to have globular structures in the neural ending layer of the crista on LM. Strong evidence that these globular structures were also neural

endings was provided by finding ribbon synaptic specializations of adjacent hair cells aligned with post-synaptic densities in the globular structures. Using immunohistochemical techniques and antibodies selective for calyx associated proteins (tenascin) and calyx only afferents (calretinin), we found further morphologic evidence that the globular endings indeed represent calyceal remnants. Anti-calretinin antibody labeled calyceal afferents in the central zone of control cristae. Antibody to tenascin, an extracellular matrix glycoprotein, labeled the space between type I hair cells and their calyceal endings in controls. We found that calyx-associated tenascin immunoreactivity was abolished after treatment with gentamicin. However, calretinin immunoreactivity persisted after gentamicin in thick fibers within the stroma of the crista ampullaris and in the globular endings within the neuroepithelium. This suggests that afferent calyces may lose their Type I hair cells and extracellular matrices but remain in the retracted form of globular endings after gentamicin treatment. These endings may still make en face contacts with Type II hair cells, which could provide the synaptic activity for continued spontaneous firing. The preservation of spontaneous vestibular nerve activity after intratympanic gentamicin treatment may decrease the adaptive burden placed on the central vestibular system relative to destructive procedures that silence afferent firing.

Effects of Elevated Potassium on Spiral Ganglion Neurite Growth and Maintenance

PI: Marlan R. Hansen, Pamela C. Roehm, Ningyong Xu, Steven H. Green

The effect of elevated extracellular potassium ($[K^+]_o$) on spiral ganglion neurons (SGNs) and afferent cochlear innervation carries critical implications for Ménière's disease. We have begun exploring the effects of elevated $[K^+]_o$ on spiral ganglion neurites.

Elevated $[K^+]_o$ inhibits SGN neurite growth and results in loss of peripheral afferent fibers in cochlear explants. To determine the effects of elevated $[K^+]_o$ on SGN neurite growth, dissociated spiral ganglion cultures were maintained in neurotrophin 3 (NT-3) in the presence of 5.4 mM K^+ (5K), 30 mM K^+ (30K), or 80 mM K^+ (80K). After 48 hours (h), the cultures were fixed and immunostained with anti-neurofilament 200 (NF200) antibody and neurite length was determined. We found that SGNs maintained in elevated $[K^+]_o$ have significantly reduced neurite lengths compared with SGNs in 5K. The extent of neurite inhibition by depolarization varied directly with $[K^+]_o$; SGNs in 80K had shorter neurites than those in 30K.

Membrane depolarization could reduce neurite growth by inhibiting initial formation of the process or by inhibiting neurite extension. To distinguish between these possibilities, we performed time lapse imaging of SGNs expressing green fluorescent protein (GFP) to allow viewing of live neurites. Depolarization with 30K reduced the growth of neurites that had already formed while depolarization resulted in retraction of exiting neurites.

To confirm the effects of elevated $[K^+]_o$ on neurites that have already formed we used a cochlear explant preparation, which maintains the relationship of the SGNs with hair, supporting, and glial cells. Cochlear explants were exposed to 80K for 24 h, fixed, and immunolabeled with anti-NF200 antibody. Depolarization with 80K for 24 h results in blebbing and loss of the peripheral neurites, similar to the observation of neurite retraction in dissociated cultures. Treatment of explants in 80K with the L-type voltage sensitive Ca^{2+}-channel blocker, verapamil (40 μM) (VPL) prevented the blebbing and loss of SGN neurites while treatment with NT3 failed to prevent neurite degeneration. Explants that had been exposed to 80K for 24 h and maintained in 5K for an additional 72 h (96 h total) showed a near complete loss of peripheral processes.

Inhibition of neurite growth by depolarization results from Ca^{2+} entry through multiple types of Ca^{2+}-channels. The inhibition of neurite growth by depolarization depends on Ca^{2+} entry since SGNs cultured in the absence of extracellular Ca^{2+} showed normal neurite growth. Further,

the negative effects on neurite growth are reduced in the presence of L, N, P/Q type Ca^{2+} channel blockers with the greatest effect occurring when all 3 blocker are used in combination. This differs from the effect of membrane depolarization on SGN survival, which entirely depends on Ca^{2+} entry through L-type channels.

CaMKII and PKA are not required for the inhibition of neurite growth by elevated $[K^+]_o$.

CaMKII and PKA are activity dependent kinases that promote SGN survival, are required for the survival promoting effects of elevated $[K^+]_o$, and inhibit SGN neurite growth. We transfected cultured SGNs with GFP-AIP or GPKI, small peptides fused with GFP that are specific and effective CaMKII and PKA inhibitors, respectively. Neither inhibitory peptide prevented the inhibition of neurite growth by elevated $[K^+]_o$. These results were confirmed using KN-62 and RpcAMPS, pharmacologic CaMK and PKA inhibitors. These results demonstrate that elevated $[K^+]_o$ recruits different signals to inhibit SGN neurite growth than those that are required to promote survival.

The results of these studies hold important implications for patients with Ménière's disease. For example, retraction or loss of neurites by exposure to elevated $[K^+]_o$ may reduce the density of afferent fibers innervating the organ of Corti. Manipulation of the signals activated by elevated $[K^+]_o$ could limit the potentially damaging consequences on axons.

"Genetic Modification of Mouse Inner Ear Stem Cells *in vitro*"

PI: Samuel Gubbels, MD

The first objective of this research project is to investigate whether adult mouse inner ear stem cells can be modified *in vitro* to produce hair cells through transfection with the *mouse atonal homolog 1* gene (Math1). Math1 has been shown previously to be necessary for hair cell genesis in multiple mammalian models and has been shown to generate both supernumerary and ectopic hair cells when misexpressed in the organ of Corti. The secondary goal of our study seeks to explore if stem cells transfected with Math1 can be transplanted into the developing mouse inner ear *in utero* at the otic placode or otocyst stage of development using the technique of transuterine microinjection. We aim to evaluate the ability of Math1 transfected stem cells to integrate into the organ of Corti and vestibular sensory epithelium and assume a hair cell fate once transplanted.

The first phase of the research fellowship project involved gaining facility with basic science and experimental embryology research techniques. Transuterine microinjection enables delivery of bioactive substances directly into the developing mouse inner ear at the nascent otocyst stage. It is a technically difficult method with a small margin for error as injected embryos have little tolerance for mechanical trauma. I spent the majority of the time in the first 6 months of my research fellowship gaining expertise with transuterine microinjection. I focused on delivery of the Math-1 gene into the developing mouse inner ear using a variety of methods, including viral vectors. My data from injection of embryonic day 11 otocysts indicate misexpression of the Math-1 gene with subsequent generation of supernumerary and ectopic hair cells in the developing mouse organ of Corti. We are currently determining if the newly produced hair cells are innervated and capable of mechanotransduction. I have conceptually mastered the technique of transuterine microinjection and provided strong validation of our experimental embryological approach for studying mammalian inner ear development. This work will form the core of a manuscript independent of the stem cell studies. The overall significance of the work lies in the demonstration of our ability to perform gain-of-function experiments in the developing mouse inner ear using an alternative strategy to transgenics. Manipulation of the genes involved in hair cell fate specification may offer insight into developmental mechanisms that can be exploited for regenerative medical treatments of the diseased inner ear in the future.

Having gained expertise with the most demanding techniques involved in my fellowship project, I am now poised to direct my efforts toward the transfection of stem cells with Math-1 and injection of these modified stem cells into the developing mouse inner ear.

The basic science research skills gained during this research fellowship have many potential applications in the area of auditory research. I am very grateful to the American Otological Society for its support and look forward to future opportunities to use the skills developed during this fellowship to conduct research relevant to the fields of otology and neurotology.

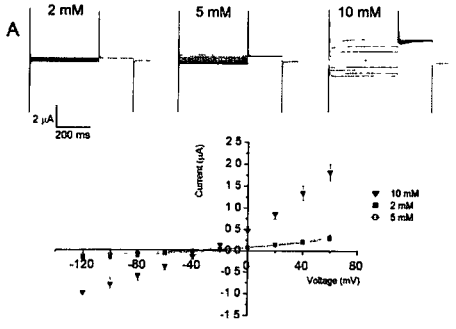
Progress Report for Karen J. Mu, AOS Medical Student Training Fellow

The specific aim of this grant is to understand the role of inner ear lateral wall-specific Cl^- channels. We hypothesize that the properties of Cl^- currents in the cells of the stria vascularis (StV) have distinct features that allow them to maintain high Cl^- outflow across marginal cells (MCs) and intermediate cells to generate endocochlear potential. Our goals are to determine the whole-cell and single channel properties of Cl^- channels in MCs, to clone inner ear/StV-specific Cl^- channels using RT-PCR techniques, and to localize the channels using immunocytochemistry and immunoelectron microscopy to determine the density and location of the channels in the StV. We hypothesize that Cl^- channel current at the MC basolateral membrane is regulated by the channel's interaction with barttin to confer electroneutrality and to ensure the dynamic flow of K^+. We have expressed the cloned channels in heterologous expression systems to determine their electrophysiological phenotype using whole-cell recording techniques and will utilize mutagenesis techniques together with functional expression to better determine channel function.

We cloned ClC-K1 and barttin in the pNLE expression vector containing the 5'- and 3'-untranslated regions of the Xenopus β-globin gene. Co-injection of RNAs of ClC-K1 and barttin yielded robust Cl^- current. Measurements were taken in solutions with differing $CaCl_2$ concentrations, pH, and anion types. The currents were elicited at voltages more positive than +40 mV and negative to -100 mV. Traces were recorded by applying step potentials from +60 mV to -120 mV and then to +60 mV from a holding potential of -30 mV. The current amplitude increased by nearly four-fold upon elevation of extracellular calcium levels from 5 mM $CaCl_2$ solution to 10mM $CaCl_2$ (Figure A). The current amplitude increased upon extracellular alkalinization to pH 8.0, was decreased by two-fold at pH 7.5 and was very small at more acidic pH (Figure B). Replacement of 100 mM extracellular chloride with other anions indicated a permeability sequence of $Br^- > Cl^- > NO_3^- > I^-$ > Glutamate (Figure C). Of particular interest, we observe very minimal inward current with glutamate substitution. While we expected the outward current to decrease as extracellular chloride was removed, the small inward current implies that there may be an extracellular chloride-dependent gating mechanism, which we will examine in several mutants that we have constructed.

We have identified four areas along the ion permeation pathway that are important for pore function: V166, K527, K149, and K165. To this end, we have constructed the following: V166E, V166C, K527C, K527A, K527E, K527R, K149R, K149A, K149E, and K165C. We are currently in the process of characterizing their contribution to ClC-K1 function, and their overall contribution to the generation of endocochlear potential .

For Figures see next page.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2 mM
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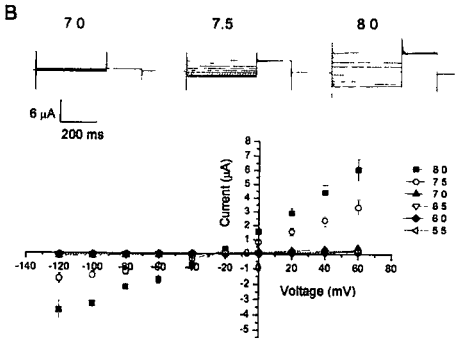
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7 0
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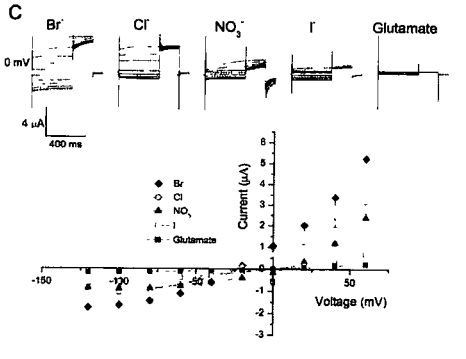
6 0
5 5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Cl⁻
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I⁻
Glutamate
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4 µA
400 ms
Current (µA)
Voltage (mV)
Br
Cl
NO3
I
Glutamate

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1927-1940	Thomas J. Harris, MD
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1955-1960	Lawrence R. Boies, MD
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1972-1977	G. Dekle Taylor, MD
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Deceased Since 2005 Meeting

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Active Member 1958; Senior Member 1990
Date of Death 12/22/2005

J. Booth, MD
Corresponding Member 1995
Date of Death 7/22/2005

Andrew Morrison
Honorary Member 1985

Catherine Smith, PhD
Associate Member 1962
Date of Death 9/27/2005