PROGRAM and ABSTRACTS

of the

One Hundred Fifty First Annual Meeting

AMERICAN OTOLOGICAL SOCIETY

April 20-21, 2018

CONFERENCE CENTER
LEVEL TWO
MARYLAND C

Gaylord National Harbor Resort
National Harbor, MD

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JULY 1, 2017 - JUNE 30, 2018

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CONTINUING MEDICAL EDUCATION CREDIT INFORMATION

Accreditation

This activity has been planned and implemented in accordance with the Essential Areas and Policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of the American College of Surgeons and American Otological Society. The American College of Surgeons is accredited by the ACCME to provide continuing medical education for physicians.

AMA PRA Category 1 Credits™

The American College of Surgeons designates this live activity for a maximum of **7.00** *AMA PRA Category 1 Credits™.* Physicians should claim only the credit commensurate with the extent of their participation in the activity.

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American Otological Society, Inc.
Mission Statement

The American Otological Society, created in 1868, is dedicated to fostering a dialog on and dissemination of, information pertaining to advances in evidence-based diagnosis and management of otologic and neurotologic disorders. The focus on otologic and neurotologic disorders and scientific advances are translated to the provision of quality care that is consistent with the ACGME general competency areas and the Institute of Medicine competencies.

Target Audience: The primary target audience for the educational efforts of the American Otological Society is the current and potential members of the society. These members are physicians, otologists, residents, fellows, and researchers in the fields of otology and neurotology. Educational activities are also open to nurses, occupational and speech therapists and other healthcare professionals who are involved in the care of patients with otologic and neurotologic conditions.

Activities: The primary activity of the American Otological Society is the Annual Meeting that focuses on the advancement of the scientific and clinical evidence that supports advances in otologic and neurotologic care to patients. Additionally, non-certified educational support and resources include the publication and dissemination of peer reviewed and evidence based content through the Otology & Neurotology Journal and support for research in otology/ neurotology and lateral skull base surgery and related disciplines.

Content: The content for the Annual Meeting and other related educational efforts are limited to the otologic and neurotologic evidence-based science, clinical standards of care, and effects on communication.

Expected Results: The expected results are focused on enhancing knowledge translation and promoting competence for the membership and other identified target audiences. The Annual Meeting, the CME certified annual activity of the society, and the other scholarly activities such as the publication of the Journal and support for research provide a rich and robust environment for self-assessment and reflection, access to resources for lifelong learning and opportunities for discussion and re-evaluation

2018 Spring Meeting CME Activity Planning

Practice gaps in Otology are identified through polling the AOS attendees at the close of each CME activity by way of an exit evaluation at the close of the activity; this evaluation is required to receive CME credit, so the response rate is good. The response rate from the 2017 American Otological Society meeting was 69%. The responses of the attendees are discussed in meetings of the AOS Council and Program Advisory committee. The evaluation is used as a tool to determine the success of the CME program in meeting program objectives, addressing professional practice gaps and educational needs. The responses are peer-reviewed by the Council prior to the next meeting to assist the Program Committee in developing future AOS Continuing Medical Education programs. The educational program is designed to address the topics identified as practice gaps through individual presentations and in-depth panel discussions. Based on the response, the following data regarding professional practice gaps among attendees were noted:

- Variable degrees of post-surgical changes occur within the cochlea after implant insertion. Utilization of techniques and electrode designs that reduce the risk of intracochlear fibrosis does not occur consistently.
- The differential risk of post-surgical complications between transcutaneous and percutaneous bone conduction implants is not widely known. Lack of knowledge of this differential risk impacts treatment choice and expected treatment outcomes.
- The factors determining cochlear implant benefit are not completely known. Variable rates of achieving speech recognition occur in adults receiving cochlear implants. Preoperative assessment of neurocognitive ability is not routinely employed.

The AOS chose these education formats because they have proven to be the optimal approaches that engage learners with direct impact on their knowledge and practice patterns. Panel discussions with experts in the field has been requested by attendees and highly rated as an effective format in previous meetings. Didactic presentations are focused on medical topics of high impact and interest to our attendees. Post-presentation question and answer periods facilitate knowledge and clarification for the participants.

The American Otological Society (AOS) is committed to improving public health care through the provision of high- quality continuing medical education (CME) to our members.

To close the identified practice gaps, participants of this activity will need to learn:

- Round window insertion of peri-modiolar electrodes is used whenever possible, to minimize post-surgical fibrosis and ossification within the cochlea.
- The choice of bone conduction implant in pediatric patients is informed by knowledge of increased risk with percutaneous devices.
- Impaired neurocognitive function can negatively impact cochlear implant performance. Neurocognitive testing is included in cochlear implant candidacy assessment and pre-implant counseling,

Learning Objective(s) - At the end of this activity, participants will be able to:

- Recognize the impact of implant device and surgical technique on cochlear fibrosis and ossification.
- Minimize post-operative complications in children receiving bone conduction implants.
- Implement neurocognitive testing as part of cochlear implant candidacy assessment and patient counseling.

How will this educational activity improve competence, practice performance, and patient outcomes?

- This activity will increase the practitioner's knowledge of the factors that impact intra-cochlear inflammatory reactions after cochlear implantation.
- This activity will increase the practitioner's knowledge of the differential risks of post-operative complications in children receiving different types of bone conduction implants.
- This activity will be increase the practitioner's awareness of the impact of neurocognitive function on postimplantation speech recognition performance.

Patient outcomes will be improved in the following ways:

- Practitioner's will implement surgical approaches using devices that reduce the risk of inflammatory reactions of fibrosis and ossification after cochlear implantation.
- Practitioner's will select the bone conduction device that minimizes post-surgical complications in children.
- Practitioner's will include neurocognitive testing when evaluating and counseling patients for cochlear implant candidacy.

Position Statement: Any presentations, conversations, exhibits, or other meeting communications, including descriptions of the use of drugs or devices, does not imply or constitute endorsement of any company, product, application, or use by the American Otological Society.

The following statement was read, submitted, and signed by every individual connected with this educational activity. Failure to comply disqualifies the individual from planning or speaking at any AOS Continuing Medical Education program.

Disclosure Information

In compliance with the ACCME Accreditation Criteria, the American College of Surgeons, as the accredited provider of this activity, must ensure that anyone in a position to control the content of the educational activity has disclosed all relevant financial relationships with any commercial interest. All reported conflicts are managed by a designated official to ensure a bias-free presentation. Please see the insert to this program for the complete disclosure list.

In accordance with the ACCME Accreditation Criteria, the American College of Surgeons, as the accredited provider of this activity, must ensure that anyone in a position to control the content of the educational activity has disclosed all relevant financial relationships with any commercial interest. Therefore, it is mandatory that both the program planning committee and speakers complete disclosure forms. Members of the program committee were required to disclose all financial relationships and speakers were required to disclose any financial relationship as it pertains to the content of the presentations. The ACCME defines a 'commercial interest' as "any entity producing, marketing, re-selling, or distributing health care goods or services consumed by, or used on, patients". It does not consider providers of clinical service directly to patients to be commercial interests. The ACCME considers "relevant" financial relationships as financial transactions (in

any amount) that may create a conflict of interest and occur within the 12 months preceding the time that the individual is being asked to assume a role controlling content of the educational activity.

AOS is also required, through our joint providership partners, to manage any reported conflict and eliminate the potential for bias during the activity. All program committee members and speakers were contacted and the conflicts listed below have been managed to our satisfaction. However, if you perceive a bias during a session, please report the circumstances on the session evaluation form.

Please note we have advised the speakers that it is their responsibility to disclose at the start of their presentation if they will be describing the use of a device, product, or drug that is not FDA approved or the off-label use of an approved device, product, or drug or unapproved usage.

The requirement for disclosure is not intended to imply any impropriety of such relationships, but simply to identify such relationships through full disclosure and to allow the audience to form its own judgments regarding the presentation.

PUBLICATION STATEMENT

The material in this 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 All authors were advised that the submitted paper becomes the property of Otology & Neurotology and cannot be reprinted without permission of the Journal.

THE AMERICAN OTOLOGICAL SOCIETY WOULD LIKE TO THANK THE FOLLOWING MEMBERS FOR THEIR CONTRIBUTION TO THE 2018 AOS SCIENTIFIC PROGRAM

Roberto A. Cueva, MD - President
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Judy Dubno, PhD
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Marlan R. Hansen, MD
Keiko Hirose, MD
David M. Kaylie, MD
Anil K. Lalwani, MD
Eric P. Wilkinson, MD

Poster Judges
Ana H. Kim, MD
Robert F. Labadie, MD, PhD
Jeffrey P. Harris, MD, PhD

Combined Poster Reception AOS, ANS, ASPO, TRIO
Friday, April 20, 2018
5:30 pm – 7:00 pm
Prince George's Exhibit Hall A

AOS President's Reception & Banquet
Saturday, April 21, 2018
Reception - 6:30-7:15 pm
Dinner/Dance - 7:15 to 10:45 pm
Woodrow Wilson Ballroom A
Formal attire/Black tie optional *(Advanced Reservations Required) (Members and Invited Guests only)*

UPCOMING MEETINGS

152nd AOS Spring Meeting (in conjunction with COSM) May 3-5, 2019
JW Marriott Austin - *Austin, Texas*

AAO-HNSF Annual Meeting & OTO EXPO
October 7-10, 2018 Atlanta Omni CNN Hotel - *Atlanta, GA*

The Abstract deadline for the AOS 152nd Annual meeting is Monday, October 15, 2018.

Abstract Instructions and submission form will be available on website in July.
Website - www.americanotologicalsociety.org

All primary and contributing authors are required to complete a disclosure/conflict of interest statement at time of abstract submission in order for the abstract to be considered by the Program Advisory Committee.

Journal Requirements/Instructions to Primary Authors

Manuscripts are required of ALL ORAL presentations. Manuscripts must be submitted online a minimum of four weeks prior to the annual meeting, via the journal's website. Instructions for registering, submitting a manuscript, and the author guidelines can be found on the Editorial Manager site: https://www.editorialmanager.com/on/

The journal of OTOLOGY & NEUROTOLOGY does not accept paper manuscripts. Manuscripts will be peer reviewed prior to the Annual meeting for conflict of interest review and resolution.

Failure to comply with the guidelines & requirements of the American Otological Society and the O&N Journal will result in the disqualification of your presentation.

For Society business, please forward all inquiries to:

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AMERICAN OTOLOGICAL SOCIETY
151st Annual Meeting
PRELIMINARY PROGRAM
April 20-21, 2018
Gaylord National Harbor Resort
National Harbor, MD

FRIDAY, APRIL 20, 2018

1:00 BUSINESS MEETING *(New member introduction)*
(Members Only)

1:30 SCIENTIFIC PROGRAM
(*Open to registered Members and Non-members – Badge required for admittance*)

1:30 Welcome & Opening Remarks by the President
Roberto A. Cueva, MD

PRESIDENTIAL CITATIONS
Michael E. Glasscock, III, MD
Jeffrey P. Harris, MD, PhD
Paul E. Bernstein, MD
Bill Mastrodimos, MD

1:40 GUEST OF HONOR LECTURE
A Framework for Personalized Diagnosis and Therapy of Sensorineural Hearing Loss
Konstantina M. Stankovic, MD, PhD
Massachusetts Eye and Ear Infirmary/Harvard Medical School

RESIDENT RESEARCH TRAVEL AWARD

2:10 Vestibular Function and Hippocampal Volume in the Baltimore Longitudinal Study of Aging (BLSA)
Rebecca J. Kamil, MD
Athira Jacob, MS
Tilak Ratnanather, PhD
Yuri Agrawal MD, MPH

2:18 Cognitive Predictors of Cochlear Implant Outcomes in Adults
Aaron C. Moberly, MD
Kara J. Vasil, AuD
Michael S. Harris, MD
Irina Castellanos, PhD
David B. Pisoni, PhD

2:26 Nonverbal Reasoning as a Contributor to Speech Recognition Outcomes in Adults with Cochlear Implants
Jameson K. Mattingly, MD
Irina Castellanos, PhD
David B. Pisoni, PhD
Aaron C. Moberly, MD

2:34 Hearing Loss Predicts Brain Activity in Patients with Alzheimer's Disease Dementia
Richard K. Gurgel, MD
Susan R. Naidu, PhD
Jeff S. Anderson, MD, PhD
Jace B. King, MBA
Keith G. Jones, BS
Norman L. Foster, MD

2:42 DISCUSSION

2:45 BREAK WITH EXHIBITORS

3:15 Long-term Outcomes of Ossiculoplasty with and without an Intact Malleus
Joshua C. Page, MD
Matthew D. Cox, MD
Tristan Allsopp, MD
John L. Dornhoffer, MD

3:23 Variation in Tympanoplasty Cost in a Multihospital Network
Geoffrey C. Casazza, MD
Andrew J. Thomas, MD
Richard K. Gurgel, MD
Clough Shelton, MD
Jeremy D. Meier, MD

3:31 BAHA Skin Complications in the Pediatric Population: Systematic Review with Meta-Analysis
Scott Shapiro, MD
Jad Ramadan, MS
Adam Cassis, MD

3:39 Cell Proliferation Patterns in the Healing Mouse Tympanic Membrane
Divya A. Chari, MD
Stacey M. Frumm, BS
Aaron D. Tward, MD, PhD

3:47 Treatment of Ciprofloxacin-Resistant Ear Infections
Kathryn Y. Noonan, MD
Soo Yeon Kim
Lye-Yeng Wong
Joseph D. Schwartzman, MD
James E. Saunders, MD

3:55 AOS CLINICIAN SCIENTIST AWARD PRESENTATION
Multi-Sensory Modulation of Tinnitus Correlates in Primary Auditory Cortex
Gregory J. Basura, MD, PhD
University of Michigan

4:10 DISCUSSION

4:15 PANEL
Management of Vestibular Schwannoma in the Only Hearing Ear
Roberto A. Cueva, MD, Moderator
Erika A. Woodson, MD
Rick A. Friedman, MD, PhD
Derald E. Brackmann, MD
John P. Leonetti, MD

5:00 Announcement of AOS/ANS Poster Awards
Carol A. Bauer, MD - AOS Education Director
Craig A. Buchman, MD - ANS Education Director

5:05 ADJOURNMENT

SATURDAY, APRIL 21, 2018

7:00 BUSINESS MEETING *(Committee Reports)*
(Members Only)

7:30 SCIENTIFIC PROGRAM
(Open to registered Members and Non-members – Badge required for admittance)

7:30 Welcome & Opening Remarks by the President
Roberto A. Cueva, MD

7:35 Acute Otitis Media and Associated Complications in United States Emergency Departments
Yin Ren, MD, PhD
Rosh K.V. Sethi, MD, MPH
Konstantina M. Stankovic, MD, PhD

7:43 Assessing Cochlear Implant Performance in Older Adults Using a Single, Universal Outcome Measure Created Via Imputation in a National Web-Based Database
Rahul K. Sharma, BS
Stephanie Y. Chen, MD
Jedidiah J. Grisel, MD
Justin S. Golub, MD, MS

7:51 Adolescent Obesity is an Independent Risk Factor for Sensorineural Hearing Loss: Results from the National Health and Nutrition Examination Survey (NHANES) 2005-2010
Gavriel D. Kohlberg, MD
Ryan T. Demmer, PhD
Anil K. Lalwani, MD

7:59 Feasibility of a Direct-to-Patient Electronic Survey for the Diagnosis of BPPV
David R. Friedland, MD, PhD
Heidi A. Richburg, MS
Richard J. Povinelli, PhD

8:07 Risk of Sensorineural Hearing Loss with Short-term Azithromycin Therapy: A Retrospective Cohort Study
Adel Alrwisan, PhD
Patrick J. Antonelli, MD
Babette A. Brumback, PhD
Yu-Jung Wei, PhD
Almut G. Winterstein, PhD

RESIDENT RESEARCH TRAVEL AWARD

8:15 Idiopathic Sudden Sensorineural Hearing Loss is Not a Sentinel Event for Acute Myocardial Infarction
Matthew G. Crowson, MD
Alan W. Langman, MD
Walter T. Lee, MD, MHS
Kourosh Parham, MD, PhD
Kristine Schulz, MPH, DrPH
Jennifer J. Shin, MD
Andrea Vambutas, MD

8:23 DISCUSSION/INTRODUCTION

8:30 SAUMIL N. MERCHANT MEMORIAL LECTURE
Music for Deaf Ears: Cochlear Implants, Music and the Brain
Charles J. Limb, MD
University of California San Francisco School of Medicine

9:00 Rational Cochlear Implant Electrode Design Based upon Temporal Bone Histopathology
Akira Ishiyama, MD
Ivan Lopez, PhD
Gail Ishiyama, MD
Fred Linthicum, MD

9:08 Safety and Outcomes of Children Implanted under 36 Months
Stephen R. Hoff, MD
Denise Thomas, AuD, CCC-A
Elizabeth Tournis, AuD
Hannah Kenny
Maura Ryan, MD
Nancy M. Young, MD

9:16 Beyond Sentence Recognition in Quiet for Older Adults: Implications for Cochlear Implant Candidacy
Emily Zhang, BA
Daniel H. Coelho, MD

9:24 Further Evidence of the Relationship Between Cochlear Implant Electrode Positioning and Hearing Outcomes
Jack H. Noble, PhD
Rene H. Gifford, PhD
Benoit M. Dawant, PhD
Brendan O'Connell, MD
Jianing Wang, MS
Robert F. Labadie, MD, PhD

9:32 Earphone and Aided Word Recognition Differences in Cochlear Implant Evaluations
Theodore R. McRackan, MD, MSCR
Jane Burton, AuD
Joshua E. Fabie, BS
Meredith E. Holcomb, AuD
Ted A. Meyer, MD, PhD
Paul R. Lambert, MD
Judy R. Dubno, PhD

9:40 DISCUSSION

9:45 BREAK WITH EXHIBITORS

10:15 Inappropriate Use of Systemic Antibiotics for Acute Otitis Externa: Impact of the 2006 Clinical Practice Guideline
Xi Wang, MPH
Almut G. Winterstein, PhD
Yan Li, MS
Yanmin Zhu, BS
Patrick J. Antonelli, MD

10:23 A Case-Control Study of Hearing Outcomes between Middle Fossa Craniotomy and Transmastoid Approach for Surgical Repair of Superior Semicircular Canal Dehiscence Syndrome
Lisa Zhang, BS
Francis X. Creighton Jr, MD
Bryan Ward, MD
Stephen Bowditch, AuD, CCC-A
John P. Carey, MD

10:31 Next-Generation Sequencing of Sporadic Vestibular Schwannoma: Necessity of the Two-Hit Mechanism and Implications of Accessory Non-NF2 Alterations
Matthew L. Carlson, MD
Michael J. Link, MD
James B. Smadbeck, PhD
Eric W. Klee, PhD
Lisa Schimmenti, MD
George Vasmatzis, PhD

10:39 Immunolocalization of the Amiloride-Sensitive Epithelium Sodium Channel Beta Subunit (ENaCβ) in Human Vestibular End Organs in Normative and Meniere's Disease
Michele M. Gandolfi, MD
Gail Ishiyama, MD
Ivan A. Lopez, PhD
Akira Ishiyama, MD

10:47 Perceptions from Adult Individuals with Hearing Loss when Communicating in the Healthcare Setting
Madelyn N. Stevens, BA
Judy R. Dubno, PhD
Margaret I. Wallhagen, PhD
Debara L. Tucci, MD

10:55 Flat Panel Computed Tomography in the Diagnosis of Superior Canal Dehiscence Syndrome
Alexandra E. Tunkel
John P. Carey, MD
Monica S. Pearl, MD, DABR

11:03 DISCUSSION

11:08 PANEL
Current Management of Single Sided Deafness: Options and Controversies
Anil K. Lalwani, MD, Moderator
Kevin D. Brown, MD, PhD
Joni K. Doherty, MD, PhD
Samuel P. Gubbels, MD
Marlan R. Hansen, MD
Craig A. Buchman, MD

12:00 ADJOURNMENT

AOS President's Reception & Banquet
Saturday, April 21, 2018
Reception - 6:30-7:15 p.m.
Dinner/Dance - 7:15 to 10:45 p.m.
Woodrow Wilson Ballroom A
Formal attire/Black tie optional - (Members and Invited Guests only)
(Advanced Reservations Required)

SELECTED ABSTRACTS

ORAL PRESENTATIONS

IN ORDER OF PRESENTATION

151st Annual Meeting

AMERICAN OTOLOGICAL SOCIETY

April 20-21, 2018

Gaylord National Resort

National Harbor, MD

RESIDENT RESEARCH TRAVEL AWARD

Vestibular Function and Hippocampal Volume in the Baltimore Longitudinal Study of Aging (BLSA)

Rebecca J. Kamil, MD; Athira Jacob, MS
Tilak Ratnanather, PhD; Yuri Agrawal, MD, MPH

Objective: This study evaluated whether vestibular hypofunction in aging adults is associated with hippocampal atrophy.

Study Design: Cross-sectional study design using data from the Baltimore Longitudinal Study of Aging (BLSA), a long-running longitudinal cohort study of healthy aging.

Setting: Community-dwelling older adults.

Patients: Eligible participants were age ≥ 60 years and had both vestibular physiological testing and brain MRI on the same visit.

Intervention: Vestibular function testing consisted of the cervical vestibular-evoked myogenic potential (cVEMP) to assess saccular function, the ocular VEMP (oVEMP) to assess utricular function, and the video head-impulse test (VHIT) to assess the horizontal semicircular canal vestibulo-ocular reflex (VOR). Brain MRI scans were performed on a 3T Philips Achieva scanner.

Main Outcome Measure: Vestibular function quantified by cVEMP, oVEMP, and VOR gain and hippocampal volume calculated using diffeomorphometry.

Results: The study sample included a total of 74 participants with mean (±SD) age of 77.0 (±8.15) years and mean hippocampal volume of 3102.8 (±371.5) mm^3. Multivariate linear regression models showed that every 1μV amplitude increase of cVEMP was associated with a significant increase of 258.0 mm^3 (p=0.049) in mean hippocampal volume. This significant relationship was not observed with oVEMP amplitude or VOR gain.

Conclusions: We observed a significant association between cVEMP amplitude and mean hippocampal volume in adjusted models, which is in line with prior work demonstrating a link between saccular function and spatial cognition. Hippocampal atrophy may be a mechanism by which vestibular loss contributes to impaired spatial cognition in older adults.

Define Professional Practice Gap & Educational Need: Vestibular loss in aging adults has been linked to decline in spatial cognition. Several animal and human experiments have shown that vestibular information is critical for accurate spatial memory and navigation behaviors. The hippocampus is a vital component of the network of brain regions involved in spatial cognition, and is known to receive peripheral vestibular input, but the relationship between the vestibular function and hippocampal volume has not been fully elucidated.

Learning Objective: The learning objective of this study is to better understand the relationship between vestibular function and hippocampal volume in older adults.

Desired Result: The results of this study support that vestibular hypofunction is associated with hippocampal atrophy.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB: Approved

Cognitive Predictors of Cochlear Implant Outcomes in Adults

Aaron C. Moberly, MD; Kara Vasil, AuD
Michael S. Harris, MD; Irina Castellanos, PhD
David Pisoni, PhD

Hypothesis: Significant variability in speech recognition outcomes is a challenging clinical problem in postlingually deafened adults with cochlear implants (CIs). The hypothesis tested in this study was that several core neurocognitive processes measured in a non-auditory fashion would serve as predictors of speech recognition outcomes.

Background: Neurocognitive functions, such as working memory capacity, information processing speed, and inhibition-concentration, have been identified as contributors to speech recognition in adults with hearing loss. This study examined these and additional neurocognitive factors as predictors of sentence recognition, both in adults who were experienced CI users as well as in CI candidates.

Methods: Forty postlingually deafened adults who were experienced CI users (ECIs) and fifteen CI candidates (CICs) were enrolled. Participants were assessed using non-auditory measures of working memory capacity, information processing speed, inhibitory control, and nonverbal reasoning. Sentence recognition in quiet was assessed for ECIs during the same testing session, and for CICs 6 months after implantation.

Results: Sentence recognition scores correlated significantly with scores of information processing speed, inhibitory control, and nonverbal reasoning in ECI participants. Similarly, for CIC participants, pre-implant neurocognitive skills of information processing speed and nonverbal reasoning predicted scores of sentence recognition 6 months after implantation.

Conclusions: Findings provide further converging evidence that neurocognitive factors contribute to speech processing by experienced adult CI users, and that non-auditory neurocognitive measures can predict speech recognition outcomes preoperatively for CI candidates.

Define Professional Practice Gap & Educational Need: Lack of contemporary knowledge regarding factors that predict speech recognition outcomes after adult cochlear implantation.

Learning Objective: To develop a better understanding of cognitive factors that contribute to and predict cochlear implant outcomes in adults.

Desired Result: Attendees will consider incorporating preoperative cognitive testing to help prognosticate outcomes for adult patients who receive cochlear implants.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB: Approved

Nonverbal Reasoning as a Contributor to Speech Recognition Outcomes in Adults with Cochlear Implants

Jameson K. Mattingly, MD; Irina Castellanos, PhD
David B. Pisoni, PhD, Aaron C. Moberly, MD

Hypothesis: Significant variability in speech recognition persists among postlingually deafened adults with cochlear implants (CIs). We hypothesize that nonverbal fluid reasoning testing can predict sentence recognition in adult CI users.

Background: Neurocognitive functions contribute to speech recognition outcomes in adults with hearing loss. These functions may be particularly important for CI users who constantly hear degraded speech signals. This study used a visual measure of fluid reasoning (the ability to solve novel problems), Raven's Progressive Matrices, to determine its ability to predict sentence recognition in both CI users and normal-hearing (NH) controls listening to spectrally degraded speech.

Methods: Participants were 39 postlingually deafened adults with CIs and 43 age-matched NH controls. CI users were assessed for recognition of words in sentences in quiet, and NH controls listened to 8-channel vocoded versions to simulate the degraded signal delivered by CIs. A computerized visual task of Raven's Progressive Matrices, requiring participants to identify the correct missing piece in a 3 x 3 matrix of geometric designs, was also performed.

Results: Overall number and percent of items answered correctly significantly correlated with sentence recognition for CI users (r=0.34-0.55) and NH controls (0.35-0.58). Response times and total number of items completed did not correlate with outcomes. Particular items were also evaluated for their ability to predict sentence recognition.

Conclusions: Nonverbal reasoning predicted sentence recognition in both CI and NH subjects. Our findings provide further converging evidence that neurocognitive factors contribute to speech processing by adult CI users and can help explain variability in outcomes.

Define Professional Practice Gap & Educational Need: Our inability as a field to explain variability in cochlear implant outcomes among postlingually deafened adults.

Learning Objective: To develop a better understanding of neurocognitive factors that contribute to speech recognition outcomes in adults with cochlear implants.

Desired Result: The participant will be better equipped to understand and describe neurocognitive factors as they relate to speech recognition, particularly in adults with cochlear implants.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB: Approved

Hearing Loss Predicts Brain Activity in Patients with Alzheimer's Disease Dementia

Richard K. Gurgel, MD; Susan R. Naidu, PhD
Jeff S. Anderson, MD, PhD; Jace B. King
Keith G. Jones; Norman L. Foster

Objective: To determine whether hearing ability in noise predicts brain activity in adults with Alzheimer's disease (AD) dementia.

Study design: Prospective, interventional study

Setting: Tertiary referral center

Patients: Patients with AD who had individual-ear pure tone averages ≤40dB HL. Patients underwent comprehensive peripheral and central audiometric testing.

Intervention(s): While in a functional MRI (fMRI) scanner, subjects listened to favorite familiar musical pieces (active state) and were also examined with resting state fMRI in which they listened to nonsensical, reversed music with two runs of 10 minutes each.

Main outcome measure(s): Functional MRI connectivity in 361 distinct gray matter brain regions of interest (ROIs) during active and resting states. Average global connectivity was calculated as mean functional connectivity between an ROI and the other 360 regions, a quantitative marker representing overall functional connectivity in the brain.

Results: Sixteen subjects had adequate fMRI and hearing data. The average age was 71.5 years old (±6.0). The average Dichotic Sentence Identification (DSI) test, which measures central auditory processing, for the left ear was 40% (±34%) compared to 90% (±10%) in the right ear ($p<0.001$). Of the fMRI ROIs, 289 of the 361 had significant correlations between global connectivity and DSI of the left ear ($p=0.0039$, $r^2=0.4597$), and all 289 showed higher functional connectivity for individuals with higher left DSI score.

Conclusions: The DSI can predict functional connectivity in patients with AD. Moreover, auditory input from the left ear was more susceptible to impairment, suggesting that side-specific auditory input may influence central auditory processing.

Define Professional Practice Gap & Educational Need: 1. Lack of awareness how certain hearing tests can predict brain activity in patients with Alzheimer's disease dementia 2. Lack of contemporary knowledge about the mechanisms between hearing loss and Alzheimer's disease dementia.

Learning Objective: To educate about the correlation between performance on hearing tests can predict brain activity in patients with Alzheimer's disease.

Desired Result: For attendees to recognize how clinical hearing testing can be utilized to identify those with diminished brain activity.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB: Approved

Long-term Outcomes of Ossiculoplasty with and without an Intact Malleus

Joshua C. Page, MD; Matthew D. Cox, MD
Tristan Allsopp, MD; John L. Dornhoffer, MD

Objective: To compare long-term hearing outcomes following ossiculoplasty with cartilage tympanoplasty with (M^+) and without (M^-) the malleus present

Study Design: Retrospective chart review.

Setting: Tertiary referral center.

Patients: 126 patients (18-88 years of age) undergoing ossiculoplasty with tympanoplasty or tympanomastoidectomy using cartilage tympanic membrane grafts from 1998 to 2012 with at least 5 years of documented postoperative follow-up.

Main Outcome Measures: Short-term hearing results (pure-tone average air-bone gap [PTA-ABG] measured between 60 days and 1 year after surgery), long-term hearing results (PTA-ABG measured ≥5 years after surgery), Ossiculoplasty Outcome Parameter Staging (OOPS) index and complications

Results: 46 patients were included in the M^+ group along with 80 in the M^- group. Pre-operative PTA-ABG was 23.8 dB for M^+ and 34.5 dB for M^- (p=.00001). Short-term PTA-ABG was 19.3 dB for M^+ and 18.5 dB for M^- (p=.727). Long-term PTA-ABG was 18.2 dB for M^+ and 19.6 dB for M^- (p=.500). OOPS index was 4.11 and 6.41 for M^+ and M^-, respectively (p=.00001). 13 patients (10.3%) experienced complications.

Conclusion: Our data suggest that the malleus is not statistically significant with regard to its impact on final audiometric outcome following ossiculoplasty when a total cartilage island flap technique is used. This has implications in our clinic, particularly in our use of the OOPS index as a preoperative staging system and will likely lead to its revision. This data may further support the coupling theory of acoustic gain and weaken the catenary lever theory.

Define Professional Practice Gap & Educational Need: Lack of consensus on the importance of the malleus in long-term hearing outcome in ossiculoplasty.

Learning Objective: To compare our clinic's long-term hearing outcomes following ossiculoplasty with total cartilage island flap tympanoplasty with and without the malleus present.

Desired Result: Our hope is that attendees have a better understanding of the role the malleus plays in reconstruction in ossiculoplasty and the mechanisms that contribute to acoustic gain of the middle ear system.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Approved

Variation in Tympanoplasty Cost in a Multihospital Network

Geoffrey C. Casazza, MD; Andrew J. Thomas, MD
Richard K. Gurgel, MD; Clough Shelton, MD
Jeremy D. Meier, MD

Objectives: Identify costs and operative times for tympanoplasty, and evaluate factors influencing cost and time variation.

Study Design: Retrospective cohort study

Setting: Multihospital network

Patients: Patients undergoing tympanoplasty from 2013 to 2017. Subjects with additional procedures were excluded.

Interventions: A multihospital network's standardized activity-based accounting system was used to determine costs and operative times of tympanoplasty.

Main Outcome Measures: Correlation between variable factors and cost were calculated by Spearman correlation coefficients. Statistical comparisons of cost and time were made between surgeons and hospitals using an ANOVA test (Kruskal-Wallis) followed by Dunn's test to correct for multiple comparisons. All providers or hospitals with single cases were excluded for statistical comparison.

Results: The study cohort included 487 tympanoplasties performed by 44 surgeons at 13 hospitals. Mean patient age was 18.2 ±17.4 years. Mean cut-to-close time was 85.8 ±56.7 minutes. Mean total encounter cost was $3491 ±$1,627, mean surgical-supply cost was $285 ±$292, and operating room supplies was $450 ±$862. Significant factors correlating with increased cost were surgical-supply cost ($r = 0.886$, 95% CI 0.861-0.906; $p < 0.0001$) and operating room supplies ($r = 0.853$, 95% CI 0.818-0.881; $p < 0.0001$). Laser utilization (mean cost $541 ±$343) and artificial graft material (mean cost $199 ±$94) were the major surgical-supply costs. Cut-to-close time was less correlated with increased cost ($r = 0.312$, 95% CI 0.216-0.402; $p < 0.0001$),

Conclusion: Significant variation in tympanoplasty costs exists among different surgeons and hospitals within a multihospital network. Reducing variation in costs while maintaining outcomes may improve healthcare value and eliminate waste.

Define Professional Practice Gap & Educational Need: Lack of awareness for the variations in cost and time for tympanoplasty surgery.

Learning Objective: Identify costs and operative times for tympanoplasty, and evaluate factors influencing cost and time variation.

Desired Result: Understand and explain variations in cost for tympanoplasty surgery.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB: Approved

BAHA Skin Complications in the Pediatric Population:
Systematic Review with Meta-Analysis

Scott Shapiro, MD; Jad Ramadan, MS; Adam Cassis, MD

Objective: Compare the incidence of skin and surgical site complications for pediatric patients undergoing percutaneous and transcutaneous bone conduction implant (pBCI and tBCI) surgery via systematic review of the literature and meta-analysis.

Data Sources: 1) Search of English language articles in PubMed, Web of Science, and EBSCOhost databases from January 2012 to April 2017. 2) Review of references of studies meeting initial screening criteria.

Study Selection: Inclusion criteria were studies that 1) involved pediatric patients (<18 yo) undergoing tBCI or pBCI surgery and 2) reported surgical complications including skin complications, implant loss, and revision surgery. Exclusion criteria were use of a previous generation implant.

Data Extraction: Multiple study characteristics were extracted but primary outcomes were incidence of skin complication, implant loss, and re-operation. Newcastle Ottawa scale was used for bias assessment.

Data Synthesis: Twenty-two studies (14 tBCI, 8 pBCI) met criteria. Meta-analyses were performed using random effects model. Cochran's Q score and I^2 inconsistency were used to assess heterogeneity. The overall skin complication rate for tBCIs was 6.3% and 31.3% for pBCIs ($p = 4 \times 10^{-12}$). Implant loss was 1.7% for tBCIs and 5.6% for pBCIs ($p = 0.004$). The re-operation rate was 2.9% for tBCIs and 6.0% for pBCIs ($p = 0.00002$).

Conclusions: There is strong evidence to suggest that in pediatric patients, the incidence of skin complications, implant loss, and rate of re-operation are higher for pBCIs compared to tBCIs. This information should be part of any discussion about BCI surgery on pediatric patients.

Define Professional Practice Gap & Educational Need: Lack of knowledge of skin complications, implant loss, and re-operation rates in the two main bone conduction implant systems in the pediatric population.

Learning Objective: Highlight the difference in skin complications in the two main bone conduction implant systems in the pediatric population to help guide surgical decision making.

Desired Result: Counsel families appropriately regarding the potential for skin and surgical site complications of bone conduction implant surgery in pediatric patients.

Level of Evidence: LEVEL II - Small RCTs with unclear results

IRB: Exempt

RESIDENT RESEARCH TRAVEL AWARD

Cell Proliferation Patterns in The Healing Mouse Tympanic Membrane

Divya A. Chari, MD; Stacey M. Frumm, BS
Aaron D. Tward, MD, PhD

Aim: To better elucidate the cellular dynamics and mechanisms by which perforations in the tympanic membrane (TM) are healed.

Background: Under normal conditions, epidermal cells are born then migrate from the handle of the malleus located near the center of the TM in a radial direction toward the annulus. In the condition of perforation healing, it is unknown how the normal pattern of proliferation and migration is altered.

Methods: Thirty-six female mice were used in this study. Ethynyl deoxyuridine (EdU), a thymidine analogue that labels proliferating cells, was injected intraperitoneally into each mouse and supplied in the drinking water, thus labelling any newly born cell. Acute perforations were performed on the right TM using a micropick under a surgical microscope. The left TM served as the control and remained intact. The animals were sacrificed at six time points between 2 hours and 6 days. We analyzed distribution of proliferating cells in the control and perforated TMs using confocal microscopy. EdU was detected with a fluorescent azide.

Results: In control TMs, proliferating cells were detected around the malleus handle then migrated radially outward over time. Perforated TMs showed significantly pronounced proliferation over the malleus handle and the region of the annulus adjacent the perforation and an increased number of newly born cells even in regions of the TM far from the perforation.

Conclusions: Perforation of the TM alters the cellular dynamics throughout the entire TM, rather than simply adjacent to the perforation. This finding argues that long distance signaling occurs in the perforated TM.

Define Professional Practice Gap & Educational Need: 1) Lack of contemporary knowledge about the cellular dynamics and mechanisms by which perforations in the tympanic membrane are healed. 2) Lack of understanding regarding the mechanism by which cellular proliferation occurs in the tympanic membrane, particularly in the perforated condition. 3) Absence of therapies that target cellular mechanisms of tympanic membrane cell proliferation and migration.

Learning Objective: To better elucidate the cellular mechanisms by which tympanic membrane perforations are healed.

Desired Result: Attendees will obtain a deeper understanding of the cellular dynamics of the tympanic membrane which may lead to broad spread applications in targeted molecular therapy to increase proliferation and healing in a perforated tympanic membrane.

Level of Evidence: LEVEL II - Small RCTs with unclear results

IRB: Approved

Treatment of Ciprofloxacin-Resistant Ear Infections

Kathryn Y. Noonan, MD; Soo Yeon Kim
Lye-Yeng Wong; Joseph D. Schwartzman, MD
James E. Saunders, MD

Objective: Ciprofloxacin-resistance has been reported in 4.5% of patients with otorrhea. Additionally, ciprofloxacin-resistance is increasing in prevalence. Due to ototoxicity, only fluoroquinolones are FDA approved for topical therapy in the middle ear. Furthermore, there is an assumption that antibiotic resistance patterns are not relevant to topical therapy because topical concentrations are much higher than the MIC used to determine resistance. This study investigates ciprofloxacin-resistant infections and seeks to develop a better understanding of treatment options and outcomes.

Study design: Retrospective review of 141 ciprofloxacin-resistant otologic infections.

Setting: Primary care and specialty outpatient clinics at a tertiary-care hospital.

Patients: All patients with culture-proven ciprofloxacin-resistant otologic infections from 2009-2017.

Intervention(s): Antibiotic treatment with ciprofloxacin topical drops, ciprofloxacin plus oral antibiotics, and non-ciprofloxacin topical drops were studied.

Main outcome measure(s): Bacteriology for ciprofloxacin-resistant infections and treatment effectiveness of various therapies.

Results: MRSA (33%), Corynebacterium striatum (19%), and non-MRSA Staphylococcus aureus (11%) are the most frequent causes of ciprofloxacin-resistant infections. Topical ciprofloxacin monotherapy was successful in 2.7% of infections compared to a 64.7% success rate with the addition of an oral antibiotic ($p<0.001$). Non-ciprofloxacin drops are more effective with a 70% cure rate compared to the 2.7% of the ciprofloxacin drops $p<0.001$. There was no difference in treatment efficacy when comparing non-ciprofloxacin topical therapy (70% cure) to non-ciprofloxacin topical therapy plus oral antibiotic (83% cure) $p=0.13$.

Conclusions: Using ciprofloxacin drops to treat ciprofloxacin-resistant bacteria is ineffective and patients do significantly better with alternative therapy. This finding supports the conclusion that high concentrations achieved in topical applications are not sufficient to overcome antibiotic resistance.

Define Professional Practice Gap & Educational Need: Ciprofloxacin-resistance has been reported in 4.5% of patients with otorrhea. Additionally, ciprofloxacin-resistance is increasing in prevalence. Due to ototoxicity, only fluoroquinolones are FDA approved for topical therapy in the middle ear. There is a practice gap in proper management of these resistant infections and as a result infections are currently being treated with a wide assortment of therapies. Furthermore, there is an assumption that antibiotic resistance patterns are not relevant to topical therapy because topical concentrations are much higher than the MIC used to determine resistance. This study seeks to investigate the current treatment patterns for ciprofloxacin-resistant infections and the successful therapies that can be utilized.

Learning Objective: 1. Understand safe and adequate therapy for ciprofloxacin-resistant otologic infections 2. Topical ciprofloxacin drops are not adequate monotherapy for ciprofloxacin-resistant infections.

Desired Result: Improved decision-making process due to informed management of ciprofloxacin-resistant otologic infections.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB: Approved

Acute Otitis Media and Associated Complications in United States Emergency Departments

Yin Ren, MD, PhD; Rosh K.V. Sethi, MD, MPH
Konstantina M. Stankovic, MD, PhD

Objective: Complications associated with acute otitis media (AOM), while rare, are associated with significant morbidity and not well characterized from an epidemiological perspective. We analyze the pattern of presentation and emergency department (ED) utilization in patients with AOM and associated complications.

Study Design: Retrospective analysis of the Nationwide Emergency Department Sample (NEDS) from 2009 to 2011.

Setting: Emergency Department.

Patients: Patients who presented with a primary diagnosis of AOM or acute mastoiditis.

Intervention: Diagnostic.

Main outcome measures: NEDS was queried for patient encounters with a diagnosis of AOM or acute mastoiditis based on ICD-9 codes. Complications of severe infection, including petrositis, Gradenigo's syndrome, facial paresis, labyrinthitis, meningitis, intracranial abscess, venous sinus thrombosis, and cerebrospinal fluid leak were assessed. Weighted estimates for demographics, types of complications, socioeconomic status, and trends over time were extracted.

Results: A weighted total of 5,811,127 ED visits were identified. Most were less than 18 years old (79.9%) with an average age of 10.1 years. Most were discharged (99.4%). 15,243 (0.26%) patients presented with a complication. The most common complications were acute mastoiditis (0.16%), labyrinthitis (0.06%) and facial paresis (0.03%). Patients with complicated AOM were older (37 vs. 10 years old), insured by Medicare (18% vs. 2.1%), and more likely to be admitted (43.6% vs. 0.4%) than those with uncomplicated AOM ($p < 0.0001$, respectively).

Conclusions: ED visits related to AOM or mastoiditis are common and complications are rare. A comprehensive analysis on a national level is useful for assessing healthcare utilization trends.

Define Professional Practice Gap & Educational Need: Lack of contemporary knowledge about the burden of acute otitis media and associated complications on a national level.

Learning Objective: To provide a comprehensive analysis on the demographics, presentation patterns, timing and geographic distribution of ED visits with AOM or mastoiditis. In addition, to identify clinical features in patients who develop complications from AOM.

Desired Result: A comprehensive overview of AOM and associated complications at a national level will highlight patterns of healthcare utilization in the ED setting, and improve our understanding of the disease presentation to ultimately guide triage and resource allocation.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB: Exempt

Assessing Cochlear Implant Performance in Older Adults Using a Single, Universal Outcome Measure Created via Imputation in a National Web-Based Database

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Jedidiah J. Grisel, MD; Justin S. Golub, MD, MS

Objectives: The existence of multiple cochlear implant (CI) outcome measures makes it difficult to pool data across institutions. We use a large, national CI database to generate mathematical models that can interconvert different outcome test scores. We then use CNCw as a universal outcome to study performance in older adults as a proof-of-principle.

Study Design: Prospective, national, web-based CI database (HERMES); imputation was performed with linear regression to predict missing CNCw values based on AzBio, HINT, or BKB-SIN.

Setting: Thirty-two US private practice and academic institutions

Patients: Older (≥75 years, n=166) or younger (<75 years, n=297) adult CI patients (n=463 total, n=508 ears)

Main Outcome Measures: CNCw, usage

Results: Older adults (n=32-80) had lower performance on CNCw testing (1 mo: 37%; 3 mo: 45%; 6 mo: 49%; 12 mo: 54%; 24 mo: 57%) than younger adults (n=49-146; 1 mo: 48%; 3 mo: 50%; 6 mo: 58%; 12 mo: 64%; 24 mo: 71%). This was significant at all timepoints (Mann-Whitney; $p<0.05$) except 3 mo ($p=0.12$). However, on multivariable regression, age was not a significant predictor of CNCw scores ($p = 0.380$) after controlling for sex, hearing loss duration, use, and postoperative follow-up duration. There was no difference in CI usage between older and younger patients at any timepoint ($p>0.05$).

Conclusions: Using imputation, we converted incompatible outcome scores to CNCw scores, allowing one of the largest analyses of performance in older adults to date. We confirm that older age is not a significant predictor of usage or performance when controlling for confounders.

Define Professional Practice Gap & Educational Need: Professional Practice Gaps: The outcomes of cochlear implantation in very old patients is not thoroughly understood. Additionally, it is difficult to study this problem nationally given numerous non-compatible outcome measures. Educational Needs: Clinicians must understand whether age predicts CI performance into later life. Additionally, clinicians must understand how this question can be answered using national databases despite multiple non-compatible outcome measures.

Learning Objective: To understand whether age predicts CI performance into later life. To understand how this question can be answered using statistical techniques in a national database despite multiple non-compatible outcome measures.

Desired Result: Clinicians will understand that older age alone is not a significant predictor for performance. Additionally, clinicians will understand how questions can be better answered if a universal outcome measure can be created.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB: Approved

Adolescent Obesity is an Independent Risk Factor for Sensorineural Hearing Loss: Results from the National Health and Nutrition Examination Survey (NHANES) 2005-2010

Gavriel D. Kohlberg, MD; Ryan T. Demmer, PhD
Anil K. Lalwani, MD

Objective: We investigated the hypothesis that childhood obesity is a risk factor for SNHL independent of other metabolic risk factors.

Study Design: A complex, multistage, stratified geographic area design for collecting representative data from noninstitutionalized U.S. population.

Methods: A total of 3723 adolescent participants between the ages of 12–19 from the NHANES database (2005-2010) were studied. Subjects were classified as obese if their BMI >= 95th percentile. SNHL was defined as average pure-tone greater than 15dB HL for 0.5, 1 and 2kHz or 3, 4, 6, and 8 kHz in at least one ear. Multivariable logistic regression models assessed incident hearing loss odds across obese patients in comparison to normal weight individuals (5th–85th percentile). Models included age, sex, socio-economic status, race, smoke exposure and diet. Additional models individually included metabolic risk factors: high-density lipoprotein level, triglyceride level, systolic blood pressure measurement, diabetes status, hemoglobin A1C level and C-reactive protein level.

Results: The rate of SNHL was 22.02% in obese and 13.82% in normal weight adolescents ($p < 0.0001$). In multivariate analyses, obesity was associated with 1.73 fold increase in the odds of SNHL (95% CI: 1.28–2.37, p-value = 0.001). Metabolic risk factors had minimal effect on odds of SNHL in obese study participants (OR range of 1.7–1.81, all p-values < .002).

Conclusions: Obesity is a risk factor for SNHL in adolescents independent of other metabolic risk factors. This has implications for control of obesity as a primary means to protect against hearing loss.

Define Professional Practice Gap & Educational Need: Lack of awareness of the association between obesity and adolescent hearing loss

Learning Objective: Understand the evidence linking obesity with adolescent hearing loss

Desired Result: Promote awareness of the strengthening evidence of the association between obesity and adolescent hearing loss

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB: Approved

Feasibility of a Direct-to-Patient Electronic Survey for the Diagnosis of BPPV

David R. Friedland, MD, PhD; Heidi A. Richburg, MS
Richard J. Povinelli, PhD

Objective: To assess the utility of an electronic direct-to-patient survey for predicting BPPV.

Study design: Prospective application of an electronic vestibular survey with subsequent machine learning analyses. Level III

Setting: Tertiary referral center

Patients: Patients presenting to vestibular therapy for dizziness or imbalance.

Intervention: Machine learning assessment of survey responses using J48 decision tree analyses, 10-fold cross validation, and wrapper approach.

Main outcome measures: Accuracy, sensitivity, and specificity of decision trees for predicting BPPV.

Results: 58 subjects complete the survey of which 23 had clinical evidence of BPPV and 35 did not. The first version of the survey included 84 questions of which 72 were yes/no and 12 were multiple choice. Analyses identified 41 questions which did not provide significant differentiation between affected and non-affected patients. There were 15 questions of notable significance which were analyzed with a wrapper. This identified a 4-node 5-branch decision tree categorizing BPPV patients with an accuracy of 90%, sensitivity of 87%, and specificity of 91%. The root of this tree queried whether lying in bed or rolling over triggered symptoms. Interestingly, the subsequent nodes of the tree related to the presence of migraine headache or symptoms of vestibular hypofunction.

Conclusions: A direct-to-patient electronic survey shows strong potential for predicting a diagnosis of BPPV. Refinement of the survey may afford for a quick screening protocol that can be used in primary care offices and emergency departments to reduce the high rates of BPPV misdiagnosis.

Define Professional Practice Gap & Educational Need: 1) Poor recognition of diagnostic features of BPPV 2) Poor recognition of vestibular conditions mistaken for BPPV

Learning Objective: 1) To recognize patient reported features correlating with the diagnosis of BPPV

Desired Result: Attendees will better be able to recognize and correctly diagnose BPPV in their clinics.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB: Approved

Risk of Sensorineural Hearing Loss with Short-term Azithromycin Therapy: A Retrospective Cohort Study

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Babette A. Brumback, PhD; Yu-Jung Wei, PhD
Almut G. Winterstein, PhD

Objective: Chronic use of azithromycin has been linked to sensorineural hearing loss (SNHL). We sought to examine whether short-term use of azithromycin increases the risk of SNHL.

Study Design: A retrospective cohort study using Medicaid claims data,1999 - 2010

Patients: Adults (18-64 years old) with continuous enrollment for 12 months prior to the date of first study oral antibiotic dispensation (index date).

Intervention: Azithromycin or amoxicillin (±clavulanate) treatment for uncomplicated infections.

Main outcome measure: A charge for audiometry followed by a new diagnosis of SNHL within 30 days of audiometry, within 120 days of the index date. We adjusted for the baseline covariates through propensity scores matching. The hazard of SNHL in azithromycin-exposed adults was compared to those who had amoxicillin using a Cox proportional hazard model. We performed several sensitivity analyses by varying the follow-up time, SNHL definition, adjusting for cumulative antibiotic use, and switching between exposure status during the follow-up period.

Results: 493,774 patients entered the study cohort. The unadjusted incidence rates of SNHL were 38 and 41 cases per 10,000 patient-years following exposure to azithromycin and amoxicillin, respectively. The adjusted hazard ratio of SNHL for azithromycin vs. amoxicillin was 0.91 (95% CI, 0.77-1.07). The sensitivity analyses findings were consistent with the primary analysis.

Conclusion: Short-term use of azithromycin is not associated with an increased risk of SNHL compared to amoxicillin.

Define Professional Practice Gap & Educational Need: Recently, a systematic review of case reports and case series concluded that azithromycin short-term use might be associated with the risk of sensorineural hearing loss. However, with a lack of comparison group several confounding might arise. To date, no controlled studies have evaluated the association between azithromycin short-term use and sensorineural hearing loss.

Learning Objective: To provide evidence on whether azithromycin use is associated with increased risk of sensorineural hearing loss or not.

Desired Result: The lack of an association between azithromycin short-term use for acute infections and SNHL found in this study might be reassuring for clinicians.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB: Approved

Idiopathic Sudden Sensorineural Hearing Loss is Not a Sentinel Event for Acute Myocardial Infarction

Matthew G. Crowson, MD; Alan W. Langman, MD
Walter T. Lee, MD, MHS; Kourosh Parham, MD, PhD
Kristine Schulz, MPH, DrPH; Jennifer J. Shin, MD
Andrea Vambutas, MD

Objective: Given ongoing debate about the suggested association, the primary objective was to determine if idiopathic sudden sensorineural hearing loss (ISSNHL) was a sentinel event for acute myocardial infarction (AMI) in adults.

Study Design: Case-control study.
Setting: United States MarketScan administrative health claims database.

Patients: Aged 18 years or older, had a diagnosis of ISSNHL on or after January 1st 2011 and had sufficient follow-up data available to asses for AMI occurrence.

Intervention: N/A
Main Outcome Measures: Incidence rates (per 1,000 patient years) of AMI for cases and controls was computed. Adjusted and unadjusted Cox proportional hazards models were created to explore possible associations between ISSNHL and initial AMI.

Results: A total of 10,749 ISSNHL cases and 10,749 matched controls were included. There were no significant differences in the incidence rate of AMI between ISSNHL cases (8.29 events/1000 person-years) and controls (9.25 events/1000 person-years), nor were there differences within age groups, gender or comorbidity status (overall incidence rate ratio 0.90; 95% CI 0.70-1.15 p = 0.39). The unadjusted and adjusted cox proportional hazards models did not demonstrate an association between ISSNHL and initial AMI (HR: 0.90, 95% CI: 0.70-1.15; HR: 0.86, 95% CI: 0.67-1.10, respectively).
Conclusions: ISSNHL is not a predictor of an initial AMI in adult patients from the United States. Considerable inconsistencies in associations between cardiovascular risk factors and ISSNHL exist in the literature. Further work is needed to confirm or refute direct associations between cardiovascular disease risk factors and ISSNHL before definitive mechanistic conclusions can be made.

Define Professional Practice Gap & Educational Need: There is a lack of consensus for the role for idiopathic sudden sensorineural hearing loss (ISSNHL) as a sentinel event for acute myocardial infarction in adult patients. The most common pathological mechanisms studied for ISSNHL to date include infectious (viral and bacterial), cardiovascular disease, inflammation and immunological, genetic mutations, and central nervous system abnormalities. Interestingly, two prior database studies from Taiwan reported a significant association between ISSNHL and acute myocardial infarction. As of the writing of this abstract, no evidence has been published explaining a mechanistic connection between ISSNHL and AMI. Moreover, no population-level analysis exploring ISSNHL and AMI has been completed using data from the United States.
Learning Objective: At the conclusion of this activity, the participant should be able to: 1) Critically examine population-level data that suggests there is no significant relationship between patients presenting with idiopathic sudden sensorineural hearing loss as occurring to acute myocardial infarction versus patients without a history of idiopathic sudden sensorineural hearing loss, and 2) Demonstrate an awareness of the limitations of population-level health care claims data in making generalizable statements about medical condition associations.
Desired Result: At the conclusion of this activity, the participant should be able to apply this knowledge to: 1) Develop and design rigorous claims-data research methodologies to compare conditions of relevance to Otology, and 2) Counsel patients that there is conflicting evidence regarding a higher incidence of acute myocardial infarction after idiopathic sudden sensorineural hearing loss.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB: Exempt

Rational Cochlear Implant Electrode Design Based upon Temporal Bone Histopathology

Akira Ishiyama, MD; Ivan Lopez, PhD
Gail Ishiyama, MD; Fred Linthicum, MD

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

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

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

Results: The insertion of a cochlear implant electrode through the round window approach was associated with a significantly lesser degree of fibrosis compared with cochleostomy insertion. The temporal bone surrounding perilymphatic and endolymphatic compartments contained fibrous tissue that was in some cases, localized, and in other cases, widespread and ossified in proximity to the cochleostomy. In some cases of implants with longer electrodes, there was fibrosis in areas where the electrodes encountered the anterior bend of the first cochlear segment. Seven temporal bones demonstrated erosive changes of the lateral wall consistent with secondary degeneration due to long term use of the electrode.

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

Define Professional Practice Gap & Educational Need: Provide evidence for rational cochlear implant design based upon temporal bone histopathology.

Learning Objective: To improve the surgical out come in cochlear implantation based upon temporal bone histopathology.

Desired Result: Perform cochlear implantation through round window approach and select perimodiolar cochlear implant electrode.

Level of Evidence: LEVEL I - Large RCTs with clear cut results

IRB: Approved

Safety and Outcomes of Children Implanted under 36 Months

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Elizabeth Tournis, AuD; Hannah Kenny
Maura Ryan, MD; Nancy M. Young, MD

Objective: Determine safety and outcomes of cochlear implantation of children under age 36 months, including those implanted below age 12 months.

Study design: Retrospective review

Setting: Tertiary care children's medical center

Patients: Children receiving a cochlear implant (CI) before age 36 months; 27 implanted below age 12 months (Group <12m) and 141 between 12 and 36 months (Group 12-36m). Mean ages at first CI were 9.1mos (5.9-11.8) and 23.4mos (12.1-36.8), respectively. All of Group <12m received bilateral implants as did 70.2% of Group 12-36m. Mean length of follow-up and age at last follow-up did not differ significantly between groups (follow-up 6.6yrs vs 6.3yrs; age 7.4yrs vs 8.3yrs, respectively).

Interventions: Unilateral, sequential or simultaneous bilateral cochlear implantation

Main outcome measures: Surgical complications, open-set speech discrimination, primary communication mode(s).

Results: Cerebral spinal fluid leak occurred in 3 ears (2 in Group <12m) and wound infection in one (Group 12-36m). All children in Group <12m achieved open-set ability in each ear, including 3 children with complicating medical conditions associated with developmental delay and communication disorders. 91.9% of 124 tested in Group12-36m achieved open-set, including 10 of 13 children with complicating conditions. Those implanted at <12m were significantly more likely to develop spoken language as sole communication mode than those implanted older (85.2% vs 56.8%, $p \leq .005$).

Conclusions: Children implanted below age 12 months do not have an increased rate of surgical complications. Early implantation was associated with attainment of open-set ability in both ears and spoken language as sole communication mode.

Define Professional Practice Gap & Educational Need: 1. Lack of contemporary knowledge and awareness outcomes of cochlear implantation of children under 12 months of age. 2. Provide contemporary knowledge of safety of implantation of infants below 12 months of age

Learning Objective: 1. Will increase knowledge of impact of implantation between 12 and 36 months on speech perception and communication mode outcomes, including children with complicating conditions. 2. Will increase knowledge of complications of cochlear implantation of children below 37 months

Desired Result: Attendees will improve their understanding of the advantages early cochlear implantation of children with and without complicating conditions, including those implanted below age 12 months

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Approved

Beyond Sentence Recognition in Quiet for Older Adults:
Implications for Cochlear Implant Candidacy

Emily Zhang, BA; Daniel H. Coelho, MD

Objective: To study post-operative hearing outcomes in older adult cochlear implant recipients who did not meet Medicare candidacy criteria by sentence testing in quiet.

Study Design: Case Control Series

Setting: University Based Tertiary Referral Cochlear Implant Center

Patients: 54 Patients age 60 or greater with bilateral moderate to profound sensorineural hearing loss who underwent cochlear implantation. Patients were divided into three groups by pre-operative testing scores; 1) sentence recognition in quiet and monosyllabic word recognition scores < 40%, 2) sentence recognition in quiet scores > 40% and sentence recognition in noise scores < 40%, and 3) sentence recognition in quiet scores > 40% and monosyllabic word recognition scores < 40% in the ear to be implanted.

Intervention(s): Cochlear Implantation

Main outcome measure(s): Pre- vs. post-operative sentence and word recognition scores.

Results: All 3 groups received a statistically significant benefit from their cochlear implant as measured by both post-operative sentence and word recognition. When comparing post-operative sentence recognition scores between groups, there were no statistically significant differences between groups. (Group 1: Mean 83.1%, SD +/- 17.4%; Group 2: Mean 90.1%, SD +/- 8.0%; Group 3: Mean 90.6%, SD +/- 6.9%). When comparing post-operative monosyllabic word recognition scores, there were no statistically significant differences between groups. (Group 1: Mean 60.3%, SD +/- 19.6%; Group 2: Mean 66.8%, SD +/- 20.0%; Group 3: Mean 70.%, SD +/- 18.8%).

Conclusions: Results of this study demonstrate that older patients who do not meet current Medicare candidacy criteria derive significant long-term benefit from cochlear implantation when either sentence in noise or monosyllabic word recognition in quiet <40% is used to determine candidacy. Further research and greater numbers are needed to better characterize the role of monosyllabic word recognition in cochlear implant candidacy.

Level of Evidence: III

IRB Approval: Yes

Further Evidence of the Relationship between Cochlear Implant Electrode Positioning and Hearing Outcomes

Jack H. Noble, PhD; René H. Gifford, PhD
Benoit M. Dawant, PhD; Brendan O'Connell, MD
Jianing Wang, MS; Robert F. Labadie, MD, PhD

Hypothesis: Intra-cochlear positioning of cochlear implants (CI) has a significant relationship with audiological outcomes.

Background: Post-operative imaging studies by numerous groups have revealed that final CI electrode position impacts audiological outcomes with scalar location consistently shown to be an important factor but modiolar proximity less extensively studied. Findings regarding the effect of insertion depth have been inconsistent.

Methods: Using previously developed automated algorithms, we determined CI electrode position in an IRB-approved database of 161 CI ears. Generalized linear models (GLM) were used to analyze the relationship between audiological outcomes and other factors including age, duration of CI use, device type, and electrode position.

Results: For 85 pre-curved arrays, GLM revealed that age, scalar position, and modiolar distance were significant ($p<0.0001$) factors for CNC words ($R=0.44$) and BKB-SIN ($R=0.57$). Other factors were not significant after controlling for other variables in the model. For 76 straight arrays, we found insertion depth to be the only significant ($p<0.016$) factor (CNC $R=0.28$; BKB-SIN $R=0.23$). When ordered according to significant electrode position factors, the mean scores for the top 25% versus bottom 75% were 68% versus 48% (CNC) and 8.7dB versus 15.1dB (BKB-SIN) for pre-curved arrays and 52.5% versus 38.7% and 12.9dB versus 15.5dB for straight electrodes.

Conclusion: These findings suggest that optimal audiological outcomes are associated with pre-curved electrodes that stay within scala tympani and are positioned close to the modiolus. For straight electrodes, deeper insertion depths are associated with better outcomes. Analyses on our continually expanding dataset will be presented at the conference.

Define Professional Practice Gap & Educational Need: Lack of contemporary knowledge on how intra-cochlear position of cochlear implant electrodes relate to outcomes.

Learning Objective: Attendees will learn how cochlear implant positioning correlates with outcomes.

Desired Result: Attendees will apply this knowledge when considering electrode insertion techniques and cochlear implant designs.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB: Approved

Earphone and Aided Word Recognition Differences in Cochlear Implant Evaluations

Theodore R. McRackan, MD, MSCR; Jane Burton, AuD
Joshua E. Fabie, BS, Jayne B Ahlstrom, MS
Meredith E. Holcomb, AuD, Ted A. Meyer, MD, PhD
Paul R. Lambert, MD, Judy R. Dubno, PhD

Objective: Compare word recognition scores for adults undergoing cochlear implant evaluation (CIE) measured using earphones and with hearing aids (HA)

Study design: Retrospective review of data obtained during adult CIEs.

Setting: Tertiary cochlear implant center

Patients: 338 ears in 174 subjects with greater than 10% earphone word recognition scores.

Interventions/Main outcomes measured: Pre-operative earphone and aided pure tone thresholds and word recognition scores.

Results: A review of audiological data obtained from 2012-2016 during adult CIEs was conducted. Overall, a low positive correlation (r=0.39, 95% CI 0.30-0.48, p=0.002) was observed between word recognition scores measured with earphones and in the sound field with hearing aids. Earphone to aided differences (EAD) (McRackan, et al., 2016) ranged from -59% to +87% (mean 3.3±24.3%). Consistent with EADs, 75 ears (22.2%) had earphone scores that were significantly higher than aided word recognition scores (+EAD), as determined by 95% confidence intervals; for 57 ears (16.9%), earphone scores were significantly lower than aided scores(-EAD). Using a multivariable regression model, EAD increased with pure-tone average (OR 0.31, 95% CI 0.12-0.50, p=0.001).

Conclusion: These results demonstrate the limited diagnostic value of word recognition scores measured under earphones. Nevertheless, aided word recognition is rarely measured outside of CIEs. Earlier and routine measurement of aided word recognition may help guide clinical decision making by determining whether patients are achieving maximum benefit with their hearing aids or should consider cochlear implantation.

Define Professional Practice Gap & Educational Need: 1) Lack of knowledge regarding the low correlation between word recognition scores measured with earphones and in the sound field with hearing aids. 2) Lack of understanding of how measures of aided word recognition in the clinical test battery can inform clinical decision making for cochlear implantation candidacy.

Learning Objective: 1) Attendees will learn the poor association between word recognition measured with earphones and in the sound field with hearing aids and implications for clinical decision making. 2) Attendees will learn that measures of aided word recognition provide better estimates of functional communication abilities, which is important for determining whether patients should consider cochlear implantation.

Desired Result: 1) Aided word recognition may be incorporated into the standard audiologic test battery to provide better estimates of functional communication abilities for patients who use hearing aids. 2) Aided word recognition will guide clinical decision making and improve patient care.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB: Approved

Inappropriate Use of Systemic Antibiotics for Acute Otitis Externa: Impact of the 2006 Clinical Practice Guideline

Xi Wang, MPH; Almut G. Winterstein, PhD
Yan Li, MS; Yanmin Zhu, BS
Patrick J. Antonelli, MD

Objective: We aimed to examine the extent of inappropriate use of systemic antibiotics among acute otitis externa (AOE) patients, as well as the enforcement of clinical practice guideline among Medicaid beneficiaries.

Study Design: Interrupted time series study using Medicaid claims data, 1999-2010

Patients: Children and adults with 12 months continuous Medicaid enrollment prior to the first diagnosis of AOE (index date) and antibiotic prescriptions within one day of index date

Intervention: Clinical practice guideline published in 2006 by the American Academy of Otolaryngology-Head and Neck Surgery Foundation

Main outcome measure: The primary outcome was the proportion of the systemic antibiotic use v. any antibiotic treatment for AOE. Segmented regression analysis of interrupted time series was used to evaluate changes in the primary outcome before and after the 2006 clinical practice guideline publication. Stratified analyses by age group (children and adults) were conducted.

Results: 624,368 AOE patients had at least one systemic or topical antibiotic use from January 2002 to December 2010. In the segmented regression, we did not observe any immediate (-0.021; P=0.675) or delayed (0.002; P=0.769) drop on the proportion of AOE patients with systemic antibiotic treatment associated with publication of 2006 guideline. The stratified analyses findings were consistent with the primary analysis.

Conclusion: The clinical guideline did not lead to a decline in systemic antibiotic prescriptions as initial AOE treatment. Additional efforts will be needed to curb inappropriate, systemic antibiotic treatment of AOE.

Define Professional Practice Gap & Educational Need: Avoidance of inappropriate use of systemic antibiotics among AOE patients has been a measurement in National Quality Strategy (NQS) to evaluate effectiveness of clinical care. Previous evidence was limited to insufficient observation period, small sample size, use of weak study design and statistical tests, as well as generalizability of the study population.

Learning Objective: To provide evidence on whether there is change in the trends of inappropriate use of systemic antibiotics from 2002-2010 among Medicaid beneficiaries after the 2006 guideline published.

Desired Result: Results of this study might be of interest as targets for policymakers and public health interventions, particularly more evaluation about the quality measurement of AOE for hospitals.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB: Approved

A Case-Control Study of Hearing Outcomes between Middle Fossa Craniotomy and Transmastoid Approach for Surgical Repair of Superior Semicircular Canal Dehiscence Syndrome

Lisa Zhang, BS; Francis X. Creighton Jr, MD
Bryan Ward, MD; Stephen Bowditch, AuD, CCC-A
John P. Carey, MD

Objective: To compare postoperative hearing outcomes for transmastoid (TM) approach to middle cranial fossa (MCF) approach for surgical repair of superior semicircular canal dehiscence syndrome (SCDS).

Study Design: Historical case-control study

Setting: Tertiary referral center

Patients: 13 consecutive cases with SCDS who underwent TM plugging of the superior canal; "controls" were 15 audiogram-matched patients who underwent MCF plugging and resurfacing of the canal.

Main Outcome Measures: Differences between preoperative, 7-day postoperative, and long-term (>6 weeks) postoperative air and bone conduction, speech discrimination scores (SDS), and pure tone averages (PTA) in TM cases vs MCF controls.

Methods: Controls were selected from a larger pool of MCF cases by matching preoperative BC thresholds from the TM cases within 10-dBs of BC thresholds in ≥80% of recorded frequencies. Wilcoxon signed-rank tests were performed to compare main measurement outcomes between matches

Results: No statistically significant differences were found in >6 week post-operative air and bone conduction thresholds at any frequency. Similarily, there were no differences in long-term SDS or PTA between TM and MCF patients ($p=0.43$ and $p=0.38$, respectively). However, at 7-day follow-up, patients who underwent TM surgical repair had significantly lower SDS than those who underwent MCF repair ($p<0.05$). This may reflect greater incidence of middle ear/mastoid effusions 7 days after surgery in the TM approach.

Define Professional Practice Gap & Educational Need: Understanding effects on hearing outcomes from different surgical approaches for SCDS.

Learning Objective: No long-term differences in hearing were observed between transmastoid and MFC approaches for SCDS surgical repair in this pilot study.

Desired Result: A better understanding of hearing outcomes from different surgical techniques could better inform management of SCDS.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB: Approved

Next-generation Sequencing of Sporadic Vestibular Schwannoma: Necessity of The Two-Hit Mechanism and Implications of Accessory non-*NF2* Alterations

Matthew L. Carlson, MD; Michael J. Link, MD
James B. Smadbeck, PhD; Eric W. Klee, PhD
Lisa A. Schimmenti, MD; George Vasmatzis, PhD

Objectives: 1) Describe the genetic alterations discovered in a series of sporadic vestibular schwannomas (VS). 2) Identify if more clinically aggressive variants possessed different genetic alterations compared to more indolent behaving VS.

Methods: Fresh frozen tumor and matched leukocytes from 23 cases of sporadic VS were analyzed using whole-exome sequencing, whole transcriptome expression profiling (mRNA-Seq) of tumor and mate-pair sequencing of tumor. Source cases included tumors with fast preoperative growth, giant tumors in young patients, tumors with macrocystic change, recurrent tumors following radiation or microsurgery, and indolent small tumors with minimal or no growth prior to surgery.

Results: A double hit to the *NF2* gene was discovered in all specimens and none of these mutations occurred in the peripheral blood. Thirteen tumors had complete loss of one chromosome 22 (ch22). Four tumors had loss of heterozygosity of ch22. Thirty-one unique mutations in the *NF2* gene were discovered: 10 essential splice site, 11 frame shift, 6 stop gain, 2 nonsynonymous and 2 in-frame mutations. No other common gene mutations were found. However, several other chromosomal aberrations were discovered including 2 tumors also had loss of a ch21, 3 had loss of an X or Y chromosome, 1 lost ch15 and 1 had loss of ch18p and ch16q. All of these other major chromosomal abnormalities only occurred in tumors demonstrating a more aggressive phenotype.

Conclusions: Using high-throughput sequencing, “two-hit” alterations in the *NF2* gene were identified in all cases. Type of *NF2* gene alteration and accessory mutations outside the *NF2* locus may predict phenotypic expression.

Define Professional Practice Gap & Educational Need: Lack of contemporary knowledge regarding genomic landscape of sporadic vestibular schwannoma

Learning Objective: By the conclusion of this session, participants should be able to: 1) describe patterns of the "double-hit" mechanism in the NF2 gene for cases of sporadic vestibular schwannoma; 2) Discuss non-NF2 gene alterations associated with more aggressive phenotype.

Desired Result: These data may be used in future studies examining genotype-phenotype correlation and, ultimately, for use in patient counseling and prediction of aggressive phenotype in order to tailor therapy.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB: Approved

Immunolocalization of the Amiloride-Sensitive Epithelium Sodium Channel Beta Subunit (ENaCβ) in Human Vestibular End Organs in Normative and Meniere's Disease

Michele M. Gandolfi, MD; Gail Ishiyama, MD
Ivan A. Lopez, PhD Akira Ishiyama, MD

Hypothesis: The Amiloride-sensitive epithelium sodium channel beta subunit (ENaCβ) in the human inner ear will immunolocalize to areas within the crista ampullaris and macula utricle. Its expression will be altered in intractable Meniere's disease.

Background: ENaC is a member of the epithelial sodium channel (ENaC/Degenerin (DEG) superfamily of ion channels. ENaC subunit expression has been previously investigated in the inner ear of several rodent animal models. There are no immunolocalization studies of ENaC expression in human vestibular end organs.

Methods: Vestibular endorgans were harvested within 6 to 12 hours post mortem from individuals with no history of ear pathologies (n=5). Vestibular endorgans from patients with intractable Meniere's disease (n=3) and acoustic neuroma (n = 3) were harvested. Twenty-micron thick cryostat sections were incubated with a rabbit antiserum against the ENaCβ subunit. Specimens were analyzed using fluorescent microscopy.

Results: In the crista ampullaris and macula utricle, ENaCβ immunoreactivity localized in the transitional epithelial cells at the periphery of the vestibular sensory epithelia. Hair cells and supporting cells were not immunoreactive. Colocalization of ENaCβ with Na+K+ATPase corroborates the localization of ENaCβ in non-sensory epithelial cells. ENaCβ immunoreactivity was also seen in fibroblast of the crista and utricle stroma.

Conclusions: These findings validate that animal studies of ENaC in aldosterone-modulation of vascular endothelial function are likely relevant to human inner ear physiology. The lack of alteration of expression of ENaC in intractable Meniere's disease may be significant given the lack of effectiveness of low salt diet or diuretics in these intractable cases.

Define Professional Practice Gap & Educational Need: 1. Lack of understanding of molecular and cellular biology of the human inner ear 2. Lack of understanding of the etiology of intractable Meniere's disease

Learning Objective: 1. Understanding of the molecular and cellular biology of the human inner ear 2. Understanding of the etiology of intractable Meniere's disease

Desired Result: Through increased understanding of the molecular and cellular physiology of the human inner ear comes improved clinical management and care of patients with inner ear pathologies.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB: Approved

Perceptions from Adult Individuals with Hearing Loss When Communicating in The Healthcare Setting

Madelyn N. Stevens, BA; Judy Dubno, PhD
Margaret I. Wallhagen, PhD; Debara L. Tucci, MD

Objective: To characterize communication difficulty and unmet needs in the healthcare setting for younger and middle-aged adults with hearing loss.

Study Design: Large-scale anonymous survey

Setting: Primary care clinic

Patients: Individuals 18-65 years of age with hearing loss, with or without amplification device(s)

Main outcome measures: Likert-type variables assessing communication difficulty in situations related to the clinic setting and communication with specific providers.

Results: 587 adults aged 18-65 with self-reported hearing loss responded to the survey. The majority reported using hearing aids (65%), followed by cochlear implants (14%), no device (11%), and both devices (10%). Respondents communicated most frequently with physicians, nurses, receptionists, and pharmacists, and over 50% of respondents reported moderate or significant communication difficulties with each provider. Three situations resulted in respondents sometimes or often having difficulty understanding spoken communications: the waiting room, when the speaker's back was turned, and when communicating by telephone. Of the over 90% of individuals who made clinic staff aware of their hearing impairment, 32% reported no additional special arrangements were made.

Conclusions: This study clearly demonstrates the ongoing difficulties faced by young and middle-aged adult patients with hearing loss as they attempt to navigate both providers and situations associated with a clinical setting. For this population in particular, providers may not expect patients to have significant hearing loss and therefore may not make additional efforts to appropriately communicate, even when made aware of the patient's hearing impairment. Provider-led changes to communication strategies for effective healthcare delivery should be encouraged and further explored.

Define Professional Practice Gap & Educational Need: 1. Lack of awareness of issue 3. Inconsistent provider response to communication difficulties

Learning Objective: Understand the communication difficulties described by patients seeking healthcare Understand potential gaps in effective clinical care as a result of miscommunication

Desired Result: Engage with patients to explore potential miscommunication and unmet needs Lead clinical team in modeling effective communication with patients

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Approved

Flat Panel Computed Tomography in the Diagnosis of Superior Canal Dehiscence Syndrome

Alexandra E. Tunkel; John P. Carey, MD
Monica S. Pearl, MD, DABR

Hypothesis: Flat Panel Computed Tomography (FPCT) provides more accurate estimates of dimensions for Superior Canal Dehiscence (SCD) than multi-slice CT (MSCT).

Background: SCD syndrome occurs when a bony defect of the superior semicircular canal causes an array of vestibular and auditory symptoms. MSCT has been shown to overestimate the size of SCD. Over-diagnosis of SCD and suboptimal selection of surgical approach could occur due to these overestimates. FPCT, with higher resolution for temporal bone imaging, should have smaller error.

Methods: Radiographic and surgical findings were compared and correlated in 15 patients (age 38-62) with clinical SCDS confirmed at surgery. 20-second FPCT scans were acquired prior to surgery with parameters: 109Kv, small focus, 200° rotation angle, and 0.4°/frame angulation step. Dehiscence dimensions were measured from orthogonal multiplanar reconstructions on a high-resolution LCD monitor and compared with actual measurements recorded during microsurgery.

Results: Average±SD SCD dimensions by FPCT (x) were 2.6±1.5 mm for length and 0.64±0.26 for width. The surgical measurements (y) were 2.6±1.5 mm for length and 0.62±0.34 mm for width. Linear fits between x and y yielded R^2 values of 0.95 (length) and 0.71 (width). Our previous study using MSCT had R^2 values of 0.28 (length) and 0.48 (width). The average difference between each FPCT corresponding surgical measurement was not significantly different from zero.

Conclusion: FPCT can provide more accurate measurements of SCD compared to MSCT. Clinicians should consider using FPCT for the workup of SCDS in order to avoid errors in detecting SCD and in estimating its size.

Define Professional Practice Gap & Educational Need: Multi-slice CT is typically used in the diagnosis of Superior Canal Dehiscence (SCD) syndrome, but this technique has been shown to be imprecise in the measurement of superior canal defects.

Learning Objective: Flat Panel CT (FPCT) provides higher resolution images of the superior canal with less radiation exposure. The learning objective of this study is to show that FPCT is a better technique for imaging SCD.

Desired Result: The desired result is increased use of FPCT for SCD imaging, providing more accurate SCD diagnosis and surgical treatment planning.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB: Approved

SELECTED ABSTRACTS

POSTER PRESENTATIONS

151st Annual Meeting
AMERICAN OTOLOGICAL SOCIETY

April 20-21, 2018
Gaylord National Resort
National Harbor, MD

POSTERS WILL BE VIEWED ON FRIDAY & SATURDAY

Simultaneous Labyrinthectomy and Cochlear Implantation in Unilateral Meniere's Disease

Elizabeth L. Perkins, MD; Meredith Anderson Rooth, AuD
Margaret T. Dillon, AuD; Kevin D. Brown, MD, PhD

Objective: In a single-institution, FDA-approved IDE study, subjects with unilateral Meniere's disease and intractable vertigo underwent concurrent labyrinthectomy and cochlear implantation to determine speech perception, localization, and quality of life outcomes.

Study Design: Prospective cohort study

Setting: Tertiary referral center

Patients: Subjects with unilateral Meniere's disease and intractable vertigo with normal or near-normal hearing in the contralateral ear

Intervention: Rehabilitative

Main Outcome Measures: Sound localization, AzBio, CNC in quiet, THI, SSQ, APHAB

Results: Three subjects with unilateral Meniere's disease underwent simultaneous labyrinthectomy and cochlear implantation. Sound localization testing demonstrated immediate benefit post-implantation with the cochlear implant (CI). RMS error with CI on was 22 degrees (± 2) and with CI off was 63 (± 15) at 6 months. Mean CI-alone scores were 22% (± 20) at 1-month and improved to 43% (± 20) and 49% (± 11) at the 3- and 6-month intervals, respectively. AzBio sentences in babble (0 dB SNR) scores presented in the most challenging listening condition (S0NContra) were 28% (± 20) at 1-month, 38% (± 18) at 3-months, and 45% (± 24) at 6-months. Tinnitus Handicap Inventory (THI) significantly improved from an average pre-operative score of 42 (± 26) to zero at 6 months. Quality of life measures improved overall over the post-implantation follow-up intervals.

Conclusions: Subjects with unilateral Meniere's Disease who underwent simultaneous labyrinthectomy and cochlear implantation experienced improvements in sound localization, speech understanding, tinnitus severity, and quality of life with device use. There was a trend for better performance over the postoperative intervals.

Define Professional Practice Gap & Educational Need: 1. Simultaneous labyrinthectomy and cochlear implantation provides a unique opportunity to eliminate debilitating vertigo and restore hearing in a non-aidable ear in patients with unilateral Meniere's Disease. 2. Current studies of outcomes following simultaneous labyrinthectomy and CI in Meniere's Disease are limited to retrospective studies of either bilateral disease or results part of a larger cohort. There is a current lack of prospective outcomes with consistent post-operative testing intervals.

Learning Objective: 1. To identify patients with unilateral Meniere's Disease who may benefit from simultaneous labyrinthectomy and cochlear implantation. 2. To recognize the post-operative improvement in sound localization, speech perception, and quality of life following simultaneous labyrinthectomy and cochlear implantation in patients with unilateral Meniere's Disease.

Desired Result: To expand the practice of unilateral cochlear implantation in patients with Meniere's Disease by the way of simultaneous labyrinthectomy and cochlear implantation. In addition, to provide support for future broadening of FDA approval of cochlear implantation for single sided deafness.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB: Approved

Trends in Intraoperative Testing during Cochlear Implantation

Joshua C. Page, MD; Matthew D. Cox, MD
Blake Hollowoa, BS; Juliana Bonilla-Velez, MD
Aaron Trinidade, FRCS; John L. Dornhoffer, MD

Objective: No consensus guidelines exist regarding intraoperative testing during cochlear implantation (CI) and wide variation in practice habits exists. The objective of this observational study was to survey otologists/neurotologists to understand practice habits and overall opinion of usefulness of intraoperative testing.

Study Design: Cross-sectional survey

Setting: A web-based survey was sent to 194 practicing Otologists/Neurotologists

Main Outcome Measures: Questions included practice setting and experience, habits with respect to electrodes used, intraoperative testing modalities used, overall opinion of intraoperative testing and practice habits in various scenarios.

Results: 39/194 (20%) completed the survey. For routine cases, ECAPs and EIs were most commonly used together (38%) while 33% do not perform testing at all. 89% note that testing 'rarely' or 'never' changes management. 51% marked the most important reason for testing is the reassurance provided to the family and/or the surgeon.

Conclusion: Intraoperative testing habits and opinions regarding testing during CI vary widely among otologic surgeons. The majority of surgeons use testing but many feel there is minimal benefit and that surgical decision-making is rarely impacted. The importance of testing may change as electrodes continue to evolve.

Define Professional Practice Gap & Educational Need: Lack of knowledge regarding how intraoperative testing during cochlear implantation is being used and perceived across the nation.

Learning Objective: The learner will better understand how intraoperative testing is being used across the nation and gain an understanding regarding the current opinion of intraoperative testing.

Desired Result: Our hope is that attendees may incorporate this data into his/her practice, specifically regarding use of intraoperative testing during cochlear implantation.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Exempt

Treatment Outcomes of Rituximab for Intractable Otitis Media with ANCA-Associated Vasculitis Running head: Rituximab for OMAAV

Masahiro Okada, MD, PhD; Koichiro Suemori, MD, PhD
Masato Teraoka, MD, PhD; Hiroyuki Yamada, MD, PhD
Takuya Matsumoto, MD, PhD; Hitoshi Hasegawa, MD, PhD
Naohito Hato, MD, PhD

Objective: To investigate treatment outcomes, hearing outcome, and adverse effects of rituximab (RTX) for intractable otitis media with antineutrophil cytoplasmic antibody (ANCA)-associated vasculitis (OMAAV).
Study design: Retrospective case review.

Setting: University hospital

Patients: Twenty-three patients who met the criteria proposed by the OMAAV study group were included. RTX was used for patients who had difficulty achieving induction of remission using glucocorticoids and intravenous cyclophosphamide.

Main outcome measures: Treatment outcomes, hearing outcome, and adverse effects

Results: Results: Six patients were treated with RTX (RTX group), while 17 patients did not require RTX for induction of remission (no RTX group). All 6 patients in the RTX group achieved remission. Age, sex, and months from onset to diagnosis were not significantly different between the RTX and no RTX groups. Hearing thresholds at diagnosis and remission were 71.7 ± 6.3 dB and 50.1 ± 5.1 dB in the RTX group, and 56.8 ± 4.8 dB and 35.8 ± 4.8 dB in the no RTX group, respectively. Hearing level at remission was significantly better in the no RTX group than in the RTX group ($p < 0.05$), while hearing gain was not significantly different between groups. Infectious complications were similar between groups.

Conclusions: Our findings suggest that RTX is effective and safe for intractable OMAAV. As hearing levels at remission were worse in the RTX group than in the no RTX group while hearing gain was similar between groups, earlier diagnosis may be needed to improve hearing outcome.

Define Professional Practice Gap & Educational Need: Lack of contemporary knowledge about treatment outcomes, hearing outcomes, and adverse effects of rituximab for otitis media with ANCA-associated vasculitis (OMAAV)

Learning Objective: Rituximab is effective and safe for intractable OMAAV, and hearing gain is equivalent to glucocorticoids and/or immunosuppressants.

Desired Result: Rituximab is one of the treatment choices for intractable otitis media with ANCA-associated vasculitis (OMAAV).

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Approved

An Evaluation of Intraoperative Testing during Cochlear Implantation from a Time and Cost Perspective

Joshua C. Page, MD; Fida Abdulaziz Al-Muhawas, MD
Tristan Allsopp, MD; Saleema Karim, PhD, MBA, MHA
John L. Dornhoffer, MD

Objective: To measure the time spent performing intraoperative testing during cochlear implantation (CI) and determine the impact on hospital charges.

Study Design: Prospective, blinded time study

Setting: Tertiary referral hospital

Patients: Twenty-two children (7 months-18 years old) who underwent a total of 22 consecutive primary and/or revision CI by a single surgeon from December 2016 to July 2017.

Intervention: The time spent performing intraoperative testing including evoked compound action potentials (ECAP) and electrical impedances (EI) was recorded for each case. The audiologist performing the testing was blinded to the time study. Billing information was used to determine if the testing contributed to increased operative charges to the patient.

Outcome Measures: Whether intraoperative testing contributed to increased operative charges to the patient.

Results: The average time spent testing (ECAPs/EIs in all cases) was 6.7 minutes (range: 2-26 minutes). No correlation was found between testing time and preoperative CT findings, the audiologist performing testing or the electrode type used ($p>.05$). Based on billing data including time spent in the operating room (OR), 6/22 (27%) cases incurred greater charges than if intraoperative testing had not been performed.

Conclusion: Our data suggests that intraoperative testing increases time in the OR and can contribute to increased hospital charges for CI patients. The utility of intraoperative testing in routine CI cases has been questioned and by using it selectively, costs incurred by patients and hospitals may be reduced. This is of interest in a healthcare environment that is increasingly focused on cost, quality and outcomes.

Define Professional Practice Gap & Educational Need: Lack of knowledge regarding the time it takes to perform intraoperative testing during cochlear implantation and its impact on hospital charges to patients.

Learning Objective: To share the results of our time study and cost analysis of intraoperative testing and discuss the implications each may have on practice habits.

Desired Result: Learners will better understand intraoperative testing from a time and cost perspective and how these factors impact billing and charges to patients.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Approved

Smoking Cessation and Risk of Hearing Loss

Brian M. Lin MD, ScM; Gary C. Curhan, MD, ScD; Molin Wang, PhD
Konstantina M. Stankovic, MD, PhD; Roland Eavey, MD, SM
Michael J. McKenna, MD; Sharon G. Curhan, MD, ScM

Objective: To prospectively examine the relation between smoking cessation and risk of hearing loss.

Study design: Cohort study

Setting: Nurses' Health Study II

Patients: Eligible women included 81,676 participants in the Nurses' Health Study II aged 27-44 years in 1991 who provided information on smoking status in 1991, provided information on hearing loss on either the 2009 or 2013 questionnaire, and reported hearing loss with date of onset after 1991. Information on smoking and covariates was updated biennially.

Intervention(s): None

Main outcome measure(s): Self-reported moderate or worse hearing loss

Results: During 1,546,664 person-years of follow-up, 2,799 cases of moderate or worse hearing loss were reported. There was a trend towards higher risk of hearing loss among current smokers with higher cigarette/day use (multivariable-adjusted relative risk (MVRR) of hearing loss, 1-4 cigarettes/day compared with never smokers (1.03 [0.76, 1.41]), 15+ cigarettes/day compared with never smokers (1.27, [1.07, 1.51]) *P-trend*<0.001). Among past smokers, the MVRR for hearing loss was 1.18 [1.08, 1.29], compared with never smokers. There was a trend towards lower risk of hearing loss with longer time since smoking cessation (MVRR for <5 years since smoking cessation compared with never smoker 1.33 [1.07, 1.64]; MVRR for 20+ years since smoking cessation compared with never smoker 1.18 [1.05, 1.33], *P*-trend 0.006).

Conclusions: In this large, prospective cohort of US women, past smokers and current smokers had a higher risk of hearing loss compared with never smokers, and longer time since smoking cessation was associated with lower risk of hearing loss.

Define Professional Practice Gap & Educational Need: Smoking is associated with higher risk of hearing loss, but the relation between risk of hearing loss and time since smoking cessation is unclear.

Learning Objective: Risk of hearing loss decreases with longer time since smoking cessation

Desired Result: To better understand the relation between time since smoking cessation and risk of hearing loss.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB: Approved

The Cleating Stitch: An Adjunctive Technique for Percutaneous and Revision Osseointegration Screws

Matthew M. Fort, MD; Megan E. Scarbrough, BS
Benjamin M. McGrew, MD

Objective: The bone anchored hearing aid (BAHA) has become a widely used and successful option in treatment of conductive and mixed hearing loss, and single sided deafness. Despite improvements in technique and cosmesis, complications remain that can result in implant revision or removal. Herein we describe a unique adjunctive technique, the cleating stitch, in placement of osseointegration screws and examine its impact on complication rates.

Study Design: Retrospective case review

Setting: Tertiary academic medical center

Patients: A total of 66 implants in 65 patients (35 male, 30 female) with an average age of 54 years (15-81 years). Average follow up 10.8 months.

Intervention: All patients underwent BAHA implant placement by a single surgeon between April 2012 to June 2017 using the linear incision or punch techniques with soft tissue reduction and placement of a cleating stitch.

Main Outcome Measure: Main outcome measures include rates of revision surgery, overgrowth, extrusion and Holgers reaction ≥2. Secondary outcome measures include associations between main outcome measures and outlying factors (Obesity, Smoking, Diabetes Mellitus, Coronary Artery Disease, Age).

Results: The overall rate of revision was 3%, rate of overgrowth 1.5%, rate of extrusion 1.5%, and Holgers reaction ≥2 10.6%. Overgrowth and extrusion both required revision. Older age was associated with decreased risk of Holgers reaction ≥2 ($p=0.03$) with a Hazard Ratio of 0.95 (Confidence Interval 0.9-1.0). There were no other statistically significant associations between primary outcome measures and outlying factors.

Conclusion: The cleating stitch is an effective adjunctive technique in placement of osseointegration screws associated with low rates of overgrowth and overall revision surgery.

Define Professional Practice Gap & Educational Need: 1. Variability in surgical techniques with osseointegration devices 2. Significant complications associated with procedures

Learning Objective: Introduction/demonstration of a unique surgical technique

Desired Result: 1. Improved surgical outcomes 2. Adopting a new technique in practice

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Approved

Soft Canal Wall Reconstruction in Modified Radical Tympanomastoidectomy for Aggressive Cholesteatoma

Karl Doerfer, MD, David R. Friedland, MD, PhD

Objective: To assess clinical outcomes of cholesteatoma surgery consisting of a modified radical tympanomastoidectomy with soft wall reconstruction (MRTMSWR).

Study design: Retrospective chart review. Level IV

Setting: Tertiary referral center

Patients: Patients with primary and recurrent cholesteatoma with ossicular involvement.

Intervention: Surgery for cholesteatoma consisting of a modified radical tympanomastoidectomy with reconstruction of the posterior canal wall with temporalis fascia.

Main outcome measures: Patients were assessed regarding recurrence of cholesteatoma, hearing status, post-operative healing, and surgical complications.

Results: 41 ears had sufficient follow-up for analysis. Only 13% of soft wall reconstructions broke down while 35% appeared as normal caliber external canals and 52% formed limited cavities. Retractions were typically over a broad front without small pockets or diverticula to trap debris. All ears achieved full epithelialization regardless of cavity formation with 91.7% achieving this before 3 months. Over 90% of ears were within 20dB of pre-operative thresholds after MRTMSWR and 38.5% of those undergoing second-look OCR were able to be improved. Despite starting with advanced disease, 61% of ears were free from disease on follow-up second-look or MRI. Of the16 ears showing recurrent/residual disease, 69% of these had only a small foci of <5mm.

Conclusions: Treatment of aggressive cholesteatoma with a canal wall down approach does not necessarily commit the patient to a lifetime of cavity cleanings. Soft wall reconstruction affords the opportunity for rapid epithelialization, potential ossicular reconstruction, and broad retractions minimizing the risk of recurrent disease.

Define Professional Practice Gap & Educational Need: 1) Variations in practice patterns for cholesteatoma surgery 2) Lack of awareness of alternatives to canal wall down cholesteatoma surgery

Learning Objective: To understand alternative options for radical cholesteatoma surgery

Desired Result: Attendees would be able to use gain new surgical techniques and care options for cholesteatoma.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB: Approved

Novel Computer-Based Therapy Enhances Speech Perception in Cochlear Implant Users

Akshay R. Narayan, BSc

Introduction: Our main goal was to investigate if personalized auditory therapy in the comforts of patient's homes, is more effective at improving speech perception than conventional computer-based auditory therapy in cochlear implant users.

Methods: In this randomized, prospective study, candidates were split into two groups. In round one, candidates underwent testing to record the percentage of correctly identified words. In round two, they received training by listening to sentences and identifying the constituent words. If they could not identify a word correctly, the sentence was replayed identically for candidates in the first group. In the second group, emphasis was placed on the difficult words by varying its tone and pitch. In round three, they underwent testing again and the percentage of words they were able to correctly identify before and after training was compared. A paired t-test was used to look for any significant difference in the levels of improvements.

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

Conclusion: Given our new computer program improves their speech perception to a greater extent, broadening the study to a larger patient population would be ideal.

Define Professional Practice Gap & Educational Need: Auditory therapy is offered post-surgery to cochlear implant users and helps them to differentiate between specific sounds,phonemes, and identify words. In the UK, there are very limited facilities for provision of auditory therapy. The main limitations of auditory therapy in the UK are twofold: 1) they mostly require face-to-face interaction which requires patients to come into healthcare centres to receive therapy and 2) computer-based programmes utilise the same pitch and tone. We are looking to explore the possibility that auditory therapy should be provided in the comforts of the patient's home and be unique to each patient's needs.

Learning Objective: 1. Auditory therapy can be provided via computer programmes 2. Auditory therapy can be tailored to each patient's unique needs 3. Auditory therapy combining the aforementioned attributes is superior to pre-existing auditory therapy

Desired Result: 1. Attendees will learn to embrace the role information technology in the provision of healthcare 2. Attendees can learn about the importance of auditory therapy in providing continuity of care to patients once they have left the hospital

Level of Evidence - LEVEL II - Small RCTs with unclear results

IRB: Exempt

Primary Middle Ear Mucosal Melanoma: Case Report and Review of 21 Cases of Primary Middle Ear and Eustachian Tube Melanoma in the Literature

Anne K. Maxwell, MD; Hiroki Takeda, MD
Samuel P. Gubbels, MD

Objective: To present a case of primary middle ear mucosal melanoma and perform a comprehensive literature review of middle ear or eustachian tube mucosal melanoma.

Patient: A 61-year-old female presented with no prior history of melanoma and 3 months of aural fullness. A middle ear mass was identified and returned as primary mucosal melanoma upon biopsy. The mass extended from mesotympanum into hypotympanum, epitympanum, protympanum, eustachian tube and mastoid antrum. A non-enhancing expansile lesion of the petrous apex was noted on MRI additionally.

Intervention: Subtotal temporal bone resection with transotic approach to the petrous abnormality. Postoperative adjuvant radiation and immunotherapy were given.

Results: Our patient has no evidence of disease recurrence to date. Upon comprehensive literature review, patients with primary middle ear melanomas (n=10) present with otorrhea (50%), aural fullness (40%), and hearing loss (30%) most commonly, while hearing loss (81.8%) and aural fullness (54.5%) were most common symptoms for eustachian tube melanomas (n=11). Patients were treated with combinations of surgery, radiation and/or chemotherapy. Middle ear melanoma demonstrated particularly poor outcomes with 70% rate of death, 20% local recurrence, and 40% distant metastasis in the middle ear cohort, while ET origin demonstrated 9.1%, 18.2%, and 36.4%, respectively.

Conclusions: Middle ear and eustachian tube mucosal melanomas are exceedingly rare, with middle ear melanomas demonstrating a worse prognosis of the very few cases reported in the literature. Multimodality therapy is commonly used to treat patients with this disease; however, outcomes are poor with a high mortality rate amongst affected patients.

Define Professional Practice Gap & Educational Need: Lack of awareness of primary middle ear mucosal melanoma, a very rare disease, with management previously only described with isolated case reports

Learning Objective: Comprehensive review of the 21 cases of primary middle ear and eustachian tube melanoma reported in the literature with focus on presentation, management and outcomes

Desired Result: Improved awareness of this cancer, and improved ability to counsel patients regarding treatment options and outcomes

Level of Evidence - LEVEL V - Case series, studies with no controls

IRB: Exempt

Tablet-based Hearing Screening in Children Ages 5 to 17 in Rural Dominican Republic

Dylan A. Levy, BS; Frank J. Bia, MD, MPH
David R. Hill, MD; Richard S. Feinn, PhD

Objective: The principal aim of this study was to examine the feasibility of hearing screening using tablet audiometry among a cohort of school-aged children in rural Dominican Republic. The authors hypothesized that the tablet audiometer would serve as an expeditious means for hearing loss screening in various remote locations.

Study design: Cross-sectional.

Setting: The tablet audiometer was used in 23 remote locations in and around the city of La Romana, DR. The quietest location available in each site was used for testing.

Patients: Inclusion criteria comprised children ages 5 to 17 currently residing in the testing location. There were not exclusion criteria.

Intervention: Screening.

Main outcome measures: For each subject, air conduction thresholds were obtained bilaterally at 500, 1000, 2000, and 4000 Hz; testing duration was also measured. Hearing loss was suspected if any threshold was 30dB or greater.

Results: In this cohort, 10.4% of subjects failed the screening protocol. The mean thresholds for 500, 1000, 2000, and 4000 Hz frequencies were 26.05, 22.73, 17.57, and 17.15 dB, respectively. Of the 658 thresholds obtained at ≥ 30 dB, 81.1% were at 500 or 1000Hz. The median testing duration was 465 seconds.

Conclusions: These results suggest that children living in remote communities can be screened quickly for hearing loss using a tablet audiometer. However, significant background noise during testing negatively impacted the low frequency measurements, thus compromising test objectivity. Despite extending the reach of existing audiological services, the value of tablet audiometry is not entirely clear in rural environments with uncontrollable background noise.

Define Professional Practice Gap & Educational Need: There is currently a lack of contemporary knowledge regarding the use of tablet-based audiometers for hearing loss screening in rural communities in developing countries.

Learning Objective: The learning objective is to understand the advantages and disadvantages of using a tablet-based audiometer to screen for hearing loss among school-age children in remote communities in a developing country.

Desired Result: The attendees will apply the knowledge learned from this presentation to guide the development of outreach projects that may involve the assessment of the hearing system including, but not limited to, screening for hearing loss, in a pediatric population.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Approved

Clinical Doppler Optical Coherence Tomographic Imaging of Otosclerosis

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Christine Morrison; Matthew Jahns
Loran Morrison; David P. Morris, MA, FRCS
Manohar L. Bance MA, FRCS

Objective: This study examines the use of Doppler optical coherence tomography (DOCT) in the diagnosis of otosclerosis.

Study design: This is an observational case-control study comparing ears with confirmed otosclerosis (N=10 ears) to normal controls (N=42 ears).

Patients: Inclusion criteria for the otosclerosis group were an air-bone gap >10dB, a history of otosclerosis in the contralateral ear and/or confirmation of otosclerosis during post-imaging surgery. Normal controls were selected for auditory thresholds within 10dB of normal and no previous history of ear disease.

Methods: Middle ear DOCT produces simultaneous 3D structural images and spatially-resolved functional measurements of the vibration of middle ear structures in response to sound. We used DOCT to measure the response of the lenticular process of the incus and the umbo to 90 dBSPL tones at 500 Hz, 1000 Hz and 2000 Hz.

Results: The best discrimination between the two groups was seen in the incus vibration at 500 Hz. Otosclerotic ears exhibited a mean incus vibration amplitude of 15.2±17 nm (1σ) compared to 77±55 nm for normal ears. In a receiver operator characteristic (ROC) analysis, incus vibration achieved an area under curve (AUC) of 0.91 compared to 0.74 for umbo vibration. At the optimal threshold sensitivity and specificity in detecting otosclerosis with DOCT were 0.90.

Conclusions: DOCT offers a promising new approach to diagnosing otosclerosis through spatially-resolved measurement of ossicular vibration. The increased diagnostic power observed at the incus compared to the umbo implies that DOCT may be superior to laser Doppler vibrometry for diagnosing otosclerosis.

Define Professional Practice Gap & Educational Need: 1. Lack of awareness of optical coherence tomography 2. Lack of awareness of Doppler optical coherence tomography

Learning Objective: 1. Understand the utility of Doppler optical coherence tomography for diagnosis of otosclerosis 2. Understand the potential for optical coherence tomography as a new imaging tool in otology

Desired Result: 1. Further research into new applications of OCT and DOCT 2. Clinical use of OCT as a diagnostic tool

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB: Approved

Cochlear Implant Receiver-Stimulator Migration Using the Subperiosteal Pocket Technique: Objective Measurements of Early and Late Positioning

Anne K. Maxwell, MD; Stephen P. Cass, MD, MPH

Objective: Current fixation techniques for the cochlear implant (CI) receiver-stimulator (RS) may not follow recommended manufacturer surgical guidelines. We investigated RS migration using a current subperiosteal pocket technique via serial objective position measurements since prior literature provided only subjective or short-term evaluation.

Study design: Retrospective review

Setting: Tertiary referral center

Patients: 122 patients underwent 138 CIs between 2012 and 2017. Of these, at least two comparison measurements were available for 52 implants in 45 patients, 71.4% adults and 26.5% children.

Interventions: CI RS placement using subperiosteal pocket technique.

Main outcome measure: Distance between the pinna and RS magnet in the early (<6 month) and late (>6 months) postoperative period.

Results: In the early period, mean RS distance was 58.0mm (SD 10.0mm) from the pinna compared with baseline intraoperative distance of 57.0mm (SD 8.0mm), p=0.57. With some shifts closer and some farther from the pinna, there was a 3.4mm absolute value migration (median 2mm). 27.3% of implants migrated >5mm in the early period, 5/12 (41.7%) closer and 7/12 (58.3%) farther from pinna. In the late period, mean RS final distance was 54.8mm (SD 11.0mm), compared with its baseline of 57.2mm (SD 8.8mm), p=0.48. This late period mean 3.1mm shift (median 1mm) was driven by one adult patient with 2 implants that each migrated 14mm closer. All others demonstrated no or minimal migration of <5mm.

Conclusions: A subperiosteal pocket technique provides sufficient stabilization to avoid clinically significant RS migration. These small shifts were not associated with any electrode migrations or symptoms. Formal tie downs as indicated in the surgeon's manual are not required.

Define Professional Practice Gap & Educational Need: Lack of objective evidence of cochlear implant receiver-stimulator migration using a subperiosteal pocket technique. Previous reports only provide subjective reports of migration, short term follow up, or studies only in children.

Learning Objective: To bring attention to receiver-stimulator stability in both adults and children using a subperiosteal pocket technique. To make clinicians aware that objective evidence supports the assertion that formal tie down sutures or drilling bony wells as recommended by the manufacturer are not required to stabilize the implant.

Desired Result: Can use this objective evidence to make a surgical technique change to shorten operative time and increase safety of the procedure.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Approved

Modular High-Fidelity Otologic Surgical Simulator for the Training of Multiple Temporal Bone Procedures

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Pamela C. Roehm, MD, PhD

Hypothesis: Modern imaging and 3D technology may be used to create low-cost, high fidelity training simulations for otologic surgery.

Background: Cadaveric temporal bones are the current gold standard for the training of otologic procedures; however, they have their limitations, especially when training require abnormal anatomical formations. Advances in software and manufacturing processes provide a solution this limited system. Using 3D modeling and printing systems, our team has produced a surgical simulator platform for the training of multiple otologic procedures, specifically stapedotomy and cochlear implantation.

Methods: From microCT scans of cadaveric temporal bones and CT data from patients with known anatomic malformations, 3D models of middle and inner ear anatomy were generated. Models for both 'normal' and abnormal anatomy, such as severe otosclerosis and common cavity cochlea were created. These models may be 3D printed for rapid, low-cost manufacturing at high-resolutions. Electronic components were then included in both models to provide objective, measurable feedback of user performance.

Results: Low-cost, high fidelity simulators for the practice of stapedotomy and cochlear implant procedures on 'normal' and 'abnormal' variants could be produced. These models are reusable and allow for rapid reassembly between cases, facilitating multiple uses. Additionally, trainees may benefit from the metrics provided by the electronic components of the models.

Conclusion: We have generated a modular, high-fidelity simulator as an efficient training system for cochlear implantation and stapedotomy procedures, with the potential to be expanded to other procedures in the future.

Define Professional Practice Gap & Educational Need: Lack of awareness

Learning Objective: Efficient method of practicing otologic procedures

Desired Result: Be aware of alternative training systems to cadaveric temporal bones

Level of Evidence: LEVEL II - Small RCTs with unclear results

IRB: Exempt

Electro-Natural Stimulation (ENS) in Partial Deafness Treatment: Pediatric Case Series

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Objective: The aim of the study is to present pediatric cases with normal hearing in the frequencies 125– 1500 Hz and severe-to-profound hearing loss in frequencies above 1500 Hz. Cochlear implantation was conducted to restore functional hearing at high frequencies and preserve low and mid frequencies.

Study Design: Prospective clinical study based on the evaluation of hearing preservation.

Setting: Tertiary ENT center

Patients: A series of 11 children (aged 9 to16 years old) with good functional hearing to 1.5 kHz and deafness in all other frequencies was evaluated pre-and postoperatively. All of them had a prelingual bilateral hearing loss.

Interventions: During cochlear implantation, a careful insertion of a flexible active electrode was inserted through the round window into scala tympani to a depth of 18 mm by an experienced surgeon.

Main outcomes measures: Hearing preservation was assessed according to the *Hearing Preservation Calculation* based on the pure-tone audiometry.

Result: In the 3-years observation period, the preoperative hearing threshold were completely preserved in 70% of children and partially in 30% of children.

Conclusion: As ENS patients are beyond the scope of effective rehabilitation with hearing aids, cochlear implantation seems to be a successful way of restoring hearing ability in the frequencies above 1.5 kHz. Our results are in favour of extending the inclusion criteria applied so far for this group of patients.

Define Professional Practice Gap & Educational Need: Lack of contemporary firm knowledge regarding the hearing preservation after cochlear implantation in the pediatric Electro-Natural Stimulation (ENS) group classified according to the Partial Deafness Treatment classification.

Learning Objective: To assess the hearing preservation in children with normal hearing in the frequencies 125– 1500 Hz and severe-to-profound hearing loss in frequencies above 1500 Hz.

Desired Result: The results confirm the possibility of complete hearing preservation in the majority of evaluated cases and are in favour of extending the inclusion criteria applied so far for this group of patients.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Approved

Spontaneous Resolution of Cholesteatoma in a Patient on Long-Term Infliximab

Janet R. Chao, BA; Nicholas A. Dewyer, MD
Michael J. McKenna, MD

Objective: To describe an observed case of spontaneous regression of cholesteatoma in a patient on chronic anti-tumor necrosis factor-alpha (TNFa) therapy and to inspire further research into the role of TNFa in cholesteatoma.

Patients: Case report

Intervention: Observational

Main Outcome Measure: Clinical assessment of disease

Results: A 49-year-old woman suffered a severe case of Stevens-Johnson syndrome when she was 12-years-old, leaving her with bilateral corneal opacification and tympanic membrane perforations with extensive cholesteatoma. For her corneal opacification, a corneal prosthesis was placed, which was complicated by a foreign body reaction necessitating long-term therapy with infliximab, a monoclonal antibody against TNFa that is therapeutic in some chronic inflammatory diseases. She was otherwise healthy and took no other medications. While on infliximab, the patient had spontaneous and complete resolution of her cholesteatoma, without any surgical intervention.

Conclusions: This surprising case suggests that there may be a prominent role of TNFa in cholesteatoma pathophysiology and that TNFa may be an effective target for non-surgical therapy.

Define Professional Practice Gap & Educational Need: Lack of awareness about the possibility for medical treatment of cholesteatoma and lack of contemporary knowledge about the role of anti-tumor necrosis factor-alpha therapy in the management of cholesteatoma

Learning Objective: To describe an observed case of spontaneous regression of cholesteatoma in a patient on chronic anti-tumor necrosis factor-alpha (TNFa) therapy and to inspire further research into the role of TNFa in cholesteatoma.

Desired Result: Attendees will be more aware of the potential role of medical treatment for cholesteatoma and researchers will consider possible future studies into the role of anti-tumor-necrosis-alpha therapy for cholesteatoma

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Exempt

Use of Transcutaneous Vagal Nerve Stimulator Associated with Reversible Sensorineural Hearing Loss

Samuel A. Early MS; Konstantina M. Stankovic, MD, PhD

Objective: Transcutaneous vagal nerve stimulators (tVNSs) are indicated for treatment of refractory epilepsy in Europe, where they are available over-the-counter. We present a patient who developed sensorineural hearing loss (SNHL) after beginning to use a tVNS, and whose hearing improved upon device discontinuation.

Patient: The patient is a 58-year-old woman with dysautonomia, chronic fatigue syndrome and sarcoidosis, who started using a tVNS in her left concha and reported improvement in overall wellbeing. She previously had baseline SNHL for which she used hearing aids. She noticed a new, gradual decline in hearing on her left after several months of using tVNS.

Results: Compared to baseline hearing five months prior to starting tVNS, audiometry after 14 months of using tVNS revealed a 7dB increase in pure tone average bilaterally and reduced word recognition from 92% to 72% on the left only; right sided word recognition remained >90%. She discontinued tVNS and reported gradually improved hearing; repeat audiogram five months after discontinuation showed word recognition improvement to 98% on the left side. Electrical testing of the device revealed a small charge imbalance producing 61 nA direct current with typical use.

Conclusion: This is the first report of SNHL due to a vagal nerve stimulator. Possible mechanisms for SNHL include inadvertent stimulation of the trigeminal nerve (whose branches innervate the cochlear vasculature) through an adjacent auricular dermatome, autonomic system modulation in the setting of dysautonomia, or charge imbalance interfering with the endocochlear potential. Patients using tVNSs should be warned about the risk of SNHL due to the device.

Define Professional Practice Gap & Educational Need: Transcutaneous vagal nerve stimulators are over-the-counter devices that patients may use for a variety of indications. Side effects related to hearing have not been previously reported in the literature.

Learning Objective: To present an association between use of a transcutaneous vagal nerve stimulator and changes in hearing, and to describe possible causal mechanisms for this relationship.

Desired Result: 1. To appreciate the possible association between use of a transcutaneous vagal nerve stimulator and hearing loss 2. To highlight the need to develop better understanding of the pathway between attempted vagal nerve stimulation and cochlear end effects

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Exempt

Is Audiometry of Diagnostic or Prognostic Use in Bell's Palsy Patients?

Yuan Jing; Shirish Johari, MBBS
Chong Yaw Khian, MBBS

OBJECTIVE: To determine if audiometry serves a diagnostic or prognostic purpose in Bell's palsy patients.

STUDY DESIGN: This is a retrospective review of the audiological results and outcomes of all patients diagnosed with Bell's palsy in a tertiary institution from 2015 to 2017. Audiometric results were reviewed at point of presentation. Asymmetric hearing threshold was defined as >20kHz difference between left and right ear. Positive MRI findings were defined as any cerebellopontine lesion. Time to recovery was defined as achieving a House-Brackmann score of 1. Statistical analysis was performed using Stata (v13.1), significance tests were 2-sided at the 5% significance level.

SETTING: Tertiary referral center.

PATIENTS All Bell's palsy patients with no prior hearing impairment were included in the study (n=159). Mean age at presentation was 50.6yrs (16.9). Median follow-up duration was 85 days.

INTERVENTIONS: Diagnostic.

MAIN OUTCOME MEASURES: Do audiometry results correlate with severity of clinical presentation, time-to-recovery, and positive MRI findings?

RESULTS: There is no association between the audiometry results and severity of HB score at presentation (p=0.389). Ipsilateral pure-tone average was similar across all severities. No correlation was found between severity of audiometry results and time-to-recovery (p=0.807), with a median time-to-recovery of 59 days. No association was found between asymmetrical hearing thresholds and positive MRI findings (p=0.168). Of the 13 patients had MRI, 6 (46.2%) had symmetrical thresholds and 7 (53.9%) had asymmetrical thresholds. Of the 7 patients with asymmetrical hearing thresholds, only 1 had a positive MRI finding.

CONCLUSIONS: Audiometry is of limited diagnostic and prognostic utility in Bell's palsy, and should not be part of the routine clinical workup for the Bell's palsy patient.

Define Professional Practice Gap & Educational Need: Audiometry is often done routinely as standard practice for the Bell's palsy patient, regardless of whether patients present with hearing loss. However, there is little evidence to support the routine use of audiometry in Bell's palsy patients. To our best knowledge, no studies have been done so far in auditing the routine use of audiometry in Bell's palsy patients.

Learning Objective: At the conclusion of this presentation, participants should have an increased awareness of the standard routine workup in Bell's palsy patients, and an improved awareness when it comes to ordering audiometry for the Bell's palsy patient.

Desired Result: It is the authors' hope that attendees will come to the conclusion that routine use of audiometry in Bell's palsy patients is unwarranted and has limited diagnostic and prognostic purpose. Audiometry should not be routinely ordered for the Bell's palsy patient without clinical suspicion of hearing loss.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB: Exempt

A Volumetric Analysis of Glomus Jugulare Tumors Treated with Stereotactic Radiosurgery

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Objective: To assess the effect of stereotactic radiosurgery (SRS) on Glomus Jugulare Tumors (GJTs) over an extended follow up period.

Study Design: This retrospective study reviewed 30 adult patients with GJTs treated with SRS.

Setting: Tertiary referral center in an ambulatory setting.

Patients: Patients diagnosed with GJTs and treated with SRS were included. Mean age at diagnosis was 67.9 ± 10.7 years. 20% of patients were male and 80% were female.

Interventions: Treatment with either single or fractionated SRS, following the clinical diagnosis of a GJT.

Main Outcome Measure: A volumetric analysis was performed on initial pre-treatment and follow-up MRI images to assess tumor size over time. Tumor sizes, clinical characteristics, and treatment data were recorded using descriptive statistics.

Results: 20% of patients underwent prior subtotal surgical resection. 89.6% of patients underwent single fraction SRS and 10.4% underwent fractioned SRS. A headframe was used in 76.7% of treatments. Average follow up was 5.2 ± 3.6 years. Average pre-treatment tumor volume was 2.8 ± 2.3 cm^3. Average tumor volume at most recent follow up was 2.4 ± 2.2cm^3. 90% of patients had no cranial nerve injury throughout the follow up period. 6.7% of patients developed permanent CN VII palsy, 1 of which was related to temporal bone osteonecrosis. 3.3% of patients developed permanent CN VIII disruption.

Conclusions: SRS effectively prevents GJT growth over long term follow up without significant morbidity. SRS is a safe and effective method to treat GJTs in the adult population.

Define Professional Practice Gap & Educational Need: 1. Lack of contemporary knowledge of the long-term treatment outcomes of Glomus Jugulare Tumors treated with stereotactic radiosurgery.

Learning Objective: 1. To assess the long-term effect of stereotactic radiosurgery on Glomus Jugulare Tumor growth. 2. To describe the evolving role of stereotactic radiosurgery in treatment of Glomus Jugulare Tumors.

Desired Result: Demonstrating the long term treatment outcomes in this patient population will allow for more targeted screening and interventions to minimize morbidity and optimize follow up in patients who have had Glomus Jugulare tumors treated with stereotactic radiosurgery.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Approved

Primary Endoscopic Stapes Surgery: Audiologic and Surgical Outcomes

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Alejandro Rivas, MD

Objective: To evaluate postoperative outcomes following endoscopic stapes surgery.

Study Design: Retrospective case review.

Setting: Two tertiary otologic centers.

Patients: Eighty-five ears with stapes fixation that underwent primary endoscopic stapes surgeries.

Interventions: Endoscopic stapedotomy and stapedectomy.

Main outcome measures: Surgical and audiologic outcomes.

Results: Eighty-five subjects were included, of which 58% were female, with an average age of 44.2 years (range, 14-72 years). Patients had otosclerosis (94.1%), stapes tympanosclerosis (3.5%), congenital stapes fixation (1.2%), and traumatic stapes fracture (1.2%). The median follow-up was 10 months (range, 0.8-50 months). Despite use of the endoscope in all cases, 72.7% required scutum removal, and the chorda tympani nerve was transected in 9.1%. Two techniques were utilized, with 61.2% undergoing stapedectomy and 38.8% undergoing stapedotomy (with use of laser, drill or both in 63.6%, 36.4% and 6% of cases, respectively). The median air-bone gap (ABG) improved from 32.5 dB preoperatively to 7.5 dB postoperatively at last follow-up ($p<0.0001$). The ABG closed to <20 dB in 93.9% of patients. Comparison of the laser and drill groups showed that there was no difference between average postoperative ABG ($p=0.12$). The average postoperative bone conduction pure-tone average improved by 1.9 dB. Postoperative complications included altered taste in 27.3% of patients, 88.8% of which resolved within the first 3 months after surgery. Postoperative dizziness occurred in 21.2% of patients. There was no facial weakness.

Conclusions: Endoscopic stapes surgery is an effective technique to manage stapes fixation, with a median postoperative ABG of 7.5 dB.

Define Professional Practice Gap & Educational Need: Lack of contemporary knowledge regarding the surgical and audiologic outcomes of endoscopic stapes surgery.

Learning Objective: Identify intraoperative findings and complications, postoperative complications, and audiologic outcomes of primary stapedotomy and stapedectomy with an endoscopic approach.

Desired Result: Attendees will learn that primary endoscopic stapes surgery has similar audiologic and surgical outcomes to microscopic approach. With this knowledge, attendees may elect to adopt this new approach for stapes surgery in their own practice.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Approved

Construct Validation of a Printed Bone Substitute in Otologic Education

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Azam Davari Dolatabadi, MSc; Michael Gousseau, MD
Bertram Unger, BSc, MD, PhD

Hypothesis: A 3D printed temporal bone will facilitate differentiation of resident performance based on skill and experience.

Background: Patient safety demands enhancements in training. Graduated cadaveric bone exposure is fundamental to the Otologic training ethos. Printed bone provides a lower cost, anatomically consistent alternative as an adjunct in trainee skill evolution.

Methods: Cadaveric bone microCT images are digitally deconstructed to allow removal of residual print material and penetration of hardening infiltrant. Reassembly of a complete printed bone structure is facilitated by digitally generated fiducials. Nineteen residents (11M,8F) from nine graduate programs, attending a National Otolaryngology Conference completed a mastoidectomy with posterior tympanotomy on identic 3D printed bone models and a Likert Scale [1-7] survey on subjective appreciation of the simulation. Four experts graded participant performance using the previously validated Welling Scale.

Results: ANOVA revealed significant performance differences between the junior/ intermediate and junior/senior PGY cohorts ($p<0.05$). No difference was observed between intermediate/senior cohorts ($p>0.05$) based on PGY or subjective mastoid experience. Printed bone was judged similar to cadaveric in drill quality (5.22 ± 0.92). The simulation was considered a beneficial training tool for mastoidectomy (5.87 ± 0.79), posterior tympanotomy (5.45 ± 1.54) and approaches to the skullbase (5.52 ± 1.42). Participants believed the simulation would improve surgical performance (5.78 ± 1.09), comfort with actual patients (5.78 ± 1.10) and operative speed (5.83 ± 1.31).

Conclusions: The printed bone compared favorably to cadaveric. The simulation demonstrated positive construct validity but was challenged in differentiating senior trainee performance, possibly owing to fidelity of the grading scale or sample size.

Define Professional Practice Gap & Educational Need: 1. Evaluation of trainee aptitude is problematic 2. Previous attempts at validation suffer from variability in the cadaveric models used for dissection.

Learning Objective: At the conclusion of this presentation, participants should understand the generation of internally accurate rapid prototyped temporal bone models with patent air cell reproduction and be aware of the option for use in surgical training.

Desired Result: The printed bone compared favorably to cadaveric. The attendees can use the 3D printed bone for the surgical training purposes. They should consider comfort with actual patients and also operative speed.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB: Approved

Evaluation of Trainee Drill Motion Patterns during Temporal Bone Simulation with a 3D Printed Model

Jordan Hochman, MD; Katrice Kazmerik, MD
Justyn Pisa, AuD; Azam Davari Dolatabadi, MSc
Bertram Unger, BSc, MD, PhD

Hypothesis: Resident surgeon drill motion patterns during dissection of a printed and cadaveric temporal bone model are anticipated to be dissimilar owing to material properties.

Background: Virtual haptic and physical printed temporal bone simulations are commonly used to augment cadaveric training. Assessment of these tools is ongoing with a strong trainee preference for physical simulations. Trainees using virtual haptic models illustrate disparate drill motion patterns when compared to cadaveric opportunities. This has the potential to result in maladaptive skill development.

Methods: Resident surgeons dissected both printed bones generated from micro CT data and cadaveric specimens. Skill assessment was clustered into cortical mastoidectomy, thinning procedures (sigmoid sinus, dural plate, posterior canal wall) and development of a posterior tympanotomy. A magnetic position tracking system (TrakSTAR, Ascension) captured drill position and orientation at 200Hz. Dissection was performed by 8 trainees (n=5<PGY3>n=3) using kcos-metrics to analyze drill strokes within position recordings.

Results: T-tests between models showed no significant difference in drill stroke frequency (cadaveric=1.36/s, printed =1.50/s $p=0.420$) but demonstrate significantly shorter duration (cadaveric=0.37s, printed =0.16s $p<0.05$) and a higher percentage of curved strokes (cadaveric=31, printed=67 $p<0.05$) used in printed dissection procedures. Junior staff used a higher number of short strokes (junior=0.54, senior=0.38, $p<0.05$) and higher percent of curved strokes (junior=35%, senior=21%, $p<0.05$).

Conclusion: Significant differences in hand motions were present between the cadaveric specimens and printed simulations, questioning the employ of printed simulations as viable teaching instruments. Junior staff appears to adopt a more cautious approach to dissection.

Define Professional Practice Gap & Educational Need: 1. Lack of information regarding resident surgeon drill motion patterns during dissection of a printed and cadaveric temporal bone model 2. Difference between the performance of different PGY cohorts is challenging.

Learning Objective: At the conclusion of this presentation, participants should understand the generation of internally accurate rapid prototyped temporal bone models with patent air cell reproduction and be aware of the option for use in surgical training.

Desired Result: The attendees should be aware of significant differences in hand motions between the cadaveric specimens and printed simulations and evaluate their performance during drill motion on both cadaveric and 3D printed bone temporal bone model.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB: Approved

Initial Hearing Preservation Outcomes of Cochlear Implantation with a Slim Perimodiolar Electrode Array

Rebecca C. Nelson, MD; Sarah Sydlowski, AuD, PhD
Thomas Haberkamp, MD; Erika Woodson, MD

Objective: To assess the slim perimodiolar array as a hearing preservation electrode in cochlear implantation (CI)

Study design: Retrospective chart review

Setting: Tertiary referral center

Patients: All adult, post-lingual CI recipients implanted with a slim perimodiolar array from Sept 2016 to Sept 2017

Intervention(s): Cochlear implantation

Main outcome measure(s): Hearing preservation (HP). Baseline audiograms were obtained at initial CI evaluation. Patients with a threshold ≤70dB in at least one low frequency (LF) (125Hz, 250Hz, 500Hz, 750Hz, or 1000Hz) were considered HP candidates. Postoperative audiograms were obtained before activation. Successful HP was defined as retention of any LF threshold ≤70dB. A LF pure tone average (LFPTA) (125Hz, 250Hz, 500Hz, 750Hz, and 1000Hz) was calculated and the ΔLFPTA from pre- to post-operative state was used to stratify patients into three groups: full (≤15dB), partial (16-30dB), or unsuccessful HP (>30 dB).

Results: 48 patients received the slim perimodiolar array, and 29 were HP candidates. Post-operative audiograms were obtained an average of 28 days after surgery. 55% of HP candidates retained at least one LF threshold of ≤70dB. Mean ΔLFPTA was 24dB. Successful HP was achieved in 62% (45% full, 17% partial, 38% unsuccessful HP). Most of the HP failures occurred in the first 6 months of surgeon experience, suggesting a learning curve with the device. One patient (2%) experienced device deployment failure, requiring use of an alternative electrode array and resulting in complete hearing loss.

Conclusions: The slim perimodiolar array is effective at immediate hearing preservation after cochlear implantation.

Define Professional Practice Gap & Educational Need: Lack of knowledge of outcomes of a new device

Learning Objective: To better understand hearing preservation outcomes with use of the slim perimodiolar array

Desired Result: We hope that this will influence attendees practices when choosing hearing preservation cochlear implantation strategies. We hope that this can improve hearing preservation options for patients.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Approved

Recidivism after Endoscopic Treatment of Cholesteatoma

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Yann Fuu Kou, MD; Jacob B. Hunter, MD
Joe Walter Kutz, Jr, MD; Brandon Isaacson, MD

Objective: The endoscope has gained favor in treating cholesteatoma due to its improved visualization. The purpose of this study is to investigate recidivism of cholesteatomas treated endoscopically.

Study Design: Retrospective chart review

Setting: Tertiary Care Center

Patients: Adult patients with cholesteatomas treated endoscopically and one year of follow-up.

Intervention: Use of the endoscope for cholesteatoma dissection.

Main outcome measure: Residual cholesteatoma on second look surgery/MRI and recurrence on clinical exam.

Results: 37 patients with cholesteatoma treated endoscopically were analyzed. The mean age was 48.1 years (SD 16.6). Mean follow-up time was 19.9 months (SD 7.5). 70.3% of patients were treated with totally endoscopic transcanal tympanoplasty and cholesteatoma removal, and 29.7% underwent endoscopic middle ear dissection in combination with mastoidectomy. The overall recurrence rate was 18.9%. Of the 24 patients who had an MRI or second look surgery, 12.5% had residual disease. The overall recurrence rate at last follow-up was 10.9%. The mean word recognition score worsened by 2.4% (SD 26), but the mean pure tone average and mean air-bone gap improved by 10.5 dB (SD 14.8) and 8.9 dB (SD 12.7), respectively. Mean OR time was 194.3 minutes (SD 62.2). Complications included external auditory canal (EAC) stenosis (8.1%), residual perforation (8.1%), taste disturbance (8.1%), myringitis (5.4%), facial paresis (HB 2 at last visit) (2.7%), tragal hematoma (2.7%), tragal cellulitis (2.7%), EAC erosion (2.7%), and deep venous thrombosis (2.7%).

Conclusions: Cholesteatoma can be treated endoscopically with acceptable control rates with potentially less need for mastoidectomy.

Define Professional Practice Gap & Educational Need: Lack of knowledge about the recidivism of cholesteatoma treated endoscopically.

Learning Objective: Improve understanding of results of endoscopic treatment of cholesteatoma.

Desired Result: Attendees will have further understanding about the efficacy of endoscopic treatment of cholesteatoma.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Approved

Transcanal Endoscopic Tympanoplasty – Our Results

Gauri Mankekar, MD, PhD; Rahul Mehta, MD
Alexander F. Sevy, MD; Moises Arriaga, MD, MBA

Objective: To evaluate the outcomes of endoscopic transcanal tympanoplasty.

Study design: Retrospective clinical study

Setting: Tertiary referral center

Patients: 100 consecutive patients (adults and children) with tympanic membrane perforation without cholesteatoma who underwent tympanoplasty endoscopically.

Intervention: Transcanal endoscopic tympanoplasty for central or marginal tympanic membrane perforation. Tragal cartilage with perichondrium or Alloderm was used as underlay graft. Pre op and 3 months post op audiogram analyzed

Main outcome measure(s): Perforation closure, graft success and audiological improvement in hearing 3 months post op.

Results: Data of 93 ears was analyzed (7 ears were excluded as they did not have 3 month post audiogram). 3 children (3 ears) and 1adult (1 ear) had residual perforation at 3 months post op. One child and two adults (3 ears) healed initially but developed recurrent perforation within one year. Out of 7 failures, Alloderm was used in 5 ears. Mean pure tone average and air bone gap showed statistically significant improvement. None of no patients had any complication.

Conclusions: Trans canal endoscopic ear surgery is a safe option with good surgical outcomes for management of tympanic membrane perforation. Tragal cartilage graft heals well with good audiologic improvement. Re perforation in cases with Alloderm graft is higher than cartilage. Long term follow up is necessary to compare success of different graft material.

Define Professional Practice Gap & Educational Need: Lack of contemporary knowledge

Learning Objective: Trans canal endoscopic ear surgery is a safe option with good surgical outcomes for management of tympanic membrane perforation. Tragal cartilage graft heals well with good audiologic improvement.

Desired Result: Improve their use of endoscopes during tympanoplasty surgeries.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Approved

A Critical Analysis of the Information Available Online for Ménière's Disease

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Michael Carron, MD

Objective: Physicians should be aware of the online information freely available to patients regarding Ménière's disease in order to provide quality care. This study analyzes the reliability, quality, and readability of internet sources regarding Ménière's disease using validated evaluation instruments.

Data sources: A Google search was performed using the keyword “Meniere’s disease” in January 2017. The first five pages of results in English were included in this study. Websites were divided into 4 categories of publication: professional organization, academic, physician, and unidentified

Study selection: Any websites that provided information regarding Ménière's disease were considered for inclusion in this study. Excluded were any websites that were nonfunctional, unrelated to Ménière's disease, videos, and websites that required login credentials

Data extraction: The reliability, quality, and readability of websites from these four groups were then compared. The validated DISCERN instrument was used to measure reliability and quality, while the validated Flesch-Kincaid Grade Level was used to measure readability.

Data synthesis: Comparison of continuous variables was performed using Mann-Whitney U-tests, with threshold for significance set at $p < 0.05$.

Conclusions: Online information regarding Ménière's disease is deficient in both reliability and quality. Both academic and professional organizations should strongly consider publishing high-quality, easily-understood Ménière's disease literature that is freely available online in order to fill the current void. Physicians should likewise be aware of the current lack of readable, high-quality information available to patients online and be prepared to discuss possible strategies to avoid misinformation with their patients.

Define Professional Practice Gap & Educational Need: Lack of awareness

Learning Objective: Our goal is to make the physician community aware of the overall poor quality of information available online regarding Meniere's disease.

Desired Result: Our short term goal is to have attendees apply the knowledge learned from the presentation to help guide patients to better online material. We found that both professional and academic organizations scored the highest in the multiple categorized we used to grade each website, so hopefully the attendee can take a moment to mention to the patient to focus on these types of websites when they are reading information about Meniere's disease online. Our long term goal is to hopefully inspire both academic and professional organizations to publish better online material on Meniere's disease.

Level of Evidence - Does not apply, this was a review of the available online literature regarding Meniere's disease

IRB-Exempt

Neuroendocrine Tumors of The Middle Ear:
A Multi-Institutional Study of 33 Cases

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Matthew L. Carlson, MD

Objective: To-date, less than 150 cases of middle ear neuroendocrine tumors (MENT) have been reported in the English literature, and considerable controversy exists surrounding their clinical behavior. This study aims to provide a contemporary multicenter examination of these rare lesions.

Study Design: Multi-center retrospective review.

Setting: Six tertiary referral centers.

Patients: Thirty-three patients with pathologically confirmed MENT.

Intervention: Surgical resection +/- adjuvant therapy.

Main Outcome Measures: Preoperative clinical features, intraoperative findings, recurrence-free survival, and malignant potential.

Results: Twenty-one (64%) patients presented with primary disease, while 12 (36%) were referred for management of residual/recurrent disease. The median year-of-diagnosis was 2011 (IQR, 2008-2015) with an average clinical follow-up of 45 months (IQR, 12-64). The median time-to-diagnosis following onset of symptoms was 12 months (IQR, 6-48). Ninety-percent of patients presented with progressive hearing loss, while no patient displayed evidence of cranial neuropathy at time of diagnosis. Temporal bone paraganglioma (31%) and cholesteatoma (19%) represented the most common initial clinical diagnoses before surgery. Intraoperatively, tumors often exhibited dense adherence to surrounding critical structures. Two patients (10%) who presented with primary disease experienced recurrence, both of whom were initially treated with gross-total resection. The median time-to-recurrence for the entire cohort was 72 months (IQR, 39-108). Malignant transformation occurred in two patients (6%).

Conclusions: MENTs exhibit a proclivity for dense adhesion to surrounding critical structures. Nonetheless, recurrence among patients presenting with primary disease remained low in this cohort. MENTs have the potential for malignant transformation, and this feature necessitates long-term clinical follow-up.

Define Professional Practice Gap & Educational Need: Neuroendocrine tumors of the middle ear are rare with fewer than 150 reported cases in the English literature. As a result, significant controversy exists surrounding the most appropriate classification as well as the clinical behavior of these lesions. Further, many of the reported cases pre-date key developments in disease classification (eg, recognition of endolymphatic sac tumors as a unique entity). Therefore, there exists a lack of contemporary knowledge examining these tumors and their management.
Learning Objective: (1) Describe the typical clinical manifestations of neuroendocrine tumors of the middle ear. (2) Recognize the intraoperative challenges posed by neuroendocrine tumors of the middle ear. (3) Describe the management strategies for patients treated with gross-total and sub-total resections. (4) Recognize the risk for disease recurrence and potential for malignant transformation. (5) Understand the contemporary classification of neuroendocrine tumors of the middle ear in light of their varying historical designations.
Desired Result: Attendees will gain knowledge that will facilitate accurate diagnosis and operative planning. Attendees' knowledge surrounding management of subtotal resections, disease recurrence, and the possibility of malignant transformation will facilitate improved long-term patient outcomes. Attendees' understanding of the contemporary classification of neuroendocrine tumors of the middle ear will facilitate their interpretation of previous literature and guide future patient-care and research.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB-Approval

Prevalence of Cranial Nerve Imaging Abnormalities in Patients with Hereditary Peripheral Neuropathies

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Reza Sadjadi, MD; Robert K. Jackler, MD
C. Eduardo Corrales, MD

Objective: To estimate the prevalence of intracranial imaging findings, with particular attention to cranial nerves at the skull base, and associated symptoms in patients with hereditary peripheral neuropathies.

Study Design: Multicenter retrospective review.

Setting: Four tertiary academic medical centers.

Patients: 29 patients with hereditary peripheral neuropathy diagnoses who have had magnetic resonance imaging (MRI) of the brain. Patient demographics, hereditary peripheral neuropathy diagnosis type, imaging indication, and symptoms were tabulated and analyzed.

Intervention(s): Contrast-enhanced MRI sequences were reviewed in detail using axial, coronal and sagittal planes.

Main Outcome Measure(s): Prevalence of intracranial cranial nerve (CN) abnormalities, including enhancement and thickening; presence or absence of associated cranial nerve deficits.

Results: Among 29 patients, 8 had CN abnormalities on imaging (27.6%). All 8 patients had enhancement and/or thickening of the CN VII/VIII complex in the internal auditory canal (5/8 unilaterally, 3/8 bilaterally), with 1 patient also having unilateral thickening of CN V. Only 2/8 patients had unexplained CN deficits, each with sensorineural hearing loss and tinnitus. Another patient had an unexplained unilateral CN IV palsy without associated imaging abnormalities.

Conclusions: Hereditary peripheral neuropathies are a heterogeneous group of rare genetic conditions characterized by peripheral motor and sensory deficits. Intracranial involvement has largely been limited to single patient case reports. Our data however suggests that CN involvement in these patients is not uncommon, although it is infrequently associated with symptoms of CN deficit. CN imaging abnormalities in patients with hereditary peripheral neuropathies are unlikely to require surgical management and instead are likely reflective of the underlying neuropathy.

Define Professional Practice Gap & Educational Need: 1. Lack of contemporary knowledge about intracranial involvement in, and manifestations of, hereditary peripheral neuropathies 2. Lack of awareness that cranial nerve imaging abnormalities in patients with hereditary peripheral neuropathies may not be reflective of tumor

Learning Objective: 1. Hereditary peripheral neuropathies can manifest with cranial nerve involvement on imaging although it may not translate to a phenotype of cranial nerve deficit. 2. To learn that cranial nerve imaging abnormalities in patients with hereditary peripheral neuropathies may just be reflective of the patient's underlying neuropathy.

Desired Result: Physicians managing hereditary peripheral neuropathies will learn about the prevalence of cranial nerve involvement and surgeons who receive referrals of these patients will learn that their cranial nerve imaging abnormalities may not require surgical management.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB: Approved

Incus Position of Stapes Prosthesis Affects Sound Transmission in Human Cadaveric Temporal Bones

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Aaron K. Remenschneider, MD, MPH

Hypothesis: Specific position of the stapes piston prosthesis along the incus long process influences sound-induced displacement magnitude.

Background: During reconstruction following stapedotomy, a wire piston prosthesis placed over the incus and through the fenestrated footplate can reestablish sound transmission to the inner ear. Little is known, however, about how the discrete position of the wire along the length of the incus long process affects ossicular sound transmission.

Methods: Cadaveric temporal bones without history of otologic disease underwent laser stapedotomy through a facial recess approach, maintaining an intact tympanic membrane. Stapes prosthesis was placed within the fenestrated footplate and crimped at three different locations (distal, middle and proximal), each 1 mm apart as measured from the end of the incus long process. Pure tone sound (200-10kHz) induced displacement measurements were obtained by laser Doppler vibrometry (LDV) at each incus long process position.

Results: Prosthesis position influenced sound induced displacement in reproducible ways across the tested frequency range. The middle and distal positions demonstrated up to 4x greater displacement between 1k-4kHz compared to proximal position. Above 6 kHz, middle and distal positions delivered, on average 2x greater displacement than proximal positioning. Anatomic variability in incus long process position was observed between specimens.

Conclusion: The position of stapes prostheses along the incus long process in stapedotomy affects sound induced motion. Middle and distal positioning tend to result in higher displacement magnitude than proximal positioning. These findings have implications for intraoperative positioning of stapes prostheses. Further studies are required to determine if position influences audiometric outcomes in humans.

Define Professional Practice Gap & Educational Need: Little is known about how the incus position of a wire/piston stapes prosthesis affects sound induced motion after stapedectomy. To maximize sound conduction, especially at mid and high frequencies, optimal positioning of the prosthesis may afford improved audiometric results.

Learning Objective: Understand how the relative position of the stapes piston along the incus long process affects sound induced motion of the prosthesis.

Desired Result: Knowledge of the sound transmission effects of stapes prosthesis position will help guide surgical planning in stapedectomy.

Level of Evidence: Does not apply, Basic science report

IRB: Exempt

Cochlear Implantation in Pediatric Single Sided Deafness

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Holly F. Teagle, AuD; Erica Gagnon, AuD
Jennifer Woodard, AuD

Objective: Cochlear implantation in the setting of single sided deafness has been demonstrated to result in improved speech in noise, sound localization and quality of life in adults. Limited studies to date have examined cochlear implantation in pediatric single sided deafness (SSD). The objective of this study was to evaluate outcomes of cochlear implantation for asymmetric hearing loss/SSD in children.

Study Design: Retrospective case review

Setting: Tertiary referral center

Patients: Children (age 0-12) with asymmetric hearing loss with no worse than moderate loss in the better ear.

Intervention: Unilateral cochlear implantation between years 2014-2015

Main Outcome Measures: Age at implantation, age at hearing loss, sound localization error, pre-operative, 1 and 2 year speech recognition outcomes of implanted and contralateral ears. Ratios of implanted ear word scores to contralateral ear word scores were calculated.

Results: Seven patients underwent cochlear implantation for single sided deafness. As different tests were used at different stages of subjects' development, ratios of the implanted ear to normal ear word scores were created. Pre-operative ratios of implanted ear word recognition scores (WRS) to contralateral ear WRS had a mean of 0.02(range 0-0.14). One year WRS ratios had a mean of 0.80(range 0.45-1.09) and two year WRS a mean of 1.0(0.41-1.31). Mean RMS error with devices turned off was 56.3(range 41-72) and 30.7(16-41) with devices on.

Conclusion: Pediatric SSD patients with normal or near-normal hearing in the contralateral ear experienced significant improvement in word recognition scores up to 2 years post-implant and demonstrated substantial improvement in localization scores.

Define Professional Practice Gap & Educational Need: Lack of knowledge of potential benefit of cochlear implantation in the setting of single sided deafness. Specifically, the significant benefit received by children and significant impact on development and learning after pediatric cochlear implantation for single sided deafness.

Learning Objective: To understand the benefits of cochlear implantation for asymmetric hearing loss/single sided deafness in children. Additionally, to understand the importance of age at implantation with regard to hearing outcomes.

Desired Result: To further advance the indications for cochlear implantation in the situation of asymmetric hearing loss/single sided deafness, and to have a better understanding of appropriate indications for implantation and post-operative expectations.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Approved

Awake Trans-Tympanic Membrane Otoendoscopy for Diagnosis of Stapedial Myoclonus

Elliott Kozin, MD; Eric Barbarite, MD
C. Eduardo Corrales, MD

Objective: Stapedial myoclonus is the rhythmic contraction stapedius muscle that can result in a host of symptoms, including tinnitus. There is a dearth of robust diagnostic modalities for stapedial myoclonus, and most patients are treated without a definitive diagnosis. Herein, we hypothesize that stapedial myoclonus can be readily diagnosed by awake otoendoscopy.

Study design: Case report

Setting: Tertiary care center

Patient: 21-year-old male professional singer described five years of "thumping" tinnitus, which was triggered by singing. His right ear was more symptomatic than left. Work-up, including otologic exam, audiometry, stapedial reflex testing, and imaging of the temporal bone, was unrevealing. Stapedial tendon myoclonus was suspected.

Intervention: Awake transtympanic membrane otoendoscopy in the operating room to evaluate stapedial tendon, followed by transection of the stapedial tendon.

Main outcome measure: Resolution of tinnitus.

Results: While awake in the operating room, a 2mm inferior myringotomy was made, and a 1.9mm 0 and 30 degree 3-CCD Hopkins rod endoscope was used to visualize the stapedial tendon. On vocalization by the patient, there was movement of the tendon that corresponded with the timing of his tinnitus. The patient subsequently underwent transection of the stapedial tendon and removal of pyramidal eminence under general anesthesia. The patient had resolution of his symptoms, and he underwent a successful identical procedure on the contralateral ear three months later.

Conclusions: We describe a case of stapedial myoclonus that was diagnosed by transtympanic otoendsocpic in an awake patient. This approach may be readily applied in patients suspected of having stapedial myoclonus.

Define Professional Practice Gap & Educational Need: Stapedial myoclonus can result in a host of symptoms, including tinnitus; however, there is a dearth of robust diagnostic modalities.

Learning Objective: In this presentation, we will present a method to diagnose stapedial myoclonus.

Desired Result: Attendees will be able to apply the techniques learned in the presentation to diagnose stapedial myoclonus

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Exempt

Long term Otologic Outcomes Following Blast Injury:
The Boston Marathon Bombings

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Iman Ghanad; Elliott Kozin, MD
Danielle Trakimas; Sharon Kujawa, PhD
Daniel Lee, MD; Alicia Quesnel, MD

Objective: Blast-related otologic trauma was the most common physical injury sustained at the Boston Marathon Bombings on April 15th, 2013. In this follow-up study, we aim to 1) report long-term tympanoplasty results from traumatic perforations, 2) understand long-term audiologic effects of blast injury, and 3) quantify long-term changes in audio-vestibular quality of life among affected individuals.

Study Design: Multi-institutional, prospective cohort study

Setting: Tertiary Referral-Center

Patients: Individuals sustaining otologic trauma at the 2013 Boston Marathon Bombings

Interventions: Tympanoplasty, audiometry and quality of life assessment

Main Outcomes measures: Tympanoplasty closure rate, high-frequency pure tone thresholds and hearing, tinnitus, dizziness handicap inventory

Results: Of the more than 90 patients identified at the time of the initial study, long-term follow up data was available in 41 patients. The most common ongoing complaints were hearing loss and tinnitus. Of 62 initial perforations in 48 patients, spontaneous healing was observed in 20 ears. Twenty-six patients underwent tympanoplasty with a revision rate of 15.4%, including two patients with late failure. High frequency bone conduction thresholds were not significantly elevated in long-term follow up when compared to initial thresholds. Quality of life scores for hearing, tinnitus and dizziness demonstrated ongoing, severe impairment in participants responding at 48 months.

Conclusion: Four years following the Boston Marathon bombings, audio-vestibular quality of life remains impaired in survivors, despite a lack of distinct audiometric changes on standard testing. Further audiometric evaluation using advanced techniques may reveal objective findings due to blast induced inner ear trauma.

Define Professional Practice Gap & Educational Need: The long-term effects of blast injury to the ear are poorly understood. Durability of tympanoplasty for blast induced perforations, progressive changes in sensorineural hearing after acoustic trauma and long-term audio-vestibular quality of life are not well described in patients having been exposed to blast trauma.

Learning Objective: To improve understanding of the unique long-term challenges faced by individuals suffering from blast related otologic trauma. Specifically, tympanoplasty outcomes, sensorineural hearing loss and audiovestibular quality of life will be addressed.

Desired Result: Knowledge gained from this presentation should help guide participants to recognize the unique characteristics of blast related otologic trauma and direct appropriate long-term diagnostic and therapeutic care.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB: Approved

Partial Auricular Reconstruction After Dog Bites in Children: Building Bridges and Not Burning Them

Erin K. Haser, MD; Andrew R. Scott, MD

Objective: To demonstrate the impact of initial management of partial auricular avulsions on downstream reconstructive options and outcomes through the description of a case series of children with varying degrees of auricular avulsions due to dog bites.

Study design: Case series

Setting: Single tertiary medical center

Patients: Three pediatric patients with partial auricular avulsions from dog bites.

Background: Auricular injury caused by dog bites may range from laceration without tissue loss to skin avulsion or partial amputation. Partial avulsion of the auricle can be a reconstructive challenge due to the contours of the ear formed by the underlying cartilage. The antihelix and scaphoid fossa are particularly challenging. Management strategies at the time of injury impact the degree of reconstruction needed in follow-up.

Results: Three pediatric patients with varying degrees of partial auricular avulsions from dog bites are described. Initial management included use of the amputated tissue as a composite graft as well as burying exposed cartilage in a post-auricular pocket. Their clinical course and final outcome are described with accompanying pictures. All three patients had excellent outcomes due to the preservation of the antihelix and scaphoid fossa in the initial care of the patient.

Conclusions: On initial encounter of a partial auricular avulsion, it is imperative the provider takes all measures to preserve the antihelix and scaphoid fossa. While more time consuming, maximizing the cartilage preserved will provide the reconstructing surgeon with a scaffold on which to build and may obviate the need for more extensive and invasive grafts.

Define Professional Practice Gap & Educational Need: Management strategies for partial auricular avulsion from dog bites in pediatric patients may vary at the time of injury. Some providers favor cartilage trimming and primary closure while others prefer to conserve residual exposed cartilage or amputated cartilage by burying it in a post-auricular well-vascularized pocket with plans for a second stage procedure. This case series demonstrates the importance of conservation of cartilage at the time of injury on the reconstructive outcomes.

Learning Objective: 1. To understand the importance and feasibility of cartilage preservation during the initial management of pediatric auricular trauma from dog bites with specific attention to the antihelix and scaphoid fossa. 2. To understand the goals of reconstruction of the auricle and reconstructive options as described in the literature.

Desired Result: Our hope is that attendees will understand the importance and feasibility of preserving as much cartilage as possible in the initial management of a partial auricular avulsion in the pediatric patient, with special attention to salvage of the antihelix and scaphoid fossa. While the physician initially taking care of the patient may not necessarily perform the final reconstruction of the auricle, they play a key role in the patient's final outcome by preserving cartilage. This may save the patient from needing more invasive reconstruction later.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Exempt

Radiographic Opacification of the Protympanum and Eustachian Tube Predicts Inferior Hearing Outcomes after Ossiculoplasty

Joseph T. Breen, MD; Gavriel D. Kohlberg, MD
Ravi N. Samy, MD; Myles L. Pensak, MD

Objective: To examine the relationship between the radiographic finding of Eustachian tube and protympanic opacification and hearing outcomes after ossiculoplasty.

Study design: Retrospective case review.

Setting: Academic medical center.

Patients: Adults and children undergoing primary or staged ossiculoplasty after surgery for cholesteatoma. Patients with additional causes of conductive hearing loss (e.g. inner ear fistula, stapes footplate fixation), patent tympanostomy tubes, or tympanic membrane perforations were excluded. Preoperative CT scans were reviewed to determine whether the protympanum and bony Eustachian tube were aerated, partially opacified, or completely opacified.

Intervention: Ossiculoplasty with artificial or autologous prostheses.

Main outcome measures: Air conduction thresholds and air-bone gaps (ABGs) on preoperative and postoperative pure tone audiometry.

Results: Eighty-one patients met inclusion criteria. Complete or partial CT opacification of the protympanum and bony Eustachian tube was seen in 29 subjects. Opacification was strongly predictive of a larger postoperative ABG (24.8 dB vs 17.9 dB, $p < 0.01$). When examining the 58 patients with a preoperative ABG >20 dB, opacification was not correlated with higher preoperative ABG (31.2 dB vs 30.6 dB, $p = 0.78$), but predicted a higher postoperative ABG (26.5 dB vs 20.3 dB, $p = 0.027$) as well as a lower probability of an acceptable ossiculoplasty outcome, defined as ABG <20 dB (37.3% vs 57.6%, $p = 0.03$).

Conclusions: For patients with cholesteatoma who undergo ossiculoplasty, preoperative radiographic opacification of the protympanum and bony Eustachian tube is an independent predictor of poor hearing outcomes.

Define Professional Practice Gap & Educational Need: Lack of contemporary knowledge regarding how CT scan findings can be used to help predict hearing outcomes after ossiculoplasty.

Learning Objective: The learner will understand the impact that opacification of the bony Eustachian tube and protympanum has on the air-bone gap after ossiculoplasty.

Desired Result: Surgeons will be able to better predict postoperative air-bone gaps and counsel their patients who undergo ossiculoplasty.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB: Approved

Window Shade Tympanoplasty Technique for Anterior Membrane Perforations: An Update

Elizabeth A. Mannino, Andrew Bluher, MD
Barry Strasnick, MD

Objective: Anterior marginal perforations present unique challenges in the repair of tympanic membranes. Traditional underlay and overlay techniques are complicated by poor visualization and graft blunting, respectively. The “window shade” tympanoplasty technique was developed to address these issues. The aim of the present study is to demonstrate the efficacy of the window shade technique in the largest series thus far.

Study design: We present a retrospective review of pediatric and adult patients ranging from 6 to 76 years old who have undergone a window shade tympanoplasty from 1994 to 2016 by a single surgeon at a tertiary referral center. Indications for surgery included anterior marginal tympanic membrane perforation with or without cholesteatoma.

Intervention: The “window shade” technique employs a laterally-based anterior skin flap, incorporating the tympanomeatal flap, residual tympanic membrane, anterior fibrous annulus and anterior canal wall skin. Such a flap allows for excellent visualization of anterior perforations while using the anterior fibrous annulus as an anchor to avoid issues with blunting occasionally observed in lateral graft techniques.

Main outcome measures: The main outcome measures were graft take success rate, postoperative complications, and postoperative air bone gap values.

Results: Post-operative outcomes of 412 patients were assessed. The graft take success rate was 94.2%, with only 4.6% of the patients experiencing postoperative complications. Postoperative air-bone gap values below 10 dB were present in 96.2% of patients.

Conclusions: The results of this study further reinforce the success of the window shade technique in repairing marginal tympanic membrane perforations.

Define Professional Practice Gap & Educational Need: Various tympanoplasty techniques have been utilized for membrane perforations. However, these techniques are not always ideal for anterior membrane perforations. The "window shade" technique has been developed to address some of the complications associated with the other techniques and has been successful in repairing these perforations. The degree to which this technique has been adopted is unclear; only one other paper has been written on the subject since the original description of the technique. We seek to demonstrate the technique’s efficacy and increase awareness of its applications to anterior marginal perforations.

Learning Objective: The objective is to demonstrate the efficacy of the "window shade" tympanoplasty technique for anterior membrane perforations.

Desired Result: Attendees will have increased awareness of a surgical technique tailored to the unique challenges presented by anterior membrane perforations. Adopters of the technique will be able to avoid many of the complications associated with other tympanoplasty techniques.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Approved

The Potential for Preserved Cochleovestibular Function in the Setting of Prolonged Pneumolabyrinth

Joseph T. Breen, MD; Alex D. Sweeney, MD
Jeffrey T. Vrabec, MD

Objective: To discuss the natural history and management of pneumolabyrinth.

Design: Case series and literature review.

Setting: Two academic medical centers.

Intervention: Documentation of pneumolabyrinth on CT imaging with subsequent surgery or observation.

Methods: Individuals with pneumolabyrinth on imaging were evaluated. Inner ear function is documented with audiometry and vestibular testing.

Results: All patients presented with severe hearing loss following blunt trauma with or without temporal bone fracture (3 cases), penetrating trauma (1 case), or stapedectomy (3 cases). Late pneumolabyrinth, defined as air in the labyrinth more than 1 month after the initial injury, was detailed in four cases with resolution of vestibular symptoms and partial recovery of hearing after surgery in two cases. Two patients with additional inner ear abnormalities (enlarged vestibular aqueduct, prior otic capsule-violating temporal bone fracture) were observed to have continuous egress of CSF through the oval window at the time of surgery.

Conclusion: Management of pneumolabyrinth is individualized based on the mechanism of injury, severity of symptoms, and timing of the imaging study. In most cases, the defect is expected to heal spontaneously, leading to rapid resolution of pneumolabyrinth. However, even in cases where pneumolabyrinth persists for weeks to months following an injury, repair can lead to improvement in audiologic and vestibular symptoms and can be considered before ablative options. As such, the presence of air in the vestibule, even weeks or months after trauma, cannot be assumed to be indicative of irreversible inner ear damage.

Define Professional Practice Gap & Educational Need: Pneumolabyrinth is an uncommonly encountered condition without well-defined management principles.

Learning Objective: The learner will be aware that surgical repair of persistent defects at the oval window can result in a return of cochleovestibular function in some cases. The learner will be introduced to a proposed underlying mechanism for these imaging and clinical findings.

Desired Result: Pneumolabyrinth present weeks or months after an initial injury should not be assumed to be indicative of irreversible damage, and surgeons should not necessarily resort to ablative treatments to treat this condition.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Approved

Pediatric Single-Sided Deafness Cochlear Implant Candidacy: A Study of Prevalence and Imaging Characteristics

Sullivan Smith, BS; Nicholas A. Dewyer, MD
Peter Marciniak, MSc; Daniel J. Lee, MD

Objective: To determine the prevalence and imaging characteristics of children with single-sided deafness (SSD) who are candidates for cochlear implant (CI) surgery.

Study design: Retrospective case series

Setting: Tertiary pediatric otology center.

Patients: Children less than 18 years old who underwent audiometric testing from 1999-2017.

Intervention(s): Comprehensive audiometric testing, temporal bone computed tomography (CT) and magnetic resonance imaging (MRI).

Main outcome measure(s): Prevalence of SSD in children from a single institution, and proportion of patients with favorable anatomy for CI surgery based on imaging.

Results: Audiograms from 32,695 children were reviewed. 137 (0.42%) patients had SSD (pure tone average ≥ 70 dB in one ear and ≤ 30 dB in the other ear). 19/137 (14%) had an MRI with or without CT that demonstrated favorable anatomy for CI surgery, 87/137 (64%) had neither CT nor MRI or had imaging with inconclusive findings, and 31/137 (23%) had anomalies on CT or MRI that would preclude CI. Cochlear nerve hypoplasia/aplasia was the most common finding that precluded CI (58% of excluded patients). 41/137 (30%) had temporal bone MRIs adequate for resolving cochlear nerve anatomy.

Conclusions: SSD among children is rare, with a prevalence of 1:235 in our population. Temporal bone MRI scans should be obtained to determine CI candidacy in pediatric SSD patients as there is a high prevalence of cochlear nerve anomalies that would preclude surgery.

Define Professional Practice Gap & Educational Need: Lack of understanding about the prevalence of pediatric single-sided deafness (CI), and awareness about potential rehabilitation with cochlear implant (CI) surgery.

Learning Objective: Improve understanding of the issue of pediatric SSD and the proportion of these patients that could potentially benefit from CI.

Desired Result: Audience members will understand that pediatric SSD is rare, CI is a rehabilitation option, and evaluation with an MRI is important because of a high rate of cochlear nerve hypoplasia/aplasia.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Exempt

Diagnostic Value of Delayed High-Resolution Contrast-Enhanced MRI in the Diagnosis of Perilymphatic Fistula

Janice Erica Chang, MD, PhD; Gail Ishiyama, MD
Stellios Karnezis, MD; Akira Ishiyama, MD

Objective: Perilymphatic fistulas (PLF) of the ear can be difficult to diagnose and conventional CT and MRI imaging are normal. We present for the first time the findings using delayed high-resolution contrast-enhanced MRI designed to distinguish perilymph from endolymph in two cases of documented PLF.

Setting: Tertiary academic center

Patients: A 24-year-old male and 37-year-old female presented to outside hospitals following head trauma with unilateral sensorineural hearing loss and severe prolonged vertigo. Both had a positive Halmagyi-Curthoys head impulse.

Interventions and Main Outcome Measures: MRI sequences with 3T scanner using high resolution: "cisternographic" T2 and delayed intravenous-enhanced 3-D fluid-attenuation inversion recovery sequences, performed with 2350 ms (bright perilymph) and 2050 ms (bright endolymph) inversion times and subtracted images.

Results: Audiovestibular testing demonstrated profound hearing loss and ipsilateral 100% caloric paresis. In both, routine MRI with contrast of the internal auditory canal was normal. Specialized MRI demonstrated complete lack of visualization of the utricle. CT in one patient demonstrated a temporal bone fracture through the round window confirming the site of the PLF. The CT in the other patient was normal, but given an ipsilateral Tullio's phenomenon, persistent spontaneous nystagmus, and sensitivity to Valsalva, the patient underwent exploratory surgery. Intraoperatively, a large round window PLF was noted. Following repair, the post-surgical MRI demonstrated normal uptake of gadolinium in the utricle, and the patient had significant improvement in hearing and absence of spontaneous nystagmus.

Conclusions: High-resolution MRI IAC with a 4-hour post-contrast delay may be an invaluable tool to identify and treat patients with suspected PLF.

Define Professional Practice Gap & Educational Need: 1. Challenges in diagnosis of perilymphatic fistulas 2. Utilizing modified imaging techniques to support clinical diagnosis of perilymphatic fistulas

Learning Objective: 1. Identify clinical and objective findings to support the diagnosis of perilymphatic fistulas.

Desired Result: 1. Attendees may utilize this modified MRI imaging technique to aid in the diagnosis and treatment of patients with suspected perilymphatic fistulas.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Approved

Impact of Residual Hearing in the Non-Implanted Ear on Speech and Quality of Life Outcomes after Cochlear Implantation for Single-Sided Deafness

Tiffany Peng, MD; Abby Owen; Megan Kuhlmey, AuD
Ilana Cellum, AuD; Anil K. Lalwani, MD
Lawrence R. Lustig, MD; Ana H. Kim, MD

Objective: Our objective was to compare outcomes in speech and quality of life in those undergoing cochlear implantation for single-sided deafness, with a specific aim to characterize the clinical impact of preoperative residual hearing in the non-implanted ear.

Study Design: Prospective case series

Setting: Academic Cochlear Implant Center

Patients: We review the outcome of 24 adult patients implanted with the diagnosis of single-sided deafness.

Interventions: All patients were evaluated at 3- and 6-months post-operatively using AZBio® sentence and speech, consonant-nucleus-consonant (CNC), and Bamford-Kowal-Bench Sentences in Noise (BKB-SIN) tests depending on appropriate testing level. Our previously validated Comprehensive Cochlear Implant Quality of Life (CCIQ) questionnaire was administered pre and 6-month post implantation.

Main Outcome Measures: Speech perception, quality of life

Results: Subjects were stratified by the pure tone average (PTA) of the non-implanted ear: Group 1 (< 20dB), Group 2 (21-50dB), Group 3 (>50dB). The mean preoperative PTA of the implanted ear was 80dB±18. Group 3 demonstrated the lowest speech perception score at 3 months (27%), but demonstrated the greatest improvement at 6 months (45%). Groups 1 and 2 speech perception score at 3 months was 46% and 45%, respectively. At 6 months, Group 1 further improved to 56%, but Group 2 demonstrated no significant change (42%). All 3 groups reported improved quality of life on CCIQ testing.

Conclusions: Degree of residual hearing in the non-implanted ear impacts both speech performance and quality of life measures in cochlear implantation for single sided deafness.

Define Professional Practice Gap & Educational Need: 1. Lack of contemporary knowledge regarding natural history of post-operative adaptation after cochlear implantation for single sided deafness as it pertains to residual hearing in the non-implanted ear 2. Need for risk stratification of speech and quality of life outcomes for cochlear implantation performed for single-sided deafness

Learning Objective: 1. Quantification of how residual hearing in the non-implanted ear impacts adaptation and improvement after cochlear implantation for single-sided deafness 2. Risk stratification of speech and quality of life outcomes as they pertain to residual hearing in the non-implanted ear

Desired Result: Attendees will attain a deeper understanding of how residual hearing in the non-implanted ear affects patients who have undergone cochlear implantation for single-sided deafness. This information will allow attendees to improve pre-operative counseling of their patients and quantify expectations in their post-operative course.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Approved

Minimally Invasive, Image-Guided Approach to Congenital Aural Atresia Repair, A Demonstration of Concept

Kyle S. Kimura, MD; Robert F. Labadie, MD, PhD
Neal P. Dillon, PhD; Jack H. Noble, PhD

Hypothesis: Image-guided surgery permits safe and accurate access to the middle ear and facilitates an anatomically functional external ear canal in patients with aural atresia

Background: Congenital aural atresia, thought to affect one in 10-20,000 births, can often prove exceptionally difficult to repair due to lack of anatomical landmarks, requiring meticulous surgical technique. Our institution has developed a novel image-guided drilling system studied in other otologic surgeries which have demonstrated the feasibility of using image-guided technique to safely identify important structures and decrease the need for wide-field local exposure necessary in standard dissection.

Methods: Computed tomography (CT) scans of patients with diagnoses of aural atresia were reviewed and uploaded to proprietary image-guided drilling software. Using this software and anatomically normal ear as a template, safest drilling paths were created. Three-dimensional printed phantoms were used to test accuracy of the drilling paths and distances from critical structures were measured to determine safety.

Results: Complete set of results available at time of presentation: feasibility of creating 3D phantom temporal bones for drilling and distance of drilling path from critical structures (tegmen, ossicles, facial nerve) for each scan.

Conclusion: An image-guided approach to congenital aural atresia repair provides accurate access to the middle ear in a minimally invasive fashion, increasing safety by decreasing the need for real-time surgical landmarks. While the presenting study was confined to in vitro demonstration, these results warrant in vivo testing, which may lead to clinically applicable access.

Define Professional Practice Gap & Educational Need: 1. Lack of awareness of surgical options for correction of aural atresia 2. Lack of alternatives for correction of aural atresia

Learning Objective: Attendees will be aware of potential alternative options for surgical correction of aural atresia

Desired Result: Attendees will be aware of potential alternative options for surgical correction of aural atresia

Level of Evidence: Does not apply- Proof of concept for novel surgical approach to aural atresia repair

IRB: Approved

American Otological Society Reseach Grants
6 month Progress Reports
Reporting Period: 07/01/2017 – 06/30/2018

PI: Richard K. Gurgel, MD
Grant Title: Exploring the Impact of Hearing Loss on Impaired Cognition in Older Adults
Reporting Project Period: 07/01/2017 – 06/30/2018

Progress Report

A. Introduction

Hearing loss is associated with the development of dementia in older adults. While multiple epidemiologic studies have established the association between hearing loss and dementia, the mechanistic underpinnings of the association require further elucidation. Our overall research goal is to determine if hearing loss is a remedial risk factor for dementia. To further understand the association between hearing loss and dementia, we are working to address the following hypotheses and aims:

B. Results

1. Hypothesis: The auditory cortex is an area of selective vulnerability in AD.

Aim 1. Correlate the extent of auditory cortical damage as determined with FDG-PET imaging with the degree of hearing loss in patients with AD, controlling for severity of cognitive impairment.

We have completed comprehensive central and peripheral audiometric testing on 6 subjects who have also undergone FDG-PET imaging. We have another 4 subjects scheduled for testing, which will complete our recruitment goal of 10 test subjects. The next step of the study will be to correlate the FDG-PET results with the subjects' hearing data.

2. Hypothesis: Music processed through the auditory cortex activates other cortical domains and the hippocampus in older adults with AD.

Aim 2. Characterize auditory cortical connectivity to brain networks activated during music-listening session in subjects with AD. *Results as follows to be presented at the 2018 AOS Annual Spring meeting*

Objective: To determine whether hearing ability in noise predicts brain activity in adults with Alzheimer's disease (AD) dementia.

Study design: Prospective, interventional study

Setting: Tertiary referral center

Patients: Patients with AD who had individual-ear pure tone averages ≤40dB HL. Patients underwent comprehensive peripheral and central audiometric testing.

Intervention(s): While in a functional MRI (fMRI) scanner, subjects listened to favorite familiar musical pieces (active state) and were also examined with resting state fMRI in which they listened to nonsensical, reversed music with two runs of 10 minutes each.

Main outcome measure(s): Functional MRI connectivity in 361 distinct gray matter brain regions of interest (ROIs) during active and resting states. Average global connectivity was calculated as mean functional connectivity between an ROI and the other 360 regions, a quantitative marker representing overall functional connectivity in the brain.

Results: Sixteen subjects had adequate fMRI and hearing data. The average age was 71.5 years old (±6.0). The average Dichotic Sentence Identification (DSI) test, which measures central auditory processing, for the left ear was 40% (±34%) compared to 90% (±10%) in the right ear ($p<0.001$). Of the fMRI ROIs, 289 of the 361 had significant correlations between global connectivity and DSI of the left ear ($p=0.0039$, $r^2=0.4597$), and all 289 showed higher functional connectivity for individuals with higher left DSI score.

We found that participants listening to preferred musical selections show specific activation of the supplementary motor area, a region that has been associated with memory for familiar music, and which is typically spared in early Alzheimer disease. We also find widespread increases in functional connectivity in corticocortical and corticocerebellar networks following presentation of preferred musical stimuli compared to before stimulation, suggesting some transient effect on brain function. Findings support a mechanism whereby attentional network activation in the brain's salience network may lead to improvements in brain network synchronization.

Conclusions: The DSI can predict functional connectivity in patients with AD. Moreover, auditory input from the left ear was more susceptible to impairment, suggesting that side-specific auditory input may influence central auditory processing.

3. Hypothesis: Restoring hearing in profoundly deaf older adults by means of cochlear implantation will improve cognitive function.

Aim 3. Evaluate pre- and post-operative cognitive function in older cochlear implant patients and determine which measures are most sensitive to inform future clinical trials.

We have enrolled 29 patients 65 and older who have undergone pre-operative cognitive testing prior to cochlear implantation. Fifteen patients have completed 6 month post-op testing, and ten subjects have completed 1 year post-op testing. Our next step will be to finish out the cognitive testing for all subjects and begin our data analysis. This project has now been extended and expanded to include quality of life measures for the recipients and their care givers as part of an NIH-funded study.

C. Funding:

The work from the AOS grant provided preliminary data that was used to successfully apply for and receive the National Institute of Aging Grants for Early Medical/Surgical Specialists' Transition to Aging Research (GEMSSTAR) R03 AG056458-01.

D. Publications:

Hearing loss as a risk factor for dementia: A systematic review. Laryngoscope Investig Otolaryngol. 2017 Mar 16;2(2):69-79. PMID: 28894825

2 publications in preparation to be submitted before April, 2018

American Otological Society
AOS Research Fund Grant 2017-2018
Progress Report

Primary Investigator: **Ward R. Drennan, PhD**

Co-Investigator: **Jay T. Rubinstein, MD, PhD**

Project Title: **Early Detection of Noise-induced Hearing Loss**

This study addresses the issue of a lack of sensitivity of current assessments to hearing handicap, specifically speech understanding, in the most adverse listening conditions. This is particularly common in patients with a history of noise exposure (i.e., military exposure, musician, construction worker). Testing involves a series of behavioral hearing tests designed to give us more information about how well the participants can hear than would be provided in current clinical practice. The goal is to document in a "normal hearing" adult population, if substantial disabilities could result before current diagnostics indicate a potentially preventable problem. Our research tests the hypothesis that several audiometric tests could identify symptoms that are consistent with early-stage noise-induced hearing loss, when thresholds of sound detection, as tested in the clinical audiogram, are "normal". This condition is called "hidden" hearing loss, because the loss is subclinical, hidden to the audiogram.

The goal is to document in a "normal hearing" adult population, if substantial disabilities could result before current diagnostics indicate a potentially preventable problem. Our research tests the hypothesis that several diagnostics could identify symptoms that are consistent with early-stage noise-induced hearing loss, when thresholds of sound detection, as tested in the clinical audiogram, are "normal". This putative condition is called "hidden" hearing loss, because the loss is hidden to the audiogram. In our aim to establish a test that can indicate "hidden" hearing loss, we have tested several different measures. These include the (1) ultra-high frequency detection thresholds (10-16KHz), (2) the binaural intelligibility level difference (BILD), (3) Middle-ear muscle reflex thresholds, and more recently, (4) Electrocochleography (ECoG).

Specific Aim Identify and quantify early consequences of noise exposure in humans with normal audiograms.

Progress: Twelve people have been recruited to date. Nine of these met the inclusion criteria. Data collection is active, accelerating, and ongoing. Data has been obtained for binaural intelligibility level differences (BILD), clinical detection thresholds (.5-8 KHz), and ultra-high frequency thresholds (UHF, 10-16 KHz). Collection of electrocochleography data was delayed primarily due to the process of obtaining permission for and getting training for billing a research study conducted in the otolaryngology clinic. This approval has been obtained, and one person was tested to date. IRB approval was just obtained for collecting middle-ear muscle reflex (MEMR) data on these participants as well. Equipment for measuring MEMR in our lab is being donated from a retiring professor and will be in place and operational by late-February, 2018. We anticipate collecting full sets of data on at least 10 more subjects, including ECoG and

MEMR, and the first nine participants are being asked back to collect data on these measures.

A broad range of lifetime noise exposure has been observed in our cohort with the LENS-Q, a detailed self-report questionnaire. The subjects ranged in the age range from 18-32. Their noise exposure ranged from none at all, to moderate with casual musicians and concert goers, to significant with professional musicians and one military veteran having exposure to gunfire, artillery and explosions. As such, the group cannot be stratified sensibly into two noise-exposure groups, so life-time noise exposure was rated on a 10-point scale based on the LENS-Q reports.

While our cohort is still quite small (N=9), we conducted some correlation analyses. Speech perception thresholds for spondees (words with two syllables of equal emphasis) were measured as the signal-to-noise ratio at which participants could correctly identify 50% of words in a 12-word, closed-set task. Thresholds were measured in two conditions: 1) in which the speech and noise were perceptually co-located, and 2) in which the speech was perceptually shifted to the side with a 700 microsecond interaural timing difference. The perceptual shifting leads to a masking release of typically 7-10 dB. The binaural intelligibility level difference (BILD) is defined as the difference between the signal-to-noise ratios in the two conditions. We found a statistically significant correlation between the BILD and both age ($r = 0.75$) and noise exposure ($r = 0.66$). These correlations had p values of less than or equal to 0.05. Noise exposure and age were also statically significantly related ($r = 0.86$) even among our limited age range of 18-32. Also, some trends were observed between the BILD and the pure tone average (.5, 1, 2, and 4 KHz) ($r = 0.58$) and between the PTA and noise exposure and the PTA ($r = 0.60$). These observations occurred even with all PTAs well within the normal range, and no participant exceeding 13 dB HL PTA. These trending correlations had p values of less than or equal to 0.1. The extended (ultra) high frequency thresholds (UHF-PTA for 10-16 KHz) and tinnitus handicap did not show any significant correlations with other measures in our cohort.

While these results are preliminary, the extent of and number of trends observed between BILD and other measures does ***not*** seem random. Thus, it is possible that 1) the BILD is compromised in normally hearing people with noise exposure, and 2) even subclinical losses observed in the PTA might be an early indicator of noise exposure pathology.

American Otological Society - Progress Report

Project title: Changes in Na+ Channel Subunits in Vestibular Calyx Afferent Terminals during Postnatal Development

P.I. - Frances Meredith, PhD

Specific Aim 1

The goal of Specific Aim 1 was to investigate changes in the electrophysiological expression of Na^+ channel subtypes during development. We use our recently developed gerbil vestibular slice technique and patch clamp techniques to measure whole cell inward sodium currents (I_{Na}). In some cases, we dissociate cristae and make recordings from an isolated calyx ending still attached to a type I hair cell. We are testing the hypothesis that the incidence of TTX-insensitive (TTX_I) and TTX-resistant (TTX_R) currents is greater in early postnatal calyx terminals and declines with maturity. We block other known voltage-dependent conductances to isolate I_{Na} and use voltage protocols and pharmacological blockers to further dissect Nav currents. We test for the presence of non-TTX-sensitive currents in immature (postnatal days (P) 8-12) and mature (P21-29) calyx terminals using 200 nM TTX. 1 µM TTX separates TTX_I from TTX_R components. The contribution of TTX_I $Na_V1.5$ is also tested by extracellular application of Zn^{2+} and Cd^{2+}. For the TTX-sensitive (TTX_S) contribution to whole cell, we hypothesized that Nav1.6 channels underlie the dominant I_{Na} in mature peripheral zone (PZ) dimorphic calyces. We are testing this using the selective blocker 4,9-anhydrotetrodotoxin (4,9-Ah-TTX) which blocks Nav1.6 channels.

Progress: We found differences in whole cell biophysical properties of I_{Na} with respect to zone. Inactivation kinetics were slower in mature calyx-only afferents compared to dimorphic afferent calyx endings. Mean half-inactivation in PZ calyces was -85mV ± a standard error of 7 mV (n = 8), which was more hyperpolarized than in CZ calyces (-81 ± 5.2 mV; n = 4). Mean slope factor in PZ calyces was -4.9 ± 0.6 (n = 8), significantly less than the value of 6.3 ± 0.6 in CZ calyces (n = 4; P = 0.003, t-test). These results suggest differences in underlying Nav subtypes which we probed using channel blockers. We found differences in whole cell properties of I_{Na} with respect to age. We found that TTX (200–300 nM) completely blocked I_{Na} in PZ (n=5) and CZ (n=3) calyces at P21-29. However, at P8-11, approximately 5% of peak I_{Na} remained in 200 nM TTX (n=6; 3 PZ, 3 isolated) suggesting that Nav1.5, 1.8 and/or 1.9 may be present during postnatal development. Application of 1 µM TTX, which should block Nav1.5 channels, but not Nav1.8 or 1.9, completely abolished I_{Na} in immature calyces (P7 to P10; n=7). Cadmium (200 µM) blocked a component (14%) of I_{Na} in 4 of 14 immature calyces (P4 to P13), but did not block I_{Na} in more mature calyces (n=3; P22-P31). Likewise, 1 mM Zn^+ did not block I_{Na} in mature calyces (n=4, P22-P25). We used immunohistochemistry to target Nav1.5 in vestibular end organs at the two age groups and found positive staining at the heminodes of vestibular afferents. We concluded that TTX-sensitive and TTX-insensitive I_{Na} is present in calyx terminals at immature ages tested (P4 to P13), that TTX-insensitive currents may be mediated by Nav1.5, but that I_{Na} in more mature calyces is produced by TTX-sensitive channels only.

A candidate for TTX-sensitive I_{Na} is Nav1.6. In the presence of 4,9-anhydrotetrodotoxin (which blocks Nav1.6 channels), I_{Na} was reduced by 24% in P11-14 calyces (n=4), by 28% in mature PZ calyces (n=11), but by less than 5% in mature CZ terminals (n=4). 100 nM 4,9-ah-TTX had no effect on a P6 and P7 calyx. We will continue to probe electrophysiological expression of Nav1.6 during the first postnatal week to verify that $Na_V1.6$ channels are only expressed after the first postnatal week. Thus far we have tested immunohistochemical expression in a P29 gerbil and showed that Nav1.6-like staining predominates in PZ calyx terminals. We will perform additional experiments to probe immunohistochemical expression of Nav1.6 in PZ and CZ calyces in mature and immature cristae. Overall, these results suggest that Nav1.6 channels contribute to TTX-sensitive I_{Na} in calyx afferents in both age groups, but may be more prevalent in mature dimorphic calyx terminals than in calyx-only terminals. Faster inactivation of I_{Na} in dimorphic afferents could promote rapid and tonic firing.

Specific Aim 2

The goal of Specific Aim 2 was to elucidate the contribution of Na^+ channel subtypes to action potential (AP) firing properties. Firing properties of rodent primary vestibular afferent neurons change with postnatal development and reach mature levels within the first postnatal month. The role played by different Nav α subunits in AP initiation and firing in calyx terminals is not known. We hypothesized that regional variations in the expression of Na^+ channel α subunits contribute to the heterogeneity of firing observed in afferents that terminate in CZ and PZ vestibular afferents. We also hypothesized that TTX_I and TTX_R currents play a role in AP firing in early postnatal development. $Na_V1.6$ channels have been implicated in autonomous pacemaker firing in other systems and we are investigating the role of $Na_V1.6$ channels in spontaneous AP firing in vestibular dimorphic afferents.

Progress: We found that immature calyces do not fire spontaneously during the first postnatal week, but that action potentials could be evoked by applying brief, hyperpolarizing current injections to remove inactivation of Na^+ channels. 4,9-Ah-TTX did not alter the onset or amplitude of evoked action potentials in a P6 and P7 calyx. We will look at the effect of 4,9-ah-TTX on firing during the second postnatal week since we saw a significant block of I_{Na} at this stage of development (P11-P14, n=4, P=0.019). We are currently investigating the contribution of Nav1.6 to I_{Na} and to firing in pure calyx terminals innervating immature and mature CZ by including fluorescent dye (Alexa) in the patch electrode to distinguish pure calyx from dimorphic afferents. Once this experiment is completed, we will submit a manuscript for publication.

Conference posters and presentations

Meredith F, Divakar A and Rennie KJ. Identification of Na^+ currents in vestibular calyx afferent terminals. Assoc. Res. Otolaryngol. 40th annual mid-winter meeting (podium presentation #42), 2017.

Meredith F, Divakar A and Rennie KJ. Heterogeneity of Na^+ Channel Subunits in Vestibular Afferent Terminals. Assoc. Res. Otolaryngol. 41st annual mid-winter meeting (Poster# 541, February 11, 2018).

Rennie KJ and Meredith F Regional variations in ion channels in vestibular calyx terminals. Assoc. Res. Otolaryngol. 41st annual mid-winter meeting (Symposium presentation#27, February 11, 2018).

American Otological Society
Progress Report

Project Title: Brn3c as a novel target for auditory hair cell regeneration
Primary Investigator: Bradley J. Walters, Ph.D.

Sensorineural hearing loss is one of the most common long term disabilities. It costs the US healthcare system billions of dollars each year, significantly impacts quality of life for more than 1 out of every 6 adults, and while treatable, is not yet reversible. This inability to restore full hearing is due largely to the inability of sensory cells in the cochlea to regenerate. While we and others have previously demonstrated that ectopic expression of the Atoh1 gene can cause nonsensory cells to give rise to new hair cells, these regenerated hair cells fail to mature completely and do not function properly. One of the main shortcomings of these cells is that they fail to upregulate the protein prestin which is necessary for cochlear amplification.

The Brn3c gene is a pro-neural gene that was first characterized as being necessary for the differentiation and survival of neurons in the brain, retina, and other parts of the nervous system. In the inner ear, Brn3c is selectively expressed in hair cells and mutations in this gene cause hearing loss as a result of diminished numbers of hair cells. Within the cochlea it has been shown that Brn3c directly regulates the expression of hair cell specific genes such as Gfi1 and Myo6. We therefore sought to determine whether ectopic Brn3c could drive nonsensory cells to differentiate into hair cells and therefore if Brn3c could be useful for the hair cell regeneration in the organ of Corti.

Specific Aim 1 is to test the hypothesis that ectopic Brn3c promotes the conversion of pillar and Deiters cells to an outer hair cell phenotype, when initiated at various ages, or concomitant with hair cell loss. To do this, we have generated a CAG-floxed Stop-Brn3c-IRES-mCherry transgenic mouse line which we have bred with CreER mouse lines to conditionally express Brn3c in cochlear pillar and Deiters cells at either neonatal or young adult ages. Fluorescent reporter expression with Prox1 CreER is specific to pillar and Deiters cells when induced in neonates and with Fgfr3iCreER expression is specific to pillar and Deiters cells when induced in juvenile and adult mice. Therefore when we examine cochleae several weeks after induction, any hair cells that also express mCherry are presumed to have originated from cells that were either pillar or Deiters cells at the time of induction. In undamaged cochleae, we have shown that the ectopic expression of Brn3c starting at postnatal day (P) 28 results in the migration of supporting cells to the hair cell layer and the upregulation of the hair cell specific proteins myosin VIIa and parvalbumin. This suggests that ectopic Brn3c can indeed initiate the differentiation of nonsensory supporting cells to a hair cell-like fate. However, we did not observe the upregulation of either prestin or oncomodulin in these cells, suggesting that, similar to what we see with ectopic Atoh1, hair cells generated by ectopic Brn3c are immature and non-functional. These results were published in *Cell Reports* (DOI: 10.1016/j.celrep.2017.03.044). Following from this, we have tested the effects of ectopic Brn3c in juvenile (P12-13 induction) and neonatal (P0-1 induction) supporting cells and found that, similar to the P28 induction, induction at both P12-13 and P0-1 results in a number of supporting cells that migrate to the hair cell layer and upregulate myosin VIIa and parvalbumin. However, unlike the induction in young

adult and juvenile mice, induction of ectopic Brn3c in neonates resulted in a portion of the mCherry positive cells upregulating prestin and oncomodulin, suggesting that when Brn3c is ectopically expressed in neonatal supporting cells, it can promote their differentiation to a more mature outer hair cell fate than it can in juvenile or adult supporting cells. We are currently testing auditory brainstem responses (ABRs) on the neonatally induced mice to see how these new hair cells may be affecting function. Also, we are testing whether noise damage in the young adult mice can alter or enhance the differentiating effects of ectopic Brn3c. Our hypothesis is that ectopic Brn3c will yield regenerated hair cell-like cells that express myosin VIIa and parvalbumin in the denuded outer hair cell region. However it is also possible that the context of damage may recapitulate certain aspects of the neonatal cochlea which could permit the upregulation of prestin and oncomodulin in the regenerated cells. In the coming months, we plan to assay for this outcome as well as to check for any potential improvements in function by ABRs.

Specific Aim 2 is to test the hypothesis that ectopic Brn3c promotes the differentiation of embryonic precursor cells to both inner hair cells and outer hair cells. As the CreER lines used in Aim 1 only assess the question of whether ectopic Brn3c in supporting cells lateral to the tunnel of Corti can generate outer hair cells, we wanted to determine whether ectopic Brn3c might also be able to generate inner hair cells from supporting cells medial to the tunnel of Corti. To do this, we first crossed CAG-floxedStop-Brn3c-IRES-mCherry mice with Plp-CreER mice which expresses CreER in inner phalangeal cells medial to the inner hair cells. When these mice were induced at P0-P1, we did not observe any mCherry positive inner hair cells suggesting that Brn3c is not as efficient at converting medial supporting cells into inner hair cells as it is at converting lateral supporting cells to outer hair cells. However, to test whether an earlier induction might result in the conversion of medial supporting cells to inner hair cells, we bred the CAG-floxed Stop-Brn3c-IRES-mCherry mice with an Atoh1-Cre knock-in mouse line. The Atoh1-Cre, when heterozygous, expresses Cre primarily in the hair cells, but also in a reasonable number of supporting cells both medial and lateral to the developing tunnel of Corti. When we examined these mice, we did not detect any supernumerary inner hair cells suggesting that, while ectopic Brn3c is useful for generating outer hair cells from pillar or Deiters cells, it is not able to generate inner hair cells from inner phalangeal cells. We are in the process now of confirming the extent of Brn3c upregulation in our transgenic mice to make sure that this truly is a negative result, and not due to loss of transgene copy number over successive generations of breeding. Another aspect of breeding the Brn3c-mCherry mice with the Atoh1Cre mice is that we can further investigate the mechanism by which Brn3c works to upregulate hair cell specific genes. In particular, if Brn3c is to be considered as a target for hair cell regeneration, it will be important to understand whether it requires Atoh1 as a co-factor, or if it can promote hair cell differentiation independently. When Atoh1Cre mice are bred homozygous, this results in bi-allelic loss (i.e. knockout) of Atoh1. However the Cre still recombines the CAG-floxed Stop-Brn3c-IRES-mCherry transgene resulting in Brn3c expression in the prosensory cells after E14.5. We are currently characterizing these mice to see whether ectopic Brn3c can generate hair cells in the complete absence of Atoh1. A positive result would suggest Brn3c could be targeted independently of Atoh1 for hair cell regeneration approaches, whereas a negative result would suggest that Atoh1 and Pou4f3 should be manipulated in tandem.

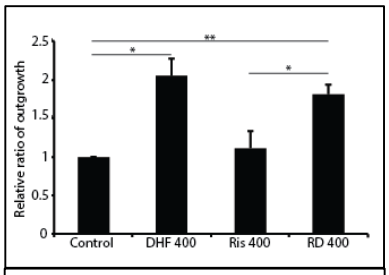

Figure 1: Comparison of SG neurite outgrowth in vitro. Neurite length is expressed in ratios relative to the untreated control sample. Asterisks denote statistically significant differences ($p<0.05$).

DHF-RIS supports neurite outgrowth and ribbon synapse regeneration *in vitro*: Cochleae were harvested from P3-4 CBA/CaJ pups, after which the spiral ganglion neurons were sharply dissected free in a clump of cells, divided into three roughly equal sections, and plated with fibronectin on DMEM. Individual sections were then treated with media alone, 400 nM DHF, 400 nM RIS, or 400 nM DHF-RIS for 48 hours. After fixing and immunostaining with TUJ1 the neurites were visualized under confocal microscopy and the neurite length quantified using ImageJ. As shown in Figure 1, DHF-RIS-treated neurites demonstrated robust outgrowth. To characterize the ability of DHF-RIS to regenerate ribbon synapses, we used a previously described organ of Corti explant system wherein kainic acid is used to mimic excitotoxic damage to the ribbon synapse.[10] Explants were treated with kainic acid for two hours to destroy synapses and then treated with 400 nM DHF, 400 nM RIS, or 400 nm DHF-RIS; comparison was made with control samples not treated with kainic acid (KA-) and samples treated with kainic acid but no other drug (KA+). Synapses were detected by co-localization of CtBP2 and PSD95 as previously described and counted using the Amira program by an observer blinded to sample identity. DHF-RIS demonstrated significant regeneration compared to non-rescued explants, although less than native DHF (Figure 2). Interestingly, RIS also showed some ability to regenerate synapses in this model, perhaps reflecting an anti-apoptotic effect upon SGNs that has been previously demonstrated for bisphosphonate treatment *in vitro*.[11]

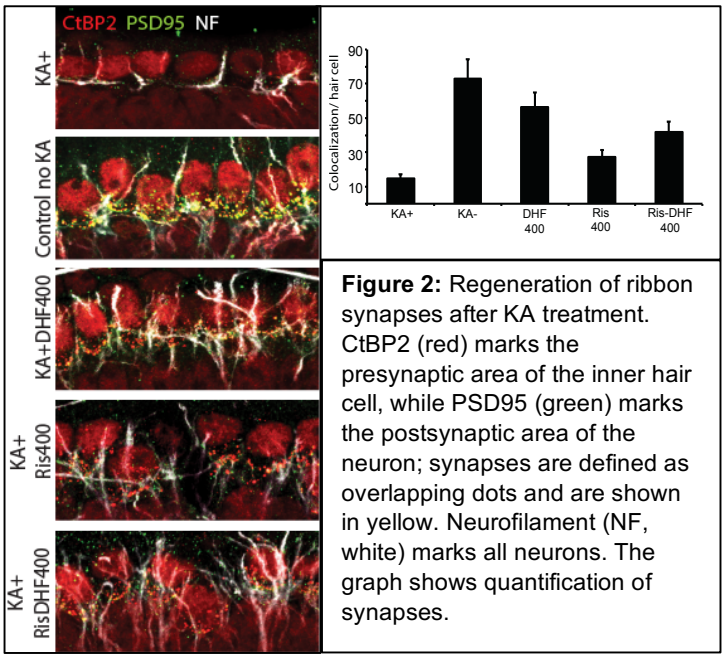

Figure 2: Regeneration of ribbon synapses after KA treatment. CtBP2 (red) marks the presynaptic area of the inner hair cell, while PSD95 (green) marks the postsynaptic area of the neuron; synapses are defined as overlapping dots and are shown in yellow. Neurofilament (NF, white) marks all neurons. The graph shows quantification of synapses.

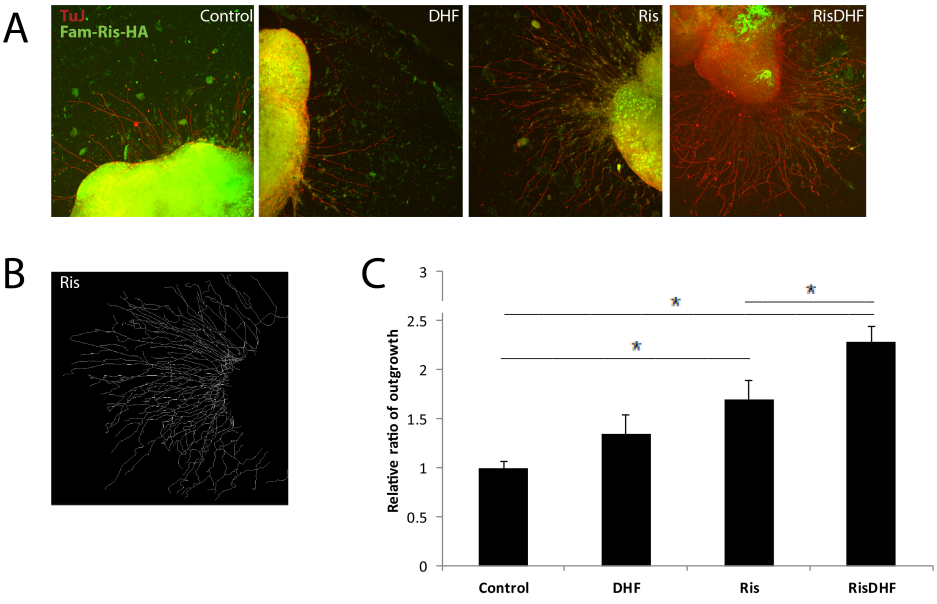

Figure 3. Comparison of SG neurite outgrowth in vitro stimulated by hydroxyapatite pellets pre-bound to drug. A) Greatest outgrowth is observed after treatment with DHF-RIS. B) Skeleton plot of neurites generated by ImageJ analysis program. C)Neurite length is expressed in ratios relative to the untreated control sample. Asterisks denote statistically significant differences ($p<0.05$).

DHF-RIS is available to attract SG neurites following pre-binding to hydroxyapatite *in vitro*: We needed to confirm that the DHF moiety within DHF-RIS remained available to attract neurites from a distance after binding to hydroxyapatite (a mineral substitute for bone). In a modification of the data shown in Figure 1, we carried out a separate set of experiments in which we pre-bound DHF-RIS to hydroxyapatite pellets, washed the pellets with media, and plated them along with SGN explants. To visualize the hydroxyapatite pellets, we added a small amount of 6-FAM-ZOL (described above) to all samples. DHF-RIS stimulated the greatest amount of outgrowth following pre-binding to HA pellets (Figure 3) as compared to RIS, no drug, or DHF. DHF is not known to bind HA.

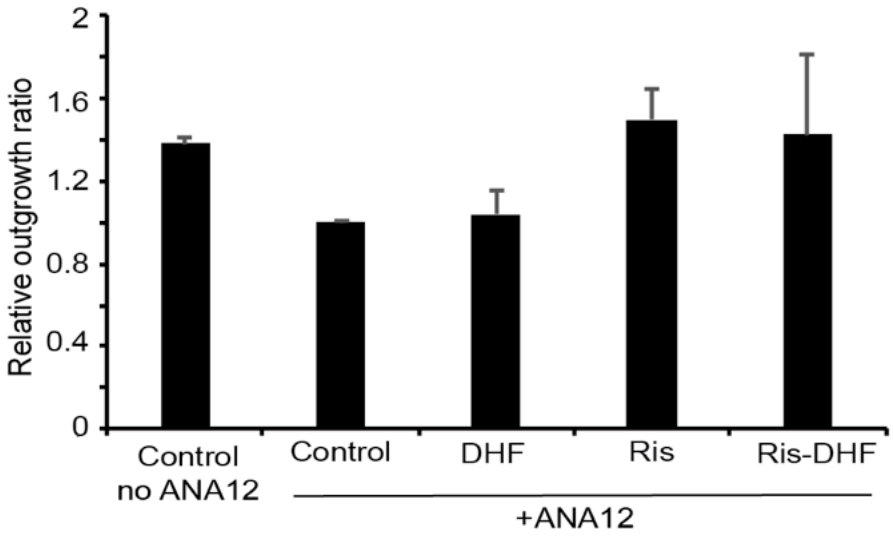

Figure 4. ANA 12, which inhibits TrkB stimulation, does not inhibit Ris-mediated neurite outgrowth. SGN explants were harvested and treated as in Figure 1, either with or without the presence of ANA 12. Ris maintained neurite lengths in the presence of ANA 12.

Ris-mediated outgrowth persists in the presence of ANA 12, a TrkB inhibitor. Because of the modest amount of SGN outgrowth and synaptic regeneration we observed following treatment with Ris (Figures 2 and 3, above), we decided to further investigate whether Ris acted via the TrkB receptor, as has been previously reported for DHF. SGNs were harvested and plated as in Figure 1. We then tested the ability of our samples to drive SGN-mediated outgrowth in the presence of ANA 12, which is a non-competitive inhibitor of TrkB. As seen in Figure 4, ANA 12 decreased average neurite length in the absence of other treatment. As expected, DHF-mediated outgrowth was abrogated in the presence of ANA 12. However, Ris maintained neurite lengths in the presence of ANA 12, suggesting that Ris acts via a TrkB independent pathway to regenerate synapses following KA treatment and to elongate neurites after binding to HA (Figures 2 and 3, above). We plan follow-up experiments to better understand the nature of Ris-mediated outgrowth, as our experiments may have uncovered a parallel novel pathway for SGN outgrowth and survival.

We are currently finalizing a submission to Bioconjugate Chemistry summarizing the synthesis of Ris-DHF and the in vitro experiments described above.

2018 plan:

In vitro experiments: We continue working on synthesis of 1Aa (small molecule analog of neurotrophin 3), and will proceed to attach 1Aa to RIS per our established techniques. A test run of 1Aa has been accomplished and we are currently scaling the synthesis up to

In vivo experiments: We have carried out an initial pilot test of the ability of Ris-DHF to regenerate synapses in vivo after noise damage. We have performed the surgery with preservation of hearing and are waiting for the mice to age further before sacrificing the animals and analyzing the synapses via whole mount staining.

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Little Rock, AR

Karen Jo Doyle-Enright, MD, PhD - Active
Fenton, MI

Colin LW Driscoll, MD - Active
Rochester, MN

Judy R Dubno, PhD – Associate
Charleston, SC

Larry G Duckert, MD - Emeritus
Seattle, WA

Arndt J Duvall III, MD - Emeritus
Minneapolis, MN

Thomas L Eby, MD - Active
Jackson, MS

Hussam K El-Kashlan, MD - Active
Ann Arbor, MI

John R Emmett, MD - Senior
Memphis, TN

Adrien A Eshraghi, MD - Active
Weston, FL

Abraham Eviatar, MD - Emeritus
Scarsdale, NY

George W Facer, MD - Senior
Bonita Springs, FL

Jay B Farrior, III, MD - Senior
Tampa, FL

Jose N Fayad, MD - Active
Dhahran, Saudi Arabia

Joseph G. Feghali, MD - Active
Bronx, NY

Ugo Fisch, MD - Honorary
Erlenbach, Switzerland

Howard W Francis, MD - Active
Durham, NC

Bernard Gil Fraysse, MD - Corresponding
Toulouse Cedex, France

David R Friedland, MD, PhD - Active
Milwaukee, WI

Rick A. Friedman, MD, PhD - Active
Los Angeles, CA

Michael H Fritsch, MD - Active
Indianapolis, IN

Richard R Gacek, MD - Emeritus
Worcester, MA

Bruce J Gantz, MD - Active
Iowa City, IA

L. Gale Gardner, Jr., MD - Senior
Shreveport, LA

George A Gates, MD - Emeritus
Boerne, TX

Gerard J Gianoli, MD - Active
Covington, LA

Paul W Gidley, MD - Active
Houston, TX

Joel A Goebel, MD - Senior
St. Louis, MO

Robert A Goldenberg, MD - Senior
Dayton, OH

Jerome C Goldstein, MD - Honorary
Lake Worth,

Richard L Goode, MD - Emeritus
Stanford, CA

Malcolm D Graham, MD - Emeritus
Atlanta, GA

J. Douglas Green Jr., MD - Active
Jacksonville, FL

John H Greinwald Jr., MD - Active
Cincinnati, OH

Andrew J Griffith, MD, PhD – Associate
Bethesda, MD

Samuel P Gubbels, MD - Active
Denver, CO

A. Julianna Gulya, MD - Emeritus
Locust Grove, VA

Thomas J Haberkamp, MD - Active
Cleveland, OH

Paul E Hammerschlag, MD - Senior
New York, NY

Marlan R Hansen, MD - Active
Iowa City, IA

Lee A Harker, MD - Emeritus
Omaha, NE

Jeffrey P Harris, MD, PhD - Senior
San Diego, CA

Cecil W.J. Hart, MD - Emeritus
Palm Springs, CA

George T Hashisaki, MD - Active
Charlottesville, VA

David S Haynes, MD - Active
Nashville, TN

David A Hilding, MD - Emeritus
Salt Lake City, UT

Keiko Hirose, MD - Active
St. Louis, MO

Barry E Hirsch, MD - Senior
Pittsburgh, PA

Michael E Hoffer, MD - Active
Miami, FL

Ronald A Hoffman, MD - Senior
New York, NY

Kenneth H Lee, MD, PhD - Active
Plano, TX

K. J. Lee, MD - Emeritus
Guilford, CT

John P Leonetti, MD - Active
Maywood, IL

S. George Lesinski, MD - Emeritus
Cincinnati, OH

Samuel C Levine, MD - Active
Minneapolis, MN

David J Lim, MD - Senior Associate

Charles J. Limb, MD - Active
San Francisco, CA

Vincent Y.W. Lin, MD - Active
Toronto, Canada Canada

Roger C Lindeman, MD - Emeritus
Mercer Island, WA

Thomas E Linder, MD - Corresponding
Luzern, Switzerland

Fred H Linthicum Jr., MD - Emeritus

William H Lippy, MD - Emeritus
Warren, OH

Phillip D Littlefield, MD - Active
Kaneohe, HI

Ward B Litton, MD - Emeritus
Bonita Springs, FL

Brenda Lonsbury-Martin, PhD – Associate
Loma Linda, CA

Charles M Luetje, MD - Senior
Olathe, KS

Larry B Lundy, MD - Active
Ponte Vedra Beach, FL

Lawrence R Lustig, MD - Active
New York, NY

John D Macias, MD - Active
Phoenix, AZ

Charles A Mangham Jr., MD - Senior
Hailey, ID

Wolf J Mann, MD - Emeritus
Mainz, Germany

Sam J Marzo, MD - Active
Maywood, IL

Douglas E Mattox, MD - Active
Atlanta, GA

John T McElveen Jr., MD - Active
Raleigh, NC

Michael McGee, MD - Active
Oklahoma City, OK

Michael J McKenna, MD - Active
Boston, MA

Brian J McKinnon, MD - Active
Philadelphia, PA

Sean O McMenomey, MD - Active
Seattle, WA

Cliff A Megerian, MD - Active
Cleveland, OH

Michael Merzenich, PhD - Senior Associate
San Francisco, CA

William L Meyerhoff, MD - Emeritus
Dallas, TX

Alan G. Micco, MD - Active
Chicago, IL

Lloyd B Minor, MD - Active
Stanford, CA

Richard T Miyamoto, MD - Senior
Indianapolis, IN

David A Moffat, MA - Corresponding
Cambridge, England

Edwin M Monsell, MD, PhD - Senior
Southfield, MI

Gary F Moore, MD - Active
Omaha, NE

William H Moretz Jr., MD - Active
Augusta, GA

Tetsuo Morizono, MD DMS - Senior Associate
Fukuoka City, Japan

Terrence P Murphy, MD - Active
Atlanta, GA

Eugene N Myers, MD - Emeritus
Pittsburgh, PA

Joseph B Nadol Jr., MD - Emeritus
Boston, MA

Hideko Heidi Nakajima, PhD – Associate
Boston, MA 02114

Julian M Nedzelski, MD - Emeritus
Toronto, Ontario, Canada

Brian A Neff, MD - Active
Rochester, MN

Erik G. Nelson, MD - Active
Lake Forest, IL

Ralph A Nelson, MD - Emeritus
Manchester, WA

Yasuya Nomura - Honorary
Tokyo, Japan

John S Oghalai, MD - Active
Stanford, CA

Carlos A Oliveira, MD, PhD - Associate
Brasília

Robert C O'Reilly, MD - Active
Philadelphia, PA

Michael M Paparella, MD - Senior
Minneapolis, MN

Dennis Pappas, MD - Emeritus
Birmingham, AL

Dennis G. Pappas Jr., MD - Active
Birmingham, AL

Blake C Papsin, MD - Active
Toronto, Ontario, Canada

Simon C Parisier, MD - Senior
New York, NY

James L Parkin, MD - Emeritus
Salt Lake City, UT

Steven M Parnes, MD - Active
Albany, NY

Lorne S Parnes, MD - Active
London, Ontario, Canada

Myles L Pensak, MD - Active
Cincinnati, OH

Rodney Perkins, MD - Senior Associate
Woodside, CA

Brian P Perry, MD - Active
San Antonio, TX

Harold C Pillsbury, MD - Active
Chapel Hill, NC

Dennis S Poe, MD - Active
Boston, MA

Leonard R Proctor, MD - Emeritus
Bel Aire, MD

G. Mark Pyle, MD - Active
Madison, WI

J. H. Thomas Rambo, MD - Emeritus
New York, NY

Steven D Rauch, MD - Active
Watertown, MA

Miriam I Redleaf, MD - Active
Chicago, IL

Jose Antonio Rivas, MD - Corresponding
Bogota., Colombia

Peter S Roland, MD - Senior
Eden, UT

J. Thomas Roland Jr., MD - Active
New York, NY

Max L Ronis, MD - Emeritus
Philadelphia, PA

Seth Rosenberg, MD - Active
Sarasota, FL

John J Rosowski, PhD – Associate
Boston, MA

Norman Wendell Todd Jr., MD - Active
Atlanta, GA

Daniel Tollin, PhD – Associate
Aurora, CO

Debara L Tucci, MD - Active
Durham, NC

Galdino Valvassori, MD - Senior Associate
Wilmette, IL

Jeffrey T Vrabec, MD - Active
Houston, TX

P. Ashley Wackym, MD - Active
New Brunswick, NJ

George B Wanna, MD - Active
New York, NY

Jack J Wazen, MD - Senior
Sarasota, FL

Peter C Weber, MD, MBA - Active
Boston, MA

Roger E Wehrs, MD - Emeritus
Tulsa, OK

D. Bradley Welling, MD, PhD - Active
Boston, MA

Stephen J Wetmore, MD - Senior
Morgantown, WV

Richard J Wiet, MD - Emeritus
Sawyer, MI

Eric P Wilkinson, MD - Active
Los Angeles, CA

David F Wilson, MD - Emeritus
Portland, OR

Robert J Wolfson, MD - Emeritus
Philadelphia, PA

Sabina Regina Wullstein, MD - Senior Associate
Wurzburg, Germany

Thomas PU Wustrow, MD - Corresponding
Munchen, Germany

Naoaki Yanagihara, MD - Honorary
Matsyama, Japan

Eiji Yanagisawa, MD - Emeritus
New Haven, CT

Nancy M Young, MD - Active
Chicago, IL

Joseph J Zwislocki, ScD - Senior Associate
Syracuse, NY

IN MEMORIUM
(in alphabetical order)

The AOS Administrative office was notified of the following members death since the last Spring meeting.

Please take a moment of silence to remember these outstanding colleagues & friends.

Bobby R. Alford, MD

Barbara Bohne, PhD

John M. Fredrickson MD

Michael E. Glasscock III, MD

Robert S. Kimura, PhD

Anthony J. Maniglia, MD

Gregory J. Matz, MD

J. Gail Neely, MD