

SELECTED ABSTRACTS

***POSTER
PRESENTATIONS***



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AMERICAN NEUROTOLOGY SOCIETY

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Cochlear Implantation in Patients with Neurofibromatosis Type-2

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Objective: To describe cochlear implant outcomes in patients with neurofibromatosis type 2 (NF2).

Study Design: Retrospective case series.

Setting: A multidisciplinary NF2 clinic at a university hospital.

Patients/Interventions: Patients with NF2 who underwent cochlear implantation.

Main Outcome Measures: Pre-implantation and post-implantation audiometric data, including pure-tone average (PTA) and AzBio Sentence scores.

Results: Seven patients with NF2 underwent cochlear implantation. The median age at implantation was 22 years (range: 17-63 years) and six were female. The median length of deafness prior to implantation was 1.5 years (range: 0.3-10 years). Two patients underwent prior microsurgical resection via middle fossa craniotomy and one patient was treated with stereotactic radiotherapy prior to cochlear implantation. Two tumors were growing at the time of cochlear implantation, four tumors were not growing for a median period of 4 years (range 0.5-6 years), and one tumor had undergone prior gross total resection. Median preoperative PTA was 115 dB (range: 45-115 dB) and all preoperative AzBio scores were 0%. These improved to a median postoperative PTA of 30 dB (range: 12.5-33.75 dB) and median postoperative AzBio score of 20% (range: 0-82%). Data logging data demonstrated that four patients were daily cochlear implant users, one was an intermittent user, and two were non-users, one of whom had normal hearing in the contralateral ear.

Conclusions: Cochlear implantation is an effective option for rehabilitating hearing loss in patients with NF2 in some patients; however, patients with normal contralateral hearing or poor follow-up do not perform as well.

Define Professional Practice Gap & Educational Need: Incomplete understanding of the efficacy of cochlear implantation in patients with neurofibromatosis type-2.

Learning Objective: To provide audiometric outcomes of neurofibromatosis type-2 patients rehabilitated with cochlear implants from a large university based program.

Desired Result: Understand the challenges, pitfalls, and potential "ideal" candidates for cochlear implantation in patients with neurofibromatosis type-2.

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

Indicate IRB or IACUC Approval: Approved

A Retrospective Matched Comparison of Endolymphatic Shunt Surgery and Intratympanic Gentamicin for Meniere's Disease

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Objective: To report audiovestibular outcomes of endolymphatic shunt surgery (ELS) and intratympanic gentamicin injections (ITG) in patients with Meniere's disease (MD).

Study Design: Retrospective matched cohort study

Setting: Tertiary referral center

Patients: Patients with MD refractory to medical management between 2004 and 2017 were reviewed: 47 patients underwent ELS and 44 had outcomes available, while 33 patients underwent ITG and 27 had outcomes available. Mean follow-up durations for the ELS and ITG groups were 39.1 and 43.3 months, respectively. Twenty-six patients from the ELS group and 24 patients from the ITG group were then included in a pre-treatment hearing- and age-matched analysis.

Intervention: ELS or ITG

Main Outcome Measures: Successful control of vertigo, pure-tone average (PTA; 0.5, 1, 2 and 4 kHz), word recognition score (WRS), and treatment complications.

Results: A matched analysis showed vertigo control rates of 88.5% in the ELS group and 66.8% in the ITG group, which were not significantly different ($p = 0.091$). The change in PTA following treatment was statistically similar between the ELS group (6.2 dB) and ITG group (4.6 dB) ($p = 0.521$), while the change in WRS for the ELS group (+3.9 %) was significantly more favorable than the ITG group (-13.6 %) ($p = 0.046$). Chronic post-treatment unsteadiness was reported in 25.0% of the ITG group and was not encountered in the ELS group ($p = 0.009$).

Conclusion: ELS provided successful vertigo control at least as well as ITG with a lower incidence of audiovestibular complications.

Define Professional Practice Gap & Educational Need: 1. Controversies regarding the efficacy of endolymphatic shunt surgery (ELS) for the treatment of Meniere's disease continue to exist and demonstrate a need for additional data. 2. Despite its efficacy and less-invasive nature, intratympanic gentamicin (ITG) injections for the treatment of Meniere's disease can be hazardous to hearing and can have significant long-term vestibular sequelae. Additional information is needed to examine outcomes of this procedure compared to other treatments options. 3. Whether a patient receives ELS or ITG often depends on their clinician. Studies comparing the outcomes of these procedures are needed to enable clinicians to be better informed about the efficacy and audiovestibular complications of these treatment options.

Learning Objective: 1. Understand the evidence supporting ELS as an effective treatment for medically refractory Meniere's disease with a low incidence of audiovestibular complications. 2. Appreciate that while ITG is also provides successful vertigo control in patients with Meniere's disease, it can have a higher incidence of audiovestibular complications. 3. Gain additional information to aid in the decision to recommend either ELS or ITG to patients with medically refractory Meniere's disease.

Desired Result: Attendees will use the knowledge they gain from this presentation to make a more informed decision regarding the use of ELS versus ITG to treat patients with Meniere's disease. They will also be able to include information related to the audiovestibular complications in the informed consent for these procedures.

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

Indicate IRB or IACUC Approval: Approved

National 30-Day Readmission and Prolonged Length of Stay after Vestibular Schwannoma Surgery: Analysis of the Nationwide Readmissions Database

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Objectives: To determine the risk factors for unanticipated readmission and prolonged index admission after vestibular schwannoma surgery.

Study design: Retrospective cohort study.

Setting: Large, national database.

Patients: Those undergoing surgery for vestibular schwannoma were identified in the Nationwide Readmissions Database (2013-2014).

Main outcome measures: readmission rate, length of stay

Results: There were 4,586 cases identified. The overall unanticipated readmission rate was 7.5%, and 7.9% had a prolonged length of stay (LOS) of >8 days. Mean and median LOS were 4.48 and 4.00 days, respectively, and >90% of patients were discharged after 7 days. Disposition to a facility occurred in 6.4% of cases. Modified Charlson score of 1 (odds ratio [OR] 1.60, $p=.001$), large hospital size (OR 0.37, $p<.001$), and prolonged LOS (OR 2.42, $p<.001$) were independently associated with unintended readmission. Variables independently associated with prolonged index admission include high-volume facility (OR 0.33, $p<.001$), disposition to a facility (OR 10.06, $p<.001$), and insurance consisting of Medicaid (OR 3.96, $p<.001$) or none (OR 6.90, $p<.001$). The most common readmission diagnoses included “other nervous system complications” (2.8%), “other postoperative infection” (1.3%), meningitis (1.2%), and cerebrospinal fluid leak (1.2%).

Conclusions: Unanticipated readmission and prolonged LOS following vestibular schwannoma surgery are common, with varied sociodemographic, hospital, and patient factors independently associated with each. Further studies are needed to investigate targeted interventions aimed at minimizing readmission and prolonged LOS using the factors outlined above.

Define Professional Practice Gap & Educational Need: 1. Lack of awareness in independent risk factors for readmission following hospitalization for vestibular schwannoma resection. 2. Lack of awareness of independent risk factors for prolonged hospitalization after vestibular schwannoma resection.

Learning Objective: To identify independent risk factors for unintended readmission and prolonged length of stay in patients undergoing vestibular schwannoma resection.

Desired Result: We hope that neurotologic surgeons who perform vestibular schwannoma resection will use the risk factors for readmission and prolonged length of stay to predict outcomes for their own patients and target interventionable variables.

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

Indicate IRB or IACUC Approval: Exempt

**Completion of an Individualized Learning Plan (ILP) for
Otology-Related Milestone Sub-competencies Leads to Improved
Otology Section OTE Scores**

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Objective: To examine the relationships among self-assessment of knowledge in otology via an individualized learning plan (ILP), otology milestone achievement rate, and OTE otology scores.

Study Design: Prospective study.

Setting: One otolaryngology residency covering a tertiary care facility, trauma and hospital center, outpatient ambulatory surgery center, and outpatient clinics.

Participants: Twenty otolaryngology residents, four from each class.

Methods: Residents identified four milestones from otology-related sub-competencies to achieve in a 3-month rotation via an ILP. During the same rotation, the residents sat for the OTE, and their overall and otology scores were analyzed.

Main Outcome Measures: Completion of an ILP prior to and at the end of the rotation, self-reported achievement of otology milestones, and OTE score components including total percent correct, scaled score, group stanine, national stanine and residency group weighted scores.

Results: Group stanine OTE otology scores were higher for those residents who completed pre- and post-rotation ILPs compared with those who did not, $4.0(\pm 0.348)$ vs. $2.75(\pm 0.453)$, respectively ($p=0.04$). Residents who self-reported achieving all four otology milestones had significantly higher otology group stanine scores than the residents who achieved less, $4.1(\pm 0.348)$ vs. 2.9 ± 0.433 , respectively ($p=0.045$). Residents who performed well in their PGY program cohort on the otology OTE one year were less inclined to complete an ILP for otology in the subsequent year (Pearson correlation -0.528 , $p=0.035$).

Conclusion: In the otology subspecialty, residents who completed ILPs scored better on OTE exams independent of resident class. Consequently, programs may find ILPs useful in other otolaryngology subspecialties and across residencies.

Define Professional Practice Gap & Educational Need: 1. Lack of active learning implementation in resident education. 2. Lack of contemporary knowledge of short-term and long-term benefits of active learning in resident education. 3. Lack of awareness of how to implement active learning into residency education. 4. Lack of awareness of alternative learning strategies to resident education outside of traditional didactics and passive learning.

Learning Objective: 1. Educate the learner about implementing active learning into resident education and why it is important. 2. Provide the learner with evidence that active learning strategies have short-term benefits (increased exam scores and ACGME-milestone achievement rates) and long-term benefits (increased chance of passing board exams, promotion of lifelong active-learning strategies in all fields) for resident physicians. 3. Offer the learner an example of active learning in resident education: the individualized learning plan (ILP), and discussing its use and benefits. 4. Describe the components of an individualized learning plan (ILP), and describing how it was implemented in a particular otolaryngology residency program.

Desired Result: Attendees and learners can take the knowledge from this abstract and study, and learn about the individualized learning plan (ILP) as an effective form of active learning for resident education, realize and discuss the benefits of the ILP in terms of improved career readiness for residents, and explore ILPs, ILP components, or inspiration for other forms of active learning to incorporate into their own practice or residency program. Ultimately, this information can be used to improve education for otolaryngology residencies across the U.S.A.

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

Indicate IRB or IACUC Approval: Exempt

Involvement of the Cochlear Aqueduct by Jugular Paraganglioma Is Associated with Sensorineural Hearing Loss

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Objective: The etiology of sensorineural hearing loss (SNHL) in patients with jugular paraganglioma (JP) whose tumors lack inner ear fistulae or vestibulocochlear nerve involvement is unknown. Recent literature has proposed that occlusion of the inferior cochlear vein may be causative. Herein, we assess the association between radiologic involvement of the cochlear aqueduct (CA) and the development of SNHL.

Study design: Blinded, retrospective review of imaging and audiometry.

Setting: Tertiary center

Patients: Adults with JP

Intervention(s): None

Main outcome measure(s): Asymmetric SNHL was assessed continuously as the difference in bone conduction pure-tone average (BCPTA) between ears and as a categorical variable (≥ 15 dB difference at two consecutive frequencies, or a difference in speech discrimination score of $\geq 15\%$). Involvement of the CA was considered present if there was evidence of medial T2 fluid signal loss, contrast enhancement, or bony erosion/expansion.

Results: Of 29 patients meeting inclusion criteria, 15 (52%) had asymmetric SNHL. Cochlear aqueduct involvement was observed in 87% of patients with asymmetric SNHL compared to 17% in those with symmetric hearing ($p < 0.001$). The median difference in BCPTA between ears in patients with CA involvement was 21.3 dB HL compared to 1.9 dB HL in those without CA involvement ($p < 0.0001$). Adjusting for age and tumor volume, CA involvement was a significant predictor of SNHL ($p = 0.006$). Age, sex, and tumor volume were not associated with SNHL.

Conclusions: Cochlear aqueduct involvement by JP is associated with SNHL. Correlation with operative findings or histopathologic evidence of tumor involvement may validate this intriguing imaging finding.

Define Professional Practice Gap & Educational Need: 1. Lack of contemporary knowledge of the mechanism of sensorineural hearing loss in patients with jugular paraganglioma 2. Insufficient data regarding baseline hearing function in patients with jugular paraganglioma

Learning Objective: To report the association between cochlear aqueduct involvement by jugular paraganglioma and sensorineural hearing loss

Desired Result: Utilize this intriguing imaging finding to better understand the etiology of hearing loss in jugular paraganglioma and counsel patients regarding the risk of hearing loss from tumor progression.

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

Indicate IRB or IACUC Approval: Approved

Utilizing Migraine Prophylaxis to Improve the Vertigo Symptoms of Patients with Vestibular Migraine

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Objectives: To evaluate the efficacy of using migraine prophylaxis, including modifications of lifestyle, diet, and pharmacotherapy, in managing the vertigo symptoms of patients with vestibular migraine (VM).

Study Design: Prospective review.

Setting: Ambulatory setting at a tertiary care medical center.

Patients: Patients who were diagnosed with VM based on clinical history and the International Classification of Headache Disorders (ICHD) criteria for VM were included in this study.

Interventions: Patients were managed with migraine prophylaxis including lifestyle changes and medications that include nortriptyline, verapamil, topiramate, or a combination thereof using a standard protocol. All patients were asked to take magnesium and riboflavin supplements.

Main outcome measure: Questionnaires evaluating duration and frequency of dizziness symptoms, as well as migraine and vertigo related symptoms were distributed to patients before treatment and approximately one year after. A composite score was calculated based on the duration and frequency of dizziness symptoms to measure changes in dizziness severity before and after treatment.

Results: Forty-one patients were diagnosed with VM with a preponderance of females (59%) and a mean age of 55 ± 15 years. After treatment with migraine prophylaxis, thirty-six (89%) improved their dizziness symptoms. The mean dizziness severity improved from 55.7 min/day before treatment to 11.8 min/day after treatment ($P = .027$; 95% CI, 5.4 to 82.2).

Conclusion: Managing vestibular symptoms of VM with migraine prophylaxis is an effective method. Future placebo-controlled clinical trials are needed to confirm the efficacy of these medications.

Define Professional Practice Gap & Educational Need: Lack of knowledge of treatments for vestibular migraine and the potential of migraine prophylaxis for managing the vertigo symptoms of vestibular migraine.

Learning Objective: To evaluate the efficacy of using migraine prophylaxis, including modifications of lifestyle, diet, and pharmacotherapy, in managing the vertigo symptoms of patients with vestibular migraine.

Desired Result: After this presentation, attendees will hopefully consider the use of migraine prophylaxis as part of their treatment plans for their patients with vestibular migraine.

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

Indicate IRB or IACUC Approval: Approved

Sigmoid Sinus Occlusion after Translabyrinthine Resection of Acoustic Neuroma

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Objective: Assess the frequency of sigmoid sinus occlusion (SSO) after translabyrinthine resection of acoustic neuroma (AN).

Study Design: Retrospective chart review.

Setting: Tertiary referral center.

Patients: Consecutive adult (18 years or older) patients underwent translabyrinthine resection of AN and post-operative imaging between November 2017 and August 2018. Patients with neurofibromatosis 2 or previous surgical resection were excluded.

Interventions: All patients underwent postoperative magnetic resonance imaging (MRI) of the posterior fossa to document extent of resection or for routine follow-up. MRI studies were reviewed by a single neuroradiologist blinded to patients' clinical and operative details.

Main outcome measures: Presence/absence of MRI evidence of SSO.

Results: Twenty-six MRI studies of 20 patients were analyzed. Mean age was 49(+/-14.7) years. Mean tumor diameter was 29.9(+/-10.6) millimeters. SSO was identified in five patients (25%). Occlusion occurred in two codominant and three non-dominant sinuses. In one patient, SSO was noted following evacuation of a postoperative epidural hematoma. Four patients demonstrated no associated neurologic symptoms. Severe narrowing in one dominant sinus resulted in stroke-like symptoms. There was no difference in age or tumor size between patients with and without SSO. Sigmoid sinus patency was preserved in all tumors <15 millimeters.

Conclusion: SSO is common after translabyrinthine resection of AN but may be asymptomatic, particularly when the affected sinus is non-dominant or co-dominant. Conversely, even partial occlusion of a dominant sigmoid sinus may manifest with neurologic changes. Sigmoid sinus patency was universally preserved when tumor size was <15 millimeters.

Define Professional Practice Gap & Educational Need: Lack of awareness regarding the frequency and clinical significance of sigmoid sinus occlusion after translabyrinthine resection of acoustic neuroma.

Learning Objective: Describe the frequency and clinical significance of sigmoid sinus occlusion after translabyrinthine resection of acoustic neuroma.

Desired Result: The presentation will present attendees with information that will influence the degree of caution exercised when operating in proximity to the sigmoid sinus during translabyrinthine surgery.

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

Indicate IRB or IACUC Approval: Approved

Validated Questionnaire to Measure the Severity of Persistent Postural-Perceptual Dizziness (PPPD)

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Objective: To establish the questionnaire to measure the severity of persistent postural-perceptual dizziness (PPPD).

Study Design: Retrospective chart review.

Patients: Fifty PPPD patients and 50 consecutive patients with other vestibular disorders as controls.

Main Outcome Measures: Patients were asked to answer the questionnaire on three exacerbating factors of PPPD (upright/walking, motion, visual stimulation). Somatic distress was evaluated by the visual analog scale (VAS). Reliability of the questionnaire was tested by the Cronbach's coefficient alpha. The questionnaire was validated by examining the differences in total scores, score for each factor, and VAS between PPPD and controls. Area under the curve (AUC) of receiver operating characteristics (ROC) curve for each factor was calculated. Existence of subtypes according to the exacerbating factor was tested by factor analysis.

Results: Cronbach's coefficient alpha for all factors was higher than 0.8 except for motion subscale (=0.75). Total scores as well as score for each factor were higher in PPPD patients than controls, while there was no significant difference in VAS. AUC was widest for visual stimulation factor (0.83), while it was narrowest for upright/walking factor (0.68). Factor analysis revealed that motion factor was divided into active and passive motion-inducement and that the PPPD had two subtypes based on the exacerbating factor: upright/walking plus active motion subtype and visual stimulation plus passive motion subtype.

Conclusion: We report here the questionnaire as a measure of PPPD that shows high reliability and validity. Visual stimulation factor may be most characteristic for PPPD. PPPD could be divided into two subtypes.

Define Professional Practice Gap & Educational Need: 1. Lack of a method of measuring the severity of persistent postural-perceptual dizziness (PPPD), which is classified as a new chronic vestibular disorder. 2. Lack of contemporary knowledge on the characteristic to distinguish PPPD from other vestibular disorders. 3. Lack of data on the existence of subtypes of PPPD.

Learning Objective: 1. Describe how to measure the severity of PPPD and distinguish it from other vestibular disorders. 2. Recognize the exacerbating factors of PPPD and its subtypes.

Desired Result: 1. Improve the differential diagnosis for chronic vestibular disorders. 2. Discuss the pathology of the PPPD.

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

Indicate IRB or IACUC Approval: Approved

Hearing Preservation Outcomes Using a Precurved Electrode Array Inserted Using an External Sheath

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Objectives: Describe audiologic outcomes in hearing preservation cochlear implantation (CI) using a precurved electrode array inserted using an external sheath and evaluate association of electrode positioning and preservation of residual hearing.

Study Design: Retrospective review.

Setting: Tertiary referral center.

Patients: Twenty-two adult patients who underwent hearing preservation CI with precurved electrode array.

Interventions: CI, intraoperative computed tomography (CT)

Outcome measures: Audiologic measures (AzBio sentences, residual hearing thresholds) and electrode imaging (scalar location, mean modiolar distance, angular insertion depth).

Results: Twenty-two adults with <80dB threshold at 250Hz were implanted with a precurved electrode array; 11 underwent intraoperative CT. Preoperative hearing thresholds at 125Hz, 250Hz, and 500Hz were 52.1dB, 56.5dB, and 66.8dB, respectively; mean AzBio scores were 10%. Imaging revealed one translocation and no instances of tip fold-over. At activation, there was no statistically significant threshold shift at 125Hz (61.6dB, $p=0.13$), 250Hz (68.4dB, $p=0.6$), or 500Hz (79.8dB, $p=0.8$), while at 6 months, hearing thresholds were 67.8dB ($p=0.01$), 79.1dB ($p<0.01$), and 91.3dB ($p<0.01$), respectively. At 6 months, mean AzBio scores were 63%. Electrode proximity to the modiulus was significantly correlated with improved AzBio scores at 6 months ($r=0.4$, $p=0.04$). Angular insertion depth was not correlated with postoperative threshold shift ($r=0.005$, $p=0.8$) or AzBio scores ($r=0.2$, $p=0.4$) at 6 months.

Conclusions: A low rate of translocation allows a precurved electrode array inserted using an external sheath to maintain hearing preservation rates comparable to straight/lateral wall electrodes. With scala tympani insertion, proximity to the modiulus is a positive marker of improved speech performance postoperatively.

Define Professional Practice Gap & Educational Need: Lack of knowledge regarding hearing preservation and speech understanding outcomes as related to electrode positioning in the slim perimodiolar non-styilet electrode.

Learning Objective: Present hearing preservation and audiologic outcomes as related to electrode positioning determined by post-insertion imaging.

Desired Result: Attendees will learn that the slim perimodiolar electrode has excellent hearing preservation rates related to minimal translocation, and will be able to apply this knowledge to decision-making around electrode selection for patients with preoperative residual low-frequency hearing.

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

Indicate IRB or IACUC Approval: Approved

Natural History of Facial Weakness following Acoustic Surgery: A Tertiary Care Cohort

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Objective: Facial nerve function is a key outcome in acoustic surgery. This study aims to describe the evolution of facial nerve function following acoustic surgery.

Study design: Retrospective case series.

Setting: Multiple tertiary otology referral centers.

Patients: Patients undergoing acoustic surgery for tumor extirpation from 2003 to 2017 with pre-operatively normal facial nerve function without subsequent additional open surgery or stereotactic radiosurgery.

Intervention(s): Removal of acoustic tumor with serial facial nerve examinations.

Main outcome measure(s): Serial facial nerve examinations measured using the House-Brackmann (HB) scale.

Results: Of 347 patients examined, 170 (49%) had documented facial weakness post-operatively, and 76% of these were noted within 24 hours post-operatively. Of patients with HB1 function immediately post-operatively, 95% had HB1 function and 100% had HB3 or better function at their ultimate visits. Conversely, of patients with HB4 or worse function immediately post-operatively, 20% ultimately achieved HB1 function and 73% ultimately achieved HB3 or better function. Eighty five percent of patients with facial weakness achieved their ultimate facial function by one year post-operatively. Final facial function poorer than HB3 was associated with subtotal resection (12% vs. 7% for near total and 2% for gross total resection, $p = 0.02$) and aspirin use (13.5% vs 3.4%, $p = 0.002$).

Conclusions: An analysis of facial nerve function over time following acoustic surgery is presented. While post-operative facial function correlates with future function, this correlation is imperfect and significant improvement or worsening is common. These data inform patient counseling following acoustic surgery.

Define Professional Practice Gap & Educational Need: 1. Absence of data on natural history of facial nerve weakness after acoustic surgery 2. Inability to provide accurate counseling to patients regarding chances and expected degree of facial function recovery after acoustic surgery resulting in facial weakness

Learning Objective: To understand the expected course of facial function following acoustic surgery with post-operative facial weakness

Desired Result: Attendees will be able to accurately counsel patients with facial nerve weakness after acoustic surgery about the chances and expected degree of recovery over time.

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

Indicate IRB or IACUC Approval: Approved

Associations of Vestibular Tests with Penn Acoustic Neuroma Quality of Life Scores after Resection of Vestibular Schwannoma

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Objective: Determine associations between preoperative caloric testing (CT) and video head impulse testing (vHIT) with baseline and postoperative Penn Acoustic Neuroma Quality of Life (PANQOL) scores following resection of vestibular schwannoma (VS).

Study design: Retrospective case series

Setting: Two tertiary referral hospitals

Patients: Adult patients with unilateral VS, preoperative CT and vHIT testing, and postoperative PANQOL scores.

Interventions: Surgical resection of VS and postoperative surveys.

Main outcome measures: PANQOL scores

Results: Forty-three patients were included (58.1% women) with a median age of 54 years (range, 28–82). Mean tumor size was 14.8 mm ($\sigma=8.6$), and 28 (65.1%) were right-sided. Average gain on preoperative vHIT was 0.7 ($\sigma = 0.3$). Covert and overt saccades were present in 8 (25%) and 14 (42.4%) patients, respectively. Average preoperative unilateral weakness was 47% ($\sigma = 33.2$). Translabyrinthine approach was performed in 26 (60.5%) patients. No significant difference of PANQOL scores was noted at baseline or over time between patients with normal (>0.8) or abnormal (<0.8) gain. Patients with more unilateral weakness ($>50\%$) had significantly higher baseline PANQOL scores compared to those with $<25\%$ or $25\%-50\%$ ($p=0.016$), but had significant improvement in scores over time ($p=0.012$). Presence of both overt and covert saccades at baseline was associated with better PANQOL scores at all timepoints ($p=0.03$). Higher preoperative dizziness handicap inventory (DHI) preoperatively was significantly associated with worse PANQOL scores at all timepoints ($\beta=0.57$, $p=0.0064$). No differences in PANQOL scores amongst surgical approaches were observed.

Conclusions: Preoperative vestibular testing with vHIT, CT, and DHI may allow for patient counseling regarding postoperative quality of life over time.

Define Professional Practice Gap & Educational Need: 1. Lack of standardization of preoperative vestibular assessment for patients with vestibular schwannoma due to the lack of objective utility of each of these studies. 2. Current assumptions regarding preoperative vestibular weakness and postoperative outcomes following vestibular schwannoma resection exist. Validation of Penn Acoustic Neuroma Quality of Life scores, though Dizziness Handicap inventory is non-specific for vestibular schwannoma and often used for assessment.

Learning Objective: Determine associations between preoperative caloric testing (CT) and video head impulse testing (vHIT) with baseline and postoperative Penn Acoustic Neuroma Quality of Life (PANQOL) scores following resection of vestibular schwannoma (VS).

Desired Result: Attendees will better understand the role of preoperative vestibular testing and how it may be used to counsel patients regarding their postoperative course and quality of life.

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

Indicate IRB or IACUC Approval: Approved

Evaluating the Effect of Inter-Implant Time for Bilateral Cochlear Implants in Adults

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Objective: Determine the relationship between time elapsed between sequential bilateral cochlear implantation (BiCI) and speech intelligibility scores in post-lingually deafened adults

Study Design: Retrospective case review

Setting: Ambulatory tertiary referral center

Patients: Post-lingually deafened adults who received bilateral cochlear implantation between January 1, 2011 and January 1, 2018.

Interventions: Bilateral cochlear implantation

Main Outcome Measures: Bilateral AzBio score in quiet, and difference between unilateral AzBio scores in quiet of first and second cochlear implants (CI Difference).

Results: 113 patients (226 cochlear implants) were initially reviewed, with 56 patients (112 implants) being included in the final analysis. Median inter-implant interval was 187.5 days (*IQ range* 54.25 – 346.5). Maximum interval was 1787 days. Mean age at first implant was 60.66 ± 13.37 . Bilateral AzBio score in quiet and inter-implant interval showed no significant correlation ($r = 0.034$, $p = 0.815$). There was no significant difference in mean bilateral AzBio scores in quiet between the simultaneous and sequential implantation groups ($p = 0.22$). Similar non-significant results were seen when examining the correlation between CI Difference and inter-implant interval ($r = -0.07$, $p = 0.66$). No significant result between mean CI Difference of simultaneous and sequential implant recipients was found ($p = 0.06$).

Conclusions: For the inter-implant intervals examined, there seems to be no significant decline in speech intelligibility scores for patients receiving sequential bilateral cochlear implants compared to simultaneously implanted patients. There was no significant correlation noted between inter-implant interval and speech intelligibility scores.

Define Professional Practice Gap & Educational Need: Lack of knowledge of whether timing between bilateral cochlear implants can effect hearing outcomes in adults 2. Lack of knowledge of trends and current practices in bilateral cochlear implantation

Learning Objective: Learn the relationship between inter-implant interval and hearing outcomes in patients receiving bilateral cochlear implants 2. Provide information about trends in demographic information, typical inter-implant intervals, and hearing outcomes in bilateral cochlear implantation

Desired Result: Better ability to council patients on how long they can wait between cochlear implantation procedures 2. Better ability to predict what kinds of hearing results patients can expect from bilateral cochlear implantation

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

Indicate IRB or IACUC Approval: Exempt

Modified Electrodiagnostic Testing for Acute Facial Nerve Paralysis

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Objective: Divergent practice patterns exist between neurologists and neurotologists in the modality of electroneurography (ENoG) used for facial nerve electrodiagnostic testing. We evaluated the accuracy and prognostic value of nasalis muscle compared to nasolabial fold ENoG in patients with acute facial nerve paralysis.

Setting: Academic tertiary care center.

Patients: Forty-nine patients who presented with traumatic or non-traumatic acute facial paralysis (House-Brackmann-HB grade 6/6) between 2008-2017.

Intervention: nasalis muscle and nasolabial fold ENoG testing.

Main outcome measures: Percent degeneration of ipsilateral facial nerve as measured by compound muscle action potential amplitudes on nasalis muscle and nasolabial fold ENoG, and HB score at one year post-paralysis.

Results: Extent of facial nerve degeneration as measured by nasalis and nasolabial fold ENoGs were highly correlated ($r=0.88$, 95% CI 0.79-0.93). When performed, serial ENoGs to assess trajectory of degeneration were also similar between modalities. For each ENoG modality, increased percent degeneration on ENoG was similarly associated with worse HB outcome at 1 year (nasalis $P\leq 0.01$, nasolabial fold $P\leq 0.01$). When stratified by non-surgical versus surgical management of facial paralysis, no significant difference (non-surgical $P=0.88$; surgical $P=0.93$) existed in prognostic values for final HB score between ENoG modalities. .

Conclusion: Nasalis testing may be a valid and comparable method to nasolabial fold ENoG for predicting the recovery of facial nerve function in acute paralysis. As nasalis testing is more broadly practiced in clinical electrophysiology, this presents an opportunity for increased penetration of electrodiagnostic testing in appropriate patients presenting with acute facial nerve paralysis.

Define Professional Practice Gap & Educational Need: Electrodiagnostic testing is seldom used by neurotologists in the setting of acute facial nerve paralysis, as nasolabial fold electroneurography (ENoG) is considered the standard, but is available at few centers. 2. Nasalis muscle ENoG testing is widely practiced, but rarely utilized by neurotologists.

Learning Objective: To describe and compare the ability of nasalis muscle and nasolabial fold ENoG testing to predict facial nerve function (HB score) at one year following acute facial paralysis.

Desired Result: Increased use of nasalis muscle ENoG and more widespread use of electrodiagnostic testing for acute facial nerve paralysis.

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

Indicate IRB or IACUC Approval: Approved

Surveillance with High-Resolution T2 MRI after Resection of Vestibular Schwannoma: Volumetric Comparison

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Matthew O'Malley, MD; Alejandro Rivas, MD
David S. Haynes, MD*

Objective: Volumetrically compare high-resolution T2 (HRT2) magnetic resonance imaging (MRI) with contrast-enhanced T1 MRI (T1WI) for surveillance after resection of vestibular schwannoma (VS).

Study Design: Retrospective chart review

Setting: Tertiary neurotologic center

Patients: Adult patients with VS who had regrowth or recurrence detected with MRI.

Outcome measures: Comparison of HRT2 versus T1WI in assessing volumetric progression of VS after microsurgical resection.

Results: Between 2010 and 2017, 14 patients (64.3 % female, mean age 44.5 - range 28-60 years) were identified who had either recurrence or growth of tumor remnant after subtotal microsurgical resection of VS requiring additional treatment. Translabyrinthine approach was used in 10 (71.4%). Mean pre-treatment tumor volume (TV) was 12.4 cm³(SD 8.7). Sub-total (STR) was performed in 8 (57.1%), near total (NTR) in 5 (35.7%) and gross total (GTR) in 1 (7.1%) case. Progression was first identified at mean follow-up of 16.2 (range 6.5-30.3 months). Mean TV of the remnant using T1WI was 2.2 cm³(SD 1.8) and mean TV using HRT2 was 2.1 cm³(SD 1.8). Volumetric analyses of HRT2 and T1WI were not significantly different (Paired t test p=0.08) with high correlation (Pearson, r=0.99, p<0.001). A Bland-Altman plot of difference and mean volume showed stability of measures (bias 0.11; SD =0.22, 95% limits of agreement [-0.32-.54]).

Conclusions: HRT2 based volumetric assessment of tumor remnant is comparable and non-inferior to T1WI. The use of HRT2 for surveillance after resection of VS is effective at diagnosing tumor progression and prevents the unnecessary use of contrast in these patients.

Define Professional Practice Gap & Educational Need: Currently, surveillance after resection of Vestibular Schwannoma is largely based on contrasted MRI scans. There is limited knowledge with regards to the accuracy of T2 based sequences in detecting progression after prior resection.

Learning Objective: Compare T2 based volumetric analysis of tumor remnant and its accuracy with T1 based analysis.

Desired Result: Potentially substitute contrast-based imaging to high-resolution T2 weight sequences to decrease cost and potential side effects of contrast.

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

Indicate IRB or IACUC Approval: Approved

Cochlear Implant Mapping Through Telemedicine – A Non-Inferiority Study

*Jacob I. Tower, MD; Jessica Preston, AuD
Adam Burkland, AuD; Cyndi E. Trueheart, AuD
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Objective: To prove that cochlear implant (CI) mapping in remote locations via telemedicine is non-inferior to mapping performed via conventional in-person visits.

Study Design: Cohort-matched retrospective analysis of patients engaged in a CI telemedicine program.

Setting: A regional healthcare network with a centralized CI center and satellite audiology clinics (maximum 283 miles away).

Patients: CI recipients who live out-of-state from the CI center and engaged in telemedicine audiology.

Intervention: All patients underwent implantation and activation at the main institution. Subsequent mapping was done either via in-person audiology visits at the main institution, or via telemedicine sessions at satellite audiology clinics.

Main outcome measure(s): AzBio sentence test scores were compared between CI patients mapped via in-person encounters and remote telemedicine encounters. Patient satisfaction scores from a post-programming survey were also analyzed.

Results: CI recipients with AzBio scores prior to and during telemedicine mapping were included in the analysis; all device manufacturers were represented. Mean age at implantation and first telemedicine encounter was 66.0 and 68.9 years, respectively. Mean post-implantation follow-up was 1042 days in-person, and 186 days via telemedicine. There was no significant difference between conventional in-person mapping and telemedicine mapping in average AzBio test scores (48.5% versus 82.5% correct in CI-only condition, respectively; $P=0.07$).

Conclusions: This cohort-matched, non-inferiority study shows that CI mapping via telemedicine at remote locations is non-inferior to conventional in-person mapping. Survey responses indicate a positive patient experience with advantages of convenience and cost-efficiency. Telemedicine is a promising tool to reach patients that live in remote areas.

Define Professional Practice Gap & Educational Need: 1. Lack of awareness of telemedicine in neurotology, specifically as it applies to a cochlear implant practice. 2. Lack of knowledge of whether telemedicine cochlear implant mapping is as good as conventional in-person mapping. 3. Lack of knowledge whether cochlear implant patients have a positive or negative experience with telemedicine.

Learning Objective: The learning objective of this presentation is to understand that telemedicine cochlear implant mapping is efficacious and non-inferior in comparison to traditional, in-person mapping.

Desired Result: Attendees will learn that telemedicine is an effective tool for reaching cochlear implant patients in remote areas, and may consider adding this tool to their clinical practice.

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

Indicate IRB or IACUC Approval: Exempt

Impact of Obstructive Sleep Apnea and Obesity on Outcomes of Lateral Skull Base Cerebrospinal Fluid Leak Repair

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Marc L. Bennett, MD, MMHC*

Objective: To investigate the prevalence and impact of obstructive sleep apnea (OSA) and obesity in lateral skull base cerebrospinal fluid leak repair (LSBR).

Study Design: Retrospective case series.

Setting: Tertiary skull base center.

Patients: Consecutive adults undergoing repair between 2012-2018 with at least 6-month follow-up.

Interventions: LSBR via transmastoid, middle cranial fossa, or combined approach.

Outcome measures: radiology, presence of intracranial hypertension (ICH), surgical outcomes.

Results: 91 patients (65.2% female, mean age 53.2 ± 13.1 years) underwent repair for spontaneous (sCSFL, 45.1%) and other etiology (oCSFL) leaks. oCSFL served as a comparison group consisting of leaks status-post lateral skull base surgery, temporal bone fractures, and chronic ear disease. Elevated BMI ($p=.005$), ipsilateral (92.7%, OR=12.67) and contralateral tegmen thinning (22%, OR=4.5), empty sella (22%, OR=13.78), and superior canal dehiscence (15.8%, OR=8.57) were more common in sCSFL. Patients with tegmen thinning had higher BMIs ($p<.0001$) and increased rates of comorbid OSA (OR=6.7, $p=.002$). Those with multiple defects had higher BMIs ($p=.0003$). Three (2.2%) required surgical revision for recurrence, and six (6.6%) resolved with shunting.

Conclusions: Obesity was associated with tegmen thinning and multiple defects and may predispose to sCSFL. Contralateral disease was infrequent, suggesting the role for additional, potentially local factors. While ICH is believed to contribute to sCSF development, shunting and revision rates were low in this series. Combined approach with multilayer repair is safe and effective with respect to outcomes and need for revision, regardless of leak etiology or presence of OSA and obesity.

Define Professional Practice Gap & Educational Need: Inconsistencies within published data of failure rates following repair of spontaneous cerebrospinal fluid leaks.

Learning Objective: To review the patient variables thought to contribute to spontaneous cerebrospinal fluid leaks and their outcomes following a autologous multilayer repair, primarily via combined transmastoid-middle cranial fossa approach.

Desired Result: Our data is consistent with the current literature in identifying obesity as a possible predisposing condition for spontaneous cerebrospinal fluid leaks. However, these patients can be repaired safely via a combined approach with multilayer repair without rare need for revision surgery. Additionally, while a few patients did require shunts, the majority of patients did not require intervention to address intracranial hypertension. This data may be useful in patient counseling, expectations regarding surgical outcomes and deciding the surgical approach and repair.

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

Indicate IRB or IACUC Approval: Approved

The Cost of Skull Base Surgery for the Resection of Vestibular Schwannomas

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Objective: To determine the surgical costs associated with the translabyrinthine (TL), retrosigmoid (RS) and middle cranial fossa (MCF) approaches for the microsurgical excision of vestibular schwannoma (VS).

Study Design: Retrospective cost analysis study.

Setting: Tertiary referral center.

Patients: Twenty-one consecutive adult patients underwent microsurgical excision of VS by either TL (n=7), RS (n=7) or MCF (n=7) approach. Tumors were restricted to size between 1-2.5 cm. Patients with a history of neurofibromatosis 2, preoperative radiosurgery, or previous surgical resection were excluded.

Interventions: Patients underwent microsurgical excision of VS by one of the three major approaches. Surgical receipts were collected for each patient. Analysis of variance was performed to compare surgical costs between approaches.

Main outcome measures: Surgical supply costs (US\$), total room time (minutes) and skin-to-skin operating time (minutes).

Results: The mean surgical supply cost was lowest for MCF and highest for RS (\$3013.85 and \$7966.39, respectively, p=0.003). Mean supply cost was \$4295.51 for the TL approach. The items associated with the highest average cost per case were the surgical aspirator (\$1020), drill burs (\$930.80) and titanium implants (\$620). There was redundancy in multiple surgical items such as drill burs and hemostatic agents. On average, total room time for all approaches was 85.8 min longer than skin-to-skin time.

Conclusion: This study is the first to examine the surgical expenses associated with VS resection. Reduction in supply redundancy provides the opportunity for decreasing surgical costs and waste. Future analyses will include total surgical day costs, intensive care unit and total admission costs.

Define Professional Practice Gap & Educational Need: Lack of awareness of surgical costs associated with lateral skull base approaches

Learning Objective: To compare and break down the surgical costs associated with the translabyrinthine, retrosigmoid and middle cranial fossa approaches for the microsurgical excision of vestibular schwannoma. Ultimately the long term goal is to reduce surgical costs and surgical waste.

Desired Result: Increase their awareness about the costs of surgical supplies, and potentially have more conservative requests in their upcoming cases.

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

Indicate IRB or IACUC Approval: Approved

The Opioid Crisis: Are We Part of the Problem?

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Objective: The United States is experiencing an opioid overdose crisis. Many of these drugs are prescribed by physicians. According to the NIH, prescription opioids were responsible for 33% of over-dose related deaths in 2015. This study seeks to quantify post-operative pain after otologic outpatient surgery and track prescription usage.

Study Design: Prospective investigation of pain control in otologic surgical patients using a pain survey and phone interviews.

Setting: Tertiary-referral otology practice

Patients: Sixty-five patients who underwent outpatient otologic surgery

Interventions: Hydrocodone-acetaminophen (20 pills prescribed) and over-the-counter (OTC) pain medications

Main outcome measures: Pain as measured on the 1-10 pain scale and use of prescription and OTC pain medications.

Results: There was a wide range of prescription use habits with 30% of post-operative patients using no prescription pain medications and 22% using most or all of their medications. The majority of patient reported steady improvement in pain levels after surgery however almost 20% report their pain was the most severe on post-operative days one to two. There was no difference in pain levels between male and female patients ($p=0.83$). One patient required a refill. Sixty-five percent used OTC analgesics. There was no statistical difference between reported pain levels in patient that used OTC medications and those that did not ($p=0.27$). Over 60% of prescribed pills were unused. The majority of patient (70%) reported saving additional medications for possible future needs.

Conclusions: Post-operative pain is subjective and varies widely between patients. Further recommendations to improve prescribing practices will be discussed.

Define Professional Practice Gap & Educational Need: In 2017 the opioid crisis was declared a "Nationwide Public Health Crisis" which is in part fueled by physician prescriptions. This stems from a significant lack of awareness and inconsistencies in prescribing habits. Pain is subjective and varies between people making it difficult to predict the required amount of necessary medications after surgery. This presentation will review patient reported pain levels and use of prescriptions medications and how this varies between different types of otologic surgeries. 1. Lack of awareness of postoperative pain levels and ideal amount of medications 2. Inconsistencies in prescribing habits

Learning Objective: Quantify patient pain levels after surgery Illustrate pain medication use in post-surgical patients and track excess pills Stratify modifying factors that predict pain levels

Desired Result: Improved prescribing habits after otology surgery Increased awareness of surgeons' contribution to the opioid crisis

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

Indicate IRB or IACUC Approval: Approved

Middle Fossa BONEBRIDGE Implantation with Self-Drilling Screws - Audiometric Outcomes in Conductive and Mixed Hearing Loss

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Objectives: To present audiometric outcomes of patients implanted with the BONEBRIDGE bone-conduction device using the novel middle fossa surgical approach with self-drilling screws.

Study design: Retrospective case series

Setting: Tertiary referral center

Patients: Adult patients who received BONEBRIDGE implantation using the middle fossa approach from Jan 2014 to May 2018 with audiological testing at activation and three months post-operatively.

Intervention: Middle fossa BONEBRIDGE implantation with self-drilling screws.

Main outcome measures: Unaided pure-tone air conduction and bone conduction thresholds were measured using standard audiometric techniques pre-operatively. Post-operatively, bone conduction thresholds were measured in sound field with the patient's BONEBRIDGE device in place. Masking of the non-implanted ear was completed as required using standard masking protocols. Average air-bone gap and functional gain values were calculated.

Results: Thirty-seven patients with either conductive or mixed hearing loss met inclusion criteria (15 males, 22 females; average age 47 years). Post-operative air-bone gap closure was seen in all cases (mean 4.69 dB), and overclosure in some cases. The average functional gain was 17.3 dB for all patients. At the time of data collection, there had been no complications. Data was collected at a mean follow-up time of 26 months (range 3-53months).

Conclusion: Audiometric outcomes of patients implanted with the BONEBRIDGE via the middle fossa approach with self-drilling screws were comparable to those previously reported in the literature using the mastoid or retrosigmoid approaches with the standard self-tapping screws. The middle fossa BONEBRIDGE implantation is therefore a viable option for patients with conductive or mixed hearing loss.

Define Professional Practice Gap & Educational Need: There is a lack of contemporary knowledge regarding the middle fossa surgical approach to BONEBRIDGE bone-conduction device implantation and associated surgical and audiological outcomes for the treatment of mixed and conductive hearing loss.

Learning Objective: At the end of this presentation, physicians and trainees should be able to describe the middle fossa surgical technique using self-drilling screws for BONEBRIDGE bone-conduction device implantation and discuss the associated outcomes as they compare to other surgical techniques.

Desired Result: This presentation will improve competence of physicians and trainees by providing education on an efficacious surgical technique for implanting the BONEBRIDGE bone-conduction device, which may in turn improve practice performance and patient outcomes.

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

Indicate IRB or IACUC Approval: Exempt

Assessment of the Role of Gender on Early Postoperative Cochlear Implant Outcomes

*Mallory J. Raymond, MD; Samir Ballestas Naissir, MD
Esther X. Vivas, MD*

Objective: To determine the presence of gender differences in cochlear implant outcomes

Study design: Retrospective chart review

Setting: Tertiary referral center

Patients: Adults who underwent standard cochlear implantation from 2009 until 2017 with 3-month post-implantation hearing outcomes

Intervention(s): Standard electrode length cochlear implantation

Main outcome measure(s): AzBio scores at the 3-month post-activation visit

Results: Of 57 patients with complete preoperative characteristics and 3-month postoperative cochlear implant speech recognition testing, 42% were male. The average age of the cohort at implantation was 64 ± 14.5 years and there was no significant difference between genders. Female gender predicted improved early post-activation AzBio scores compared to male gender ($73.6 \pm 20.8\%$ vs $47.7 \pm 26.1\%$, $p < 0.0002$), however the duration of hearing loss differed significantly between females and males (18.4 ± 14 vs 28.9 ± 21 , $p < 0.04$). After controlling for age at time of surgery, implant manufacturer, electrode type, duration of hearing loss, etiology of hearing loss and preoperative AzBio scores, the effect of gender remained significant ($p < 0.002$).

Conclusions: Gender may play a role in early cochlear implant outcomes.

Define Professional Practice Gap & Educational Need: Lack of knowledge on the role of gender in hearing restoration outcomes

Learning Objective: The objective is to demonstrate a potential role of gender on early postoperative cochlear implantation speech recognition.

Desired Result: Attendees will be aware of the potential role of gender on cochlear implant outcomes and design larger studies to further investigate the effect size.

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

Indicate IRB or IACUC Approval: Approved

Validation of High-Frequency Ovemp Testing in the Evaluation of Possible Superior Semicircular Canal Dehiscence

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Rachel Beckley, AuD; Dennis Bojrab, MD (presenter)
Brent Wilkerson, MD; Emily Johnson, DO; Robert Hong, MD*

Objective: Cervical and ocular vestibular evoked myogenic potentials (cVEMP and oVEMP) are diagnostic tests employed in the evaluation of possible superior semicircular canal dehiscence (SSCD). Manzani et al published previously that the presence of the n10 component of oVEMP at 4 kHz was diagnostic of SSCD with sensitivity and specificity of 1.0. This study reviewed 233 consecutive patients who underwent oVEMP testing to validate the diagnostic accuracy of high frequency oVEMP testing.

Study Design: Retrospective case review.

Setting: Ambulatory neurotology private practice.

Patients: 233 consecutive patients.

Intervention: oVEMP testing as well as high-resolution CT imaging of the temporal bone.

Main outcome measures: The presence or absence of CT-verified SSCD was identified from the imaging report and verified by the lead author. The presence or absence of the oVEMP n10 component at 4 kHz was identified.

Results: A total of 87 patients had CT imaging findings consistent with SSCD. 36 (41.3%) of these patients also demonstrated the n10 component on oVEMP testing. The oVEMP n10 component was present in 67 patients, of which 36 (53.7%) also had findings consistent with SSCD on CT imaging. The corresponding sensitivity is 0.41, specificity is 0.77, positive predictive value is 0.54, and negative predictive value is 0.67.

Conclusions: A consecutive series of 233 patients undergoing oVEMP testing found that the presence of the n10 component at 4 kHz was mildly predictive of CT-verified SSCD with sensitivity of 0.41, specificity of 0.77, positive predictive value of 0.54, and negative predictive value of 0.67.

Define Professional Practice Gap & Educational Need: Lack of contemporary knowledge on the usefulness of the n10 response at 4000 Hz on oVEMP testing. It was previously published that the presence of this waveform was diagnostic of superior semicircular canal dehiscence. This finding has not been verified in the literature.

Learning Objective: To present data evaluating the diagnostic accuracy of the n10 response at 4000 Hz on oVEMP testing, which was previously published as being 100% accurate.

Desired Result: The audience will have a better understanding of the utility of oVEMP testing in the diagnosis of superior semicircular canal dehiscence.

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

Indicate IRB or IACUC Approval: Exempt

Comparison of Presentation of Spontaneous Temporal Bone Cerebrospinal Fluid Leaks from the Middle and Posterior Fossa and Management of Posterior Fossa Leaks

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Andrew A. McCall, MD*

Objectives: To compare patients surgically managed for spontaneous cerebrospinal fluid (CSF) leaks of the temporal bone arising from the middle cranial fossa (MCF) and posterior cranial fossa (PCF) and to describe the surgical management of posterior fossa CSF leaks.

Study Design: Retrospective case review

Setting: Academic tertiary center

Patients: Adult patients presenting with spontaneous temporal bone CSF leaks undergoing operative repair between January 2010 and August 2018. Patients with a history of trauma, prior mastoid surgery, and iatrogenic CSF leaks were excluded.

Intervention: Transmastoid or MCF CSF leak repair.

Main Outcome Measures: Patient demographics, body mass index (BMI), comorbidities, presenting features, and lumbar puncture opening pressures were compared between groups and the management of the PCF CSF leaks described.

Results: Forty-four patients (27 females, 17 males) were included. The mean age at the time of repair was 57.8 ± 13.0 years (\pm SD). The origin of the CSF leak was from the PCF in 3 patients and MCF in 41 patients. All three patients with PCF leaks presented with a history of meningitis compared to only six in the MCF group. This difference was statistically significant ($p < 0.01$, Fisher's Exact Test). There were no statistically significant differences in age, gender, BMI, or lumbar puncture opening pressures. The PCF leaks were repaired using a transmastoid approach with multilayer closure of the bony defect and fat graft obliteration of the mastoid.

Conclusions: Spontaneous CSF leaks arising from the PCF are rare and may more commonly present with meningitis. Identification requires careful review of imaging.

Define Professional Practice Gap & Educational Need: Spontaneous temporal bone CSF leaks arising from the PCF are an uncommon presentation. More commonly, defects in the tegmen communicating with the MCF are the cause of spontaneous CSF leaks involving the temporal bone. The etiology of posterior fossa CSF leaks is hypothesized to be secondary to bony defects created by erosion from arachnoid granulations. These patients may present with conductive hearing loss, CSF otorrhea or rhinorrhea, chronic middle ear effusions, or meningitis. Due to the rarity of this presentation, description of patient demographics, presenting features, and management is limited in the literature.

Learning Objective: At the conclusion of this activity, the learner will be able to: 1. Identify the PCF as an uncommon site for spontaneous temporal bone CSF leaks. 2. Characterize patients presenting with PCF CSF leaks in comparison to those with MCF CSF leaks. 3. Describe a technique for the surgical repair of spontaneous temporal bone CSF leaks originating from the posterior fossa.

Desired Result: To stimulate discussion on the patient characteristics and management of the rare presentation of spontaneous temporal bone CSF leaks arising from the PCF. The attendees will apply this knowledge when evaluating and managing patients with CSF leaks. Attendees may choose to use described operative techniques to repair PCF CSF leaks.

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

Indicate IRB or IACUC Approval: Approved

Intraoperative Cochlear Physiology During Translabyrinthine Approaches

*Kevin Zhan, MD; William J. Riggs, AuD
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Aaron C. Moberly, MD; Edward E. Dodson, MD
Oliver F. Adunka, MD*

Objective: To evaluate whether reduction in speech recognition performance is due to sensory or neural impairments in patients with tumors of the vestibulocochlear nerve

Study design: Prospectively enrolled single-arm study

Setting: Tertiary academic hospital

Patients: Adult patients undergoing translabyrinthine tumor resection

Main outcome measure(s): Audiometric thresholds, word recognition, and electrocochleography total response (ECochG-TR)

Results: ECochG-TR data was recorded from the round window in a prospectively enrolled cohort of 34 adult patients undergoing lateral skull base tumor resection. 54% were female. Mean age was 55.7 years (range 18-77). Mean tumor size in maximum dimension was 24.5mm (range 3-56mm). 95% of tumors were vestibular schwannoma, with 1 hemangiopericytoma and 1 follicular lymphoma. Average three-tone pure tone average (PTA) was 59.4 dB HL (SD 30.6) and mean word recognition score (WRS) was 44.2% (SD 35.1). In linear regression, PTA alone accounted for 58.6% of the variance in WRS. In a combined model, PTA and ECochG TR accounted for 70.8% of speech perception. Age and maximum tumor dimension were not predictive in a multiple regression.

Conclusions: Our preliminary data suggest that reduction in WRS seen in patients with tumors of the vestibulocochlear nerve are due primarily to loss of sensory function of the cochlea.

Define Professional Practice Gap & Educational Need: Lack of physiologic evidence to explain etiology of hearing loss in patients with lateral skull base tumors.

Learning Objective: Learner will appreciate novel technique in evaluating hearing loss in patients with lateral skull base tumors.

Desired Result: Learners may consider applying this approach to evaluating etiology of hearing loss in patients with lateral skull base tumors

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

Indicate IRB or IACUC Approval: Approved

Cochlear Enhancement Precedes Cochlear Obliteration after Excision of Vestibular Schwannoma

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Objective: Cochlear obliteration after vestibular schwannoma excision has been noted, with implications on cochlear implantation. MRI radiographic findings before obliteration have been observed and are described here.

Study design: Retrospective case review

Setting: Tertiary referral center, ambulatory

Patients: Patients receiving vestibular schwannoma excision surgery by the senior author performed at one institution between January 2015 to July 2017 with post-operative MRIs.

Intervention: Diagnostic

Main outcome measure(s): The imaging characteristics on post-operative MRIs examined were loss of fluid signal on post-operative T2 images and cochlear enhancement on gadolinium enhanced T1 images. In the patient receiving labyrinthine sparing procedures, presence of post-operative hearing was evaluated.

Results: Of the 40 patients evaluated, 22 received the translabyrinthine approach and 18 received a labyrinth sparing surgery. Twenty-eight had evidence of cochlear enhancement on T1 with gadolinium contrast, and 26 had evidence of cochlear obliteration on T2 images. The odds ratio of patients with cochlear enhancement having obliteration is 13.8:1 ($p < 0.001$). Intense cochlear enhance ($n=17$) appeared on average 166 days after surgery, and complete or near complete obliteration ($n=18$) appeared on average 476 days after surgery, a statistically significant difference ($p < 0.001$). Within the labyrinth sparing group, loss of hearing was correlated with cochlear obliteration, with an odds ratio of 10.6:1 ($p < 0.05$), but the correlation between hearing loss and cochlear enhancement was not statistically significant.

Conclusions: Cochlear enhancement is correlated with cochlear obliteration, and it appears to precede it.

Define Professional Practice Gap & Educational Need: Lack of contemporary knowledge of MRI imaging characteristics of the cochlea after vestibular schwannoma excision

Learning Objective: Identify cochlear enhancement and cochlear obliteration on post-operative MRIs 2. Recognize timing of cochlear enhancement as it relates to cochlear obliteration 3. Recognize that cochlear obliteration may complicate cochlear implantation

Desired Result: In patients who have received vestibular schwannoma excision, recognizing that cochlear enhancement precedes cochlear obliteration may help identify patients who would be candidates for early cochlear implantation.

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

Indicate IRB or IACUC Approval: Approved

**Analysis of Intraoperative Electrocochleography in Patients
with Meniere's Disease Undergoing Endolymphatic
Decompression and Shunt Surgery**

*Jameson K. Mattingly, MD; Kevin Y. Zhan, MD
Megan M. Hiss, AuD; Edward E. Dodson, MD
Aaron C. Moberly, MD; Oliver F. Adunka, MD
William J. Riggs, AuD*

Hypothesis: Objective physiologic changes measured by electrocochleography at the round window (ECochGRW) will be seen during endolymphatic sac decompression and shunt surgery (ELS).

Background: Limited effective treatment options are available to patients with Meniere's disease (MD) with substantial residual hearing who have failed conservative management and experience persistent vertigo symptoms. ELS is a feasible option for these patients. However, the efficacy of this procedure has been questioned, and objective measures assessing inner ear physiologic alterations are lacking.

Methods: ECochGRW was measured in patients with recalcitrant MD undergoing ELS. Stimuli consisted of tone bursts (0.25, 0.5, 1, 2, 4 kHz) and 100 μ s broadband clicks at various intensities (60-90 dB nHL). Cochlear microphonic (CM) harmonic distortions, the summing potential (SP), compound action potential (AP), and SP:AP ratio were measured.

Results: ECochGRW was recorded from 18 patients. Mean SP magnitude at 0.5 kHz changed significantly from -8.7 μ V before to -6.8 μ V after ELS ($p < 0.05$). Mean SP/AP ratio did not significantly change (0.61 pre- and 0.62 post-ELS $p = 0.90$). CM harmonic magnitudes remained unchanged from pre- to post-ELS across all frequencies. The 1st harmonic CM saturation point of the 0.5 kHz response was identified to be between 70- 80dB nHL.

Conclusion: ECochGRW during ELS allows for analysis of acute physiologic changes. Our results indicate small changes in the low frequency SP (.5 kHz) after ELS. Further changes may be identified within the post-operative period that cannot be captured intraoperatively. Significant changes to overall CM magnitude and harmonic distortions were not observed.

Define Professional Practice Gap & Educational Need: 1) Lack of an objective physiologic measure after vestibular surgeries, such as endolymphatic decompression and sac surgery 2) Inconsistencies within the literature regarding the efficacy of endolymphatic decompression and sac surgery

Learning Objective: To provide a better understanding of physiologic measures of the inner ear (i.e. electrocochleography) in response to an intervention, such as with endolymphatic decompression and sac surgery.

Desired Result: To better understand objective changes in vestibular physiology as a result of endolymphatic decompression and sac surgery.

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

Indicate IRB or IACUC Approval: Approved

Hearing Loss Associated with Osteoradionecrosis of the Temporal Bone

*Paul W. Gidley, MD; Marc-Elie Nader, MD, MSc
Adam S. Garden, MD*

Objective: Describe the hearing loss associated with osteoradionecrosis (ORN) of the temporal bone.

Study design: Retrospective case review

Setting: Tertiary referral center

Patients: Fifty-eight patients who developed exposed bone in the ear canal following radiotherapy.

Intervention(s): Audiograms.

Main outcome measure(s): Hearing levels and radiation dosages in patients with temporal bone ORN.

Results: Sixty-four ears with osteoradionecrosis of the temporal bone were identified. The average patient age was 60.2 years (range 23-91 years). The most common primary tumors were parotid (37.9%), nasopharynx (19.0%), and periauricular skin (10.3%). Radiation technique included intensity modulated radiation therapy (IMRT) in 58.8% and appositional fields in 29.4%. Total radiation dosages to the primary tumor varied from 30 to 129 Gy (mean = 60.4, STD=16.5 Gy). The average mean dose was 44.9 Gy, 50.5 Gy, and 59.0 Gy to the cochlea, ear canal, and mastoid tip, respectively. The mean time between completing radiotherapy and diagnosis of ORN was 93 months. An air conduction pure tone average (PTA) was 47.1 dB in the ears with ORN versus 29.6 dB in the non-ORN ears ($p < 0.0001$). The average air-bone PTA gap for ORN ears was 14.8 dB versus 3.1 dB in non-ORN ears ($p < 0.001$).

Conclusions: This is the largest single institution study of hearing loss in patients with ORN. ORN is associated with significant mixed hearing loss in the affected ear.

Define Professional Practice Gap & Educational Need: Hearing loss associated with osteoradionecrosis of the temporal bone has not been well described in the literature, and this represents a lack of contemporary knowledge.

Learning Objective: To describe the hearing loss associated with osteoradionecrosis of the temporal bone.

Desired Result: Attendees will learn the degree and type of hearing loss associated with osteoradionecrosis of the temporal bone.

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

Indicate IRB or IACUC Approval: Approved

Is Longer Surgery More Dangerous? Operative Duration Not Associated with Complications after Vestibular Schwannoma Resection

*Noga Lipschitz, MD; Arun Raghavan, BS
Gavriel D. Kohlberg, MD; Ravi N. Samy, MD
Mario Zuccarello, MD; Myles L. Pensak, MD
Joseph T. Breen, MD*

Objectives: To examine the association between operative duration and complications after vestibular schwannoma (VS) surgery

Study Design: Retrospective chart review

Setting: Tertiary referral center

Patients: 148 patients undergoing vestibular schwannoma resection in a single institution

Intervention: Vestibular schwannoma resection

Main outcome measures: Operative duration, surgical approach, tumor size and postoperative complications

Results: Forty-one patients underwent middle cranial fossa (MCF) approach, 46 underwent translabyrinthine (TL) approach and sixty-one underwent retrosigmoid (RS) approach. The mean operative duration overall was 407 minutes (MCF – 339 minutes, TL – 450 minutes, RS 420 minutes). When controlling for tumor size, there was no difference in procedure duration by approach (OR 0.92, CI 0.82 – 1.02, p=0.11). When controlling for approach, there was a significant increase in procedure duration by tumor size (OR 1.36, CI 1.23 – 1.50, p<0.0001). Increased procedure duration was not associated with 30-day readmission (p=0.83), cerebrospinal fluid leak (CSF) (p=0.81), CSF leak requiring surgical repair (p=0.36), return to the operating room (p=0.73), postoperative myocardial infarction (p=0.51), postoperative deep vein thrombosis (p=1.0), postoperative stroke (p=0.21) or postoperative wound complications (p=0.69). Increased procedure duration was associated with increased hospital length of stay (p=0.03). However, when controlling for tumor size and surgical approach, hospital length of stay was no longer associated with increased procedure duration (OR 1.15, CI 0.98 – 1.33, p=0.053).

Conclusion: Increased operative duration was associated with larger tumor size, however contrary to previous reports, increased operative duration was not associated with postoperative complications.

Define Professional Practice Gap & Educational Need: Data on the impact of operative time on surgical outcome and complication is scarce. 2. Data on the association between operative time and complications in lateral skull base surgery is mostly based on national database analysis and not institutional data with patient specific characteristics.

Learning Objective: 1. Discuss the current literature on the association between operative duration and postoperative complications. 2. Discuss study's findings on the association of operative duration with surgical outcome and complications.

Desired Result: Findings may mitigate concerns related to longer operative duration and the risk for complications.

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

Indicate IRB or IACUC Approval: Approved

Detection Rates of Cholesteatoma with Preoperative Non-Echo Planar Diffusion-Weighted MRI in Patients Who Underwent Tympanomastoidectomy

*Ethan Hunter Arnaud; Moises A. Arriaga, MD, MBA
Rahul Mehta, MD; Dwayne T. Anderson, MD
Alexander B.G. Sevy, MD*

Objective: The purpose of this study is to evaluate the diagnostic performance of Non-Echo Planar DWMRI in the detection of cholesteatoma in patients who underwent mastoidectomy.

Study Design: This study was a retrospective chart review of patients who underwent mastoidectomy. Non-Echo Planar DWMRI was performed on all patients prior to mastoid surgery. Radiological findings were correlated with intraoperative findings.

Setting: Surgery was performed by one of three Otolaryngology/Neurotology fellowship trained surgeons at a tertiary referral center.

Patients: Patients in this study had preoperative imaging with Non-Echo Planar DWMRI prior to undergoing mastoidectomy.

Interventions: Patients underwent a diagnostic Non-Echo Planar MRI and a therapeutic mastoidectomy.

Main Outcome Measures: This study evaluated the reliability of Non-Echo Planar imaging based on sensitivity, specificity, positive predictive value, and negative predictive value.

Results: Non-Echo Planar DWMRI correctly identified the presence or absence of cholesteatoma in 74 out of 92 cases. The sensitivity was determined to be 75% (39/52) while the specificity was 87.5% (35/40). The positive predictive value was 88.6% (39/44) while the negative predictive value was 72.9% (35/48).

Conclusions: Non-Echo Planar imaging continues to show high specificity in diagnosing cholesteatoma prior to mastoidectomy, but due to the presence of false negatives, we believe that a negative test result should not exclude the possibility of cholesteatoma. These patients should be followed closely with routine monitoring of symptoms and regular follow up to prevent complications of cholesteatoma.

Define Professional Practice Gap & Educational Need: There are currently inconsistencies in the way providers manage patients with suspected cholesteatoma as well as in the postoperative course in those patients that have undergone mastoidectomy.

Learning Objective: We seek to determine the clinical utility of Non-Echo Planar imaging in the preoperative evaluation of patients with suspected cholesteatoma prior to mastoidectomy. We hope this can spare patients from the costly and sometimes complicated second look procedures.

Desired Result: We hope attendees will apply this knowledge to their practice to both save patients a second operation if not necessary while also performing mastoidectomy to remove pathology in those that otherwise may have gone undetected.

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

Indicate IRB or IACUC Approval: Approved

Trends in Age of Cochlear Implant Recipients and the Impact on Complication Rates

*Shayan Fakurnejad; Daniel Vail
Yohan Song, MD; Jennifer C. Alyono, MD
Nikolas H. Blevins, MD*

Objective: To examine trends in the age of patients receiving cochlear implantation, and to determine the effect of age on the rate of postoperative complications.

Study design: Retrospective analysis of de-identified administrative claims data from a US commercial insurance database (Optum), which includes medical and demographic information for nearly 53 million unique members.

Patients: Individuals undergoing cochlear implantation between 2003-2016.

Setting: US hospital and outpatient facilities serving commercially insured patients

Intervention: Cochlear implantation

Main outcome measures: age at implantation, incidence of complications within 30 postoperative days identified by ICD9/10 codes including device failure, myocardial infarction, stroke, venous thromboembolism, cellulitis, meningitis, stroke, cerebrospinal fluid leak, and facial weakness.

Results: Between 2003-2016, 4,148 patients underwent cochlear implantation. The number of implants per year increased annually from 154 surgeries in 2003 to 556 in 2016, with the greatest growth demonstrated in those aged 60-89. The average age of adults undergoing implantation increased annually from an average of 44.1 to 65.2 years ($p < 0.001$). The proportion of patients undergoing implantation who were >60 and >80 years increased from 23.1% and 2.5% among the first 7 years of analysis, respectively, to 50.5% and 14.3% in the subsequent 7 years ($p < 0.001$). No significant differences in 30-day complication rate were found between patients when grouped by age in decades, except for device related failures, which was significantly higher in younger patients (<29 years).

Conclusions: Over the past decade and a half, cochlear implantation is more frequently being performed, and in an increasingly aging population. This trend does not seem to alter the risk of perioperative complications.

Define Professional Practice Gap & Educational Need: Lack of awareness of the trends in age at the time of cochlear implantation, and the implications in regards to patient safety, due to a lack of large, claims-based studies

Learning Objective: To better understand the trends in incidence of cochlear implantation, in particular in elderly patients, and to determine what impact this trend may have on patients safety in regards to postoperative complications amongst the different age groups.

Desired Result: To demonstrate that cochlear implantation is an increasingly common procedure in an increasingly aging population, but nevertheless remains a safe procedure. As such, cochlear implantation should be considered in all age groups, including the elderly.

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

Indicate IRB or IACUC Approval: Exempt

**Treating the Individual Ear in Children:
Results of Cochlear Implantation in Children
with Asymmetric Sensory Hearing Loss**

*Elizabeth Perkins, MD; Michelle Nguyen, BS
Lisa R. Park, AuD; Erika Gagnon, AuD
Jennifer Woodard, AuD; Elizabeth Preston, AuD
Kevin D. Brown, MD, PhD*

Objective: Determine speech outcomes of children undergoing cochlear implantation with severe to profound hearing loss in the implanted ear and moderate or better hearing loss in non-implanted ear.

Study design: Retrospective chart review

Setting: Tertiary referral center

Patients: 49 children with severe to profound hearing loss in the ear to be implanted (pure tone average-PTA), and no worse than moderate hearing loss in the non-implant ear.

Intervention: Subjects underwent cochlear implantation from 2007-2017 in the ear with severe to profound hearing loss.

Main outcome measures: Consonant Nucleus Consonant or Phonetically Balanced Kindergarten word scores pre- and post-operatively were compared in both the implanted ear and binaural setting. The word score list compared pre- and post-operatively was consistent within each study subject.

Results: The average PTA for the implant ear was 92 ± 13 and 55 ± 12 in the non-implant ear. Word scores for the implant ear increased an average of 58 ($\pm 27\%$) following cochlear implantation at 12 months and 62 ($\pm 20\%$) at 24 months. Binaural best-aided word scores increased an average of 36 ($\pm 29\%$) at 12 months and 49 ($\pm 24\%$) at 24 months.

Conclusion: Children with asymmetric sensory hearing loss should have each ear treated individually as significant benefits can be gained not only in the implanted ear, but also in binaural hearing.

Define Professional Practice Gap & Educational Need: Current FDA criteria for cochlear implantation in children is bilateral severe to profound hearing loss. Expanding indications have permitted cochlear implantation in children with higher levels of hearing in the non-implant ear, although speech outcomes following cochlear implantation in this population are not well described.

Learning Objective: To gain knowledge in the expanding indications of cochlear implantation in children. To understand the potential benefits of cochlear implantation in children with asymmetric hearing loss that may not meet the standard, currently approved FDA criteria. To learn that unilateral cochlear implantation in children with asymmetric hearing loss is beneficial in both the implanted ear and binaural setting.

Desired Result: The attendee may begin to offer cochlear implantation to the non-traditional pediatric candidate with the goal of expanding current FDA criteria.

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

Indicate IRB or IACUC Approval: Approved

Electrode Type and its Impact on Impedance Fluctuations and Loss of Residual Hearing in Cochlear Implantation

*Nicholas J. Thompson, MD; Margaret T. Dillon, AuD
Emily Buss, PhD; Harold C. Pillsbury III, MD
Brendan P. O'Connell, MD; Kevin D. Brown, MD, PhD*

Hypothesis/Objective: Determine variables associated with electrode impedance fluctuations and loss of residual hearing in cochlear implant recipients.

Background: Postoperative low-frequency hearing preservation is routinely possible, resulting in improved speech perception with acoustic plus electric stimulation. Recent reports have suggested a relationship between fluctuations in electrode impedance and loss of residual hearing. Variables affecting this relationship have yet to be determined.

Methods: Review of pediatric and adult cochlear implant recipients from 2013-2016 with postoperative hearing preservation. The correlation between impedance change and change in residual low frequency hearing at 12 months was determined. Regression analysis evaluating the effect of array type (lateral wall vs. perimodiolar), manufacturer, age, and pre-operative hearing on impedance was determined.

Results: Ninety-four cochlear implant recipients presented with postoperative hearing preservation. An association between change in impedance and loss of residual hearing was observed, however differed between manufacturers ($R^2=0.30$, $P = 0.01$ vs. $R^2=0.01$, $P =0.77$). Average absolute impedance changes were higher for a slim electrode inserted to 20mm vs. a flexible electrode inserted to 24mm; approaching significance ($p=0.08$). A multivariate regression analysis demonstrated a statistically significant association between preoperative low-frequency pure-tone average ($p=0.048$), device manufacturer ($p=0.012$), and array type ($p=0.02$) on impedance changes. There was no effect of patient age.

Conclusion: Impedance fluctuations appear to be a marker for delayed loss of residual hearing for some electrode array types and manufacturers but not others. Specific electrode arrays may affect the cochlear microenvironment differently, resulting in a local reaction with subsequent negative impact on postoperative hearing preservation.

Define Professional Practice Gap & Educational Need: Lack of awareness of the association between electrode impedance fluctuations and loss of residual hearing in cochlear implantation. 2. Lack of contemporary knowledge regarding the variables that affect the relationship between electrode impedance and loss of residual hearing in cochlear implantation.

Learning Objective: To determine variables affecting the relationship between electrode impedance fluctuations and loss of residual hearing in cochlear implantation.

Desired Result: Attendees will better understand the relationship between electrode impedance fluctuations and loss of residual hearing after cochlear implantation and begin to critically think about factors that may influence this relationship and long-term hearing outcomes after implantation.

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

Indicate IRB or IACUC Approval: Approved

Custom Mastoid-Fitting Templates to Improve Cochlear Implant Electrode Insertion Trajectory

*William G. Morrel, MD; Katherine E. Riojas
Narendran Narasimhan; Robert J. Webster III, PhD
Jack H. Noble, PhD; Robert F. Labadie, MD, PhD*

Hypothesis: Intracochlear positioning of cochlear implant (CI) electrode arrays (EAs) can be improved using custom templates to specify ideal insertion trajectory.

Background: Insertion trajectory affects final intracochlear CI positioning. Limited information is available intraoperatively regarding ideal insertion trajectory.

Methods: After IRB exemption, 3D reconstructions were created from CT scans of three cadaveric temporal bones. Trajectories co-planar with each cochlea's basal turn were considered ideal. Templates were designed to fit against the mastoid and demonstrate ideal insertion trajectory with a hollow cylinder. Templates were 3D printed using stereolithography. Mastoidectomy was performed on all bones. A custom, roller-based insertion tool was used to constrain electrode insertions to intended trajectories. Insertions were performed with MED-EL Standard electrodes in three bones with three conditions: ideal trajectory with tool, non-ideal trajectory with tool, and ideal trajectory with forceps. For the final condition, the template was used to mark the mastoid as a trajectory guide. Insertion was stopped when buckling occurred.

Results: Insertions along ideal vs non-ideal trajectories averaged more intracochlear electrodes (ideal: 9, 8, 8; non-ideal: 7, 7, 8) and greater angular insertion depths (AID) (ideal: 377°, 341°, 320°; non-ideal: 278°, 302°, 290°). Insertions performed with forceps but using templates as a guide also achieved excellent results (intracochlear electrodes: 10, 7, 8; AID: 478°, 318°, 333°). No scalar translocations occurred.

Conclusions: Custom mastoid-fitting templates reliably specify a trajectory co-planar with the cochlea's basal turn and provide sufficient information for recreation of that trajectory with manual insertion after template removal. Secondly, our roller-based insertion tool achieves results comparable to manual insertion.

Define Professional Practice Gap & Educational Need: Lack on intraoperative tools for cochlear implant insertion trajectory 2. Lack of awareness of the importance of cochlear implant insertion trajectory

Learning Objective: Identify methods to improve insertion trajectory for cochlear implant electrodes

Desired Result: Understand the importance of insertion trajectory and utilize tools to improve trajectory as they become available

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

Indicate IRB or IACUC Approval: Exempt

**Impact of Cochlear Implantation on Speech Perception,
Health Utility, and Cognition in Elderly Adults,
Results From a Multi-Center Trial**

*Cameron C. Wick, MD; Jonathan L. McJunkin, MD
Nedim Durakovic, MD; Jacques A. Herzog, MD
Craig A. Buchman, MD*

Objective: To measure the impact of cochlear implantation (CI) on speech perception, cognition, and health related quality of life (HRQL) in adults 65 years and older.

Study Design: Prospective, non-randomized, multi-center study using within-subject experimental design. Post hoc analysis of data for subjects 65 years and older.

Setting: Tertiary referral centers (N = 13)

Patients: Adults \geq 65 years of age

Intervention: Cochlear implantation using a slim, modiolar array

Main Outcome Measures: All tests were performed at pre-op and 6 months post-activation. Speech perception was measured with consonant-nucleus-consonant (CNC) words and AzBio sentences in noise (+ 10 dB SNR). HRQL was measured by Health Utility Index Mark 3 (HUI3), and Speech, Spatial, Qualities of Hearing Scale (SSQ). Cognition was measured with the Montreal Cognitive Assessment (MoCA).

Results: Of 55 CI patients with 6-month data, 39 were 65 years or older (range: 65 – 91 years). Significant improvements were observed for all group outcome measures ($p < 0.001$). Using the implant alone, the mean improvement in CNC words and AzBio sentences in noise was 45% and 26%, respectively. The mean HUI3 total and hearing sub-score improved by 0.18 and 0.28 respectively; both well above the 0.03 clinically meaningful difference. Significant improvements in each SSQ subscale were also observed. For all 55 patients (mean age: 67.3 years \pm 14.2), 43% improved their MOCA by 2-points or more after 6-months.

Conclusion: Importantly, elderly patients experience substantial improvements in speech perception, cognition, and HRQL following CI.

Define Professional Practice Gap & Educational Need: Poor understanding of cochlear implant performance in the elderly.

Learning Objective: 1. Establish expected outcomes of a new perimodiolar electrode in patients 65 years and older. 2. Understand the degree of benefit regarding speech perception outcomes and health related quality of life measures following cochlear implantation. 3. Explore possible benefits of cochlear implantation on cognition.

Desired Result: The information in this presentation will help physicians counsel and screen patients 65 years and older through the cochlear implant process. The data will provide objective numbers to stratify expected results in speech perception and health related quality of life. Finally, we hope the information will shed light on possible cognitive benefits derived from cochlear implantation.

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

Indicate IRB or IACUC Approval: Approved

Insertion Depth of Pre-Curved Cochlear Implant Electrodes

*Rueben A. Banalagay; Robert F. Labadie, MD, PhD
Jack H. Noble, PhD*

Hypothesis: Generic guidelines for insertion depth of pre-curved electrodes are sub-optimal for many individuals.

Background: Insertion depths that are too shallow result in decreased cochlear coverage, and ones that are too deep lift electrodes away from the modiolus and degrade the electro-neural interface. Guidelines for insertion depth are generic and based on a depth marker (DM) at the round window entry point (EP) or a facial recess (FR) marker.

Methods: Using published methods¹, we determined the position and insertion depth where a pre-curved external sheath electrode array best fits the cochlea for each patient in an IRB approved, N=243 CT database. We measured the distance from the EP to the ideal DM location and to the FR.

Results: The distance from EP to the center of the FR was 6.74mm +/- 0.57mm and from EP to the ideal DM position was 0.52mm +/- 0.28mm. If the array was positioned by placing the FR marker medial (lateral) to the facial nerve, the difference with ideal depth on average would be 0.88mm +/- 0.57mm (1.26mm +/- .65mm). Poor outcomes (>1mm difference to ideal depth) would occur for 9, 91, and 155 cases where depth is determined using DM, medial FR, and lateral FR placement, respectively.

Conclusions: Studies show depth within 1mm from ideal permits perimodiolar positioning¹. These data suggest that the DM is a better marker for positioning than the FR. Further, marker positions are not ideal for the average cochlea (bias of 0.51mm for DM, 0.77mm for FR).

Define Professional Practice Gap & Educational Need: Lack of awareness that generic guidelines for insertion depth of pre-curved electrodes are sub-optimal for many individuals

Learning Objective: Attendees will learn improved guidelines for achieving optimum insertion depth

Desired Result: Attendees will gain awareness and knowledge of optimal insertion depth to improve electrode placement

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

Indicate IRB or IACUC Approval: Approved

Characterizing Mechanisms of Intracochlear Pressure Spikes During Cochlear Implantation via Simultaneous Cochlear Fluoroscopy and Intracochlear Pressure Measurements

*Joseph R. Gonzalez, MD; Renee M. Banakis Hartl, MD, AuD
John Peacock, PhD; Stephen P. Cass, MD, MPH
Nathaniel T. Greene, PhD*

Background: Combined electrical-acoustical stimulation has gained interest as patients with greater degrees of residual hearing are undergoing cochlear implantation (CI) and demonstrating improved outcomes, but loss of residual hearing continues to occur in a subset of patients for unclear reasons. Several mechanisms have been proposed for this hearing loss. We have previously described the generation of large amplitude pressure transients, equivalent to high-level noise exposures, in the inner ear during electrode insertion; however, the source of these events has not been identified.

Methods: Cadaveric human heads were surgically prepared with an extended facial recess approach. Fiber-optic pressure sensors were inserted into the scala vestibuli and scala tympani to measure intracochlear pressures. Three CI electrodes (straight and perimodiolar styles) from a single manufacturer were inserted while measuring intracochlear pressures under time-synced video and fluoroscopy.

Results: CI electrode insertions produced pressure transients in the cochlea up to 160-170 dB peak SPL equivalent, consistent with results from previous studies. The electrode position within the cochlea (particularly electrode contact with either the medial or lateral walls), design-related electrode dynamics, and poor surgical technique were associated with increased rates of pressure transient generation.

Conclusions: These results elucidate the risk of generating injurious pressure changes during CI electrode insertion by simultaneously correlating pressure transients with observed trauma on fluoroscopy. As the first confirmation of potential transient source, the results could be used by both CI manufacturers to improve electrode design and surgeons to improve “soft” surgical techniques with the aim of improving hearing preservation outcomes.

Define Professional Practice Gap & Educational Need: Limited understanding of the mechanisms leading to loss of residual hearing during insertion of cochlear implant electrodes.

Learning Objective: 1. Identify possible mechanisms of previously observed pressure transients during cochlear implant electrode insertion. 2. Develop an understanding of mitigation strategies to avoid undesired trauma to the cochlea during electrode insertion.

Desired Result: 1. Participants will improve understanding of potential intraoperative trauma mechanisms leading to loss of residual hearing. 2. Participants will appreciate the utility of fluoroscopy for the evaluation of electrode dynamics in cochlear implant research.

Level of Evidence - Does not apply-This is a basic science translational project aimed at examining the potential mechanism of cochlear trauma in cochlear implant surgery that cannot be randomized or blinded in a traditional sense.

Indicate IRB or IACUC Approval: Exempt

**Time-Based Assessment of Hearing Preservation Rates
after Microsurgical Resection of Vestibular Schwannomas:
Systematic Review and Treatment Comparison**

*Anastasia Hunt, BS; Nathan D. Cass, MD
Adam R. Coughlin, MD; Samuel P. Gubbels, MD*

Objective: To determine hearing preservation rates after microsurgical resection of vestibular schwannoma (VS).

Data Sources: Systematic review of the Ovid, Cochrane, EMBASE, and Web of Science databases.

Study Selection: This study was restricted to full text English language articles detailing VS resection via the middle cranial fossa (MCF) or retrosigmoid (RS) approach. Documentation of pre- and post-treatment hearing outcomes with AAO-HNS, Gardner-Robertson (GR), or word recognition score (WRS) scales, as well as time to follow up were required. Duplicate data sets, studies with >10% of patients with Neurofibromatosis 2, prior or non-surgical VS treatment, case reports with <5 patients, or studies detailing decompressive surgery were excluded.

Data Extraction: Two authors independently performed full text reviews to determine study eligibility. Discrepancies were settled by consensus. "Class A/B, I/II" hearing was defined as AAO-HNS Class A or B, GR Class 1 or 2, or PTA \leq 50 dB with WRS \geq 50% on audiogram.

Data Synthesis: Pooled estimates of preserved Class A/B, I/II hearing at last post-operative follow-up.

Conclusions: Of 1,323 reports, 18 met inclusion criteria. Fourteen were utilized in analyses yielding data from 2977 patients. Mean follow-up was 52.5 months (SD = 19.9). Class A/B, 1/2 hearing was preserved at last follow-up in 57% of patients. Meta-regression revealed female gender and resection through the MCF were associated with preservation of serviceable hearing. Thus, hearing preservation is possible with microsurgical resection in select patients with VS who have class A/B, 1/2 hearing preoperatively and when preserved, appears to be stable over time.

Define Professional Practice Gap & Educational Need: There is great variability in quoted hearing preservation rates after microsurgical resection and other modalities of management for vestibular schwannoma; thus, patients are not provided with consistent information on available therapies with which to engage in shared decision making.

Learning Objective: Participants will comprehend the existing literature and complexities in reporting of hearing preservation after microsurgical resection of vestibular schwannoma.

Desired Result: Participants will discuss with patients hearing preservation rates after microsurgical resection of vestibular schwannoma with improved accuracy, allowing improved shared decision making.

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

Indicate IRB or IACUC Approval: Exempt

**Understanding the Dizziness Handicap Inventory (DHI):
A Cross Sectional Analysis of Symptom Factors that
Contribute to DHI Variance**

*Eric J. Formeister, MD; Roseanne Krauter, FNP-BC
Laura Kirk, PA-C; Habib Rizk, MD
Jeffrey D. Sharon, MD*

Objective: Dizziness Handicap Inventory (DHI) is the most commonly used quality of life (QOL) measure for vestibular disorders. However, there is wide variability in scores, and we don't fully understand which variables contribute to dizziness related QOL. Our goal was to investigate the key demographic and symptom related factors to determine which ones account for DHI variance.

Study design: Cross sectional survey

Setting: Tertiary care dizziness clinic

Patients: Adults with dizziness

Intervention(s): none

Main outcome measure(s): DHI variance explained by multiple linear regression modelling.

Results: 67 subjects were included in our study. We performed univariate analysis on numerous demographic and dizziness related factors, and constructed a multivariate model based on explaining the highest variance in the data with the least number of independent variables. Multiple linear regression model showed that number of days per month of dizziness (0 to 30), number of dizziness descriptors (spinning, lightheadedness, disequilibrium, etc.), and the number of dizziness triggers (loud sounds, stress, riding in a car, etc.) all were associated with increased DHI. Together, this accounted for 56% of the variability in the DHI, $p = <0.0001$). Adding an index of depression, as measured by the Patient Health Questionnaire 9 (PHQ-9), to the model increased the adjusted R-squared to 64% ($p = <0.0001$).

Conclusions: By understanding the factors that contribute to variability in DHI scores, we may be better able to improve QOL for patients with dizziness.

Define Professional Practice Gap & Educational Need: Lack of contemporary knowledge: Dizziness Handicap Inventory (DHI) is the most commonly used quality of life (QOL) measure for vestibular disorders. However, there is wide variability in scores, and we don't fully understand which variables contribute to dizziness related QOL.

Learning Objective: Determination of the key demographic and symptom related factors to determine which ones account for DHI variance.

Desired Result: By understanding the factors that contribute to variability in DHI scores, attendees may be better able to implement more effective diagnostic and therapeutic strategies to improve quality of life for patients with dizziness.

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

Indicate IRB or IACUC Approval: Approved

**Mechanical Energy Dissipation through the Ossicular Chain
and Vestibular Organ Using Laser Doppler Vibrometer
Measurement of Round Window Velocity**

*John W. Lally, MD; Sophie Higgins, BS
Mostafa Ahmed, MD; Alex Diech, BS
Samuel A. Spear, MD; Carlos Esquivel, MD*

Objective. Understand impact of mechanical energy transmission and dissipation through the ossicular chain and vestibular organ through incus, stapes, and round window velocity measurements in response to sound stimulus.

Methods. Thawed human temporal bones with intact ossicular chain and tympanic membrane underwent complete mastoidectomy with facial recess approach. Laser Doppler Vibrometry (LDV) was mounted on operating microscope to measure vibration of incus, stapes, and round window in response to a sound stimulus within the external auditory canal. Frequencies of sound stimulus ranged from 0.5 to 4 kHz. The stimulus across all frequencies measured sound pressure 90 dB SPL.

Results. Five temporal bones were studied with each incus, stapes, and round window vibration velocity measured across the frequency range. Vibration curves obtained over the frequency range were similar between bones with a notable resonant frequency around 2 kHz. Amplitude of incus and stapes curves were nearly identical. The round window measurements demonstrated an earlier drop in amplitude around 6.5kHz with reduced vibratory velocity across the higher frequencies.

Conclusions. The similarity of vibration curves obtained between the incus and stapes measurements indicates that minimal mechanical energy is dissipated through the ossicular chain. The drop in round window velocity measurements at higher frequencies suggests a loss of mechanical energy within this range through the vestibular organ. A complete and thorough understanding of the biophysical properties of the middle and inner ear are critical for optimal ossiculoplasty outcomes and the development of future ossicular prosthetics.

Define Professional Practice Gap & Educational Need: There currently has not been a documented velocity study quantifying the loss of mechanical energy through ossicular chain components and the vestibular organ. This model provides a accurate model for studying maximal conductive hearing loss and quantifying the loss of mechanical energy through this organ system with the ultimate goal of optimizing ossiculoplasty outcomes.

Learning Objective: Understand impact of mechanical energy transmission and dissipation through the ossicular chain and vestibular organ through incus, stapes, and round window velocity measurements in response to sound stimulus.

Desired Result: Attendees will consider and apply these physical outcome measurements when selecting, implanting, and developing prosthetic material for middle ear ossiculoplasty. They will also leave with a better understanding of the order of magnitude of energy that is dissipated through a healthy vestibular organ or through a situation of ossicular discontinuity and what this may mean for their patients with conductive hearing loss.

Level of Evidence - Does not apply-basic science study using correlational analysis of ossicular velocity

Indicate IRB or IACUC Approval: Approved

Hearing Preservation in Elderly Cochlear Implant Recipients

Holden D. Sanders, BS; Abraham Jacob, MD

Objective: Examine hearing preservation rates in cochlear implant recipients over age 72 years.

Study design: Retrospective case series

Setting: Tertiary otology/neurotology practice

Patients: Cochlear implant recipients April 2017 to June 2018

Intervention: Surgical/rehabilitative

Main outcome measure(s): Residual hearing outcomes were measured 3 and 6-months after cochlear implantation. Hearing preservation was defined as a low frequency PTA of 85 dB or better. Between April 2017 and June 2018, 123 cochlear implant operations were performed by the senior author (AJ). Out of a cohort of 45 cochlear implant recipients, 32 were eligible for hearing preservation. Of the 32 patients eligible for hearing preservation, 17 were 72 years or older. Overall, hearing was preserved in 60% of patients. Of those patients older than 72 years of age, 71% had hearing preservation. This suggests that the vast majority of patients, including an elderly cohort can benefit from soft surgery techniques. Despite concerns about cochlear fragility in elderly patients, preservation of residual hearing is feasible in cochlear implant recipients age 72 years and older.

Conclusion: Despite concerns about cochlear fragility in elderly patients, preservation of residual hearing is feasible in cochlear implant recipients age 72 years and older.

Define Professional Practice Gap & Educational Need: Lack of awareness of the potential for hearing preservation in elderly cochlear implant recipients

Learning Objective: Understand hearing preservation is possible in the majority of patients with residual hearing prior to cochlear implantation, including among elderly cochlear implant recipients.

Desired Result: Begin or continue to use soft surgery techniques for cochlear implant recipients, including elderly patients. Use this information to counsel elderly cochlear implant recipients on expected outcomes following cochlear implantation with soft surgery techniques.

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

Indicate IRB or IACUC Approval: Exempt

Factors Affecting Cochlear Patency after Retrosigmoid Surgery

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Objective: To determine predictive factors for cochlear patency after retrosigmoid approaches for posterior fossa tumors.

Study Design: Retrospective chart review.

Setting: Tertiary referral center.

Subjects and Methods: In total, 319 patients were reviewed, resulting in 107 patients who underwent retrosigmoid approaches between October 2005 and November 2017, with adequate, postoperative heavily T2-weighted MRI. Postoperative, heavily T2-weighted surveillance MRI was obtained a median of 391 days after surgery, and reviewed for cochlear patency. Tumor size, preoperative audiograms, and postoperative audiograms were also compared between patients with cochlear patency and cochlear obliteration.

Results: One hundred seven patients underwent retrosigmoid craniotomy. Of 87 patients who underwent retrosigmoid craniotomy with drilling of the internal auditory canal, 52 patients (60%) retained cochlear patency. Of 20 patients who underwent retrosigmoid craniotomy without drilling of the internal auditory canal, 15 patients (75%) retained cochlear patency. Tumor pathology was comprised of 98 vestibular schwannomas (92%) and 9 meningiomas (8%). When comparing patients who retained cochlear patency with those who had cochlear obliteration, there were no significant differences between the two groups in terms of tumor size, preoperative speech reception thresholds (SRT) and speech discrimination scores (SDS), and postoperative SRT and SDS scores.

Conclusion: In retrosigmoid approaches without drilling of the internal auditory canal, 75% of patients retain cochlear patency. When the internal auditory canal is entered, cochlear patency decreases to 60%. Tumor size and preoperative hearing performance do not predict postoperative cochlear patency. This may have important implications when considering cochlear implantation for unilateral deafness after tumor resection.

Define Professional Practice Gap & Educational Need: Lack of large studies studying cochlear patency after retrosigmoid approaches to posterior fossa tumors

Learning Objective: Describe factors affecting cochlear patency after retrosigmoid approaches to posterior fossa tumor resection.

Desired Result: Attendees will gain further knowledge about cochlear patency after retrosigmoid approaches, helping them understand the potential for cochlear implantation after tumor resection.

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

Indicate IRB or IACUC Approval: Approved