SELECTED ABSTRACTS

in order of presentation

ORAL PRESENTATIONS

57th Annual Spring Meeting

AMERICAN NEUROTOLOGY SOCIETY

April 30 - May 1, 2022
Hyatt Regency Dallas
Dallas, TX

Posters will be viewed on Friday & Saturday, April 29-30. Oral presentations are Saturday & Sunday, April 30-May 1.

NEUROTOLOGY FELLOW AWARD

Cochlear Implantation for Single Sided Deafness: Speech Outcomes, Quality of Life, and Effects on Tinnitus

Nathan R. Lindquist, MD; Ankita Patro, MD
Jourdan T. Holder, AuD, PhD; Elizabeth L. Perkins, MD

Objective: To report our experience for adults undergoing cochlear implantation (CI) for single-sided deafness (SSD).

Study Design: Retrospective case series.

Setting: Tertiary referral center.

Patients: Adults cochlear implantation recipients for SSD between 2013 and 2021.

Interventions: Unilateral CI.

Main Outcome Measures: Tinnitus handicap inventory (THI), speech, spatial and qualities of hearing scale (SSQ-12), CT mean modiolar distance (MMD), CNC and AzBio speech recognition scores.

Results: 67 adults underwent CI for SSD (mean 50.6 years, SD = 15.9 years). Mean CNC word recognition scores were 8% (SD = 12%) pre-operatively and 45% (SD = 26%) at 6 months post-activation (p = 0.0001). 23 patients (35.4%) received perimodiolar electrodes (MMD 0.45, SD = 0.35 mm) while 44 patients (65.7%) had lateral wall electrodes (MMD 1.12, SD = 0.13 mm, p = 0.0001). There was no significant difference in CNC scores between perimodiolar (47%, SD = 28%) and lateral wall (44%, SD = 25%) electrodes at 6 months (p = 0.6982). Patients did demonstrate significant improvement in SSQ-12 scores in 'speech' and 'spatial' sections but not in the 'qualities' domain at six months. THI was significantly improved from a mean score of 55 ± 24 preoperatively to 21 ± 23 at 6 months ($p < 0.0001$).

Conclusions: Herein, we present the largest cohort of patients with SSD treated with CI to date. This group demonstrates significant benefit with regards to speech recognition scores, tinnitus measures, and quality of life metrics including speech in noise and spatial subdomains as early as 6 months post-operatively.

***Professional Practice Gap & Educational Need:** CI for patients with SSD is a relatively recent trend, with many prior implantations occurring outside of FDA approval. Increased data surrounding the speech recognition outcomes, quality of life metrics, and importance of electrode type for these patients will help guide patient counseling and decision-making for patients, surgeons, and audiologists.

***Learning Objective:**
For patients undergoing CI for SSD

1. Describe speech recognition scores, tinnitus measures, and quality of life metrics for these patients, and
2. Understand how this may translate to clinical guidance, counseling, and expectations for this cohort.

***Desired Result:** Increased data surrounding the speech recognition outcomes, quality of life metrics, and importance of electrode type for these patients will help guide patient counseling and decision-making for patients, surgeons, and audiologists.

***Level of Evidence -** Level IV

***Indicate IRB or IACUC :** Vanderbilt University Medical Center IRB# 211355

Cochlear Implantation Outcomes in Adults with Single-Sided Deafness: A Systematic Review and Meta-analysis

Ghazal S. Daher, MD; Armine Kocharyan, MD
Margaret T. Dillon, AuD; Matthew L. Carlson, MD

Objective: Assess hearing, tinnitus, and quality-of-life outcomes in adults with single-sided deafness (SSD) who underwent cochlear implantation.

Data Sources: PubMed, MEDLINE, Embase, Cochrane Central Register of Controlled Trials, Web of Science, and Scopus databases were searched from January 2008 to September 2021 following PRISMA guidelines.

Study Selection: Studies reporting hearing, tinnitus, and quality-of-life outcomes in adult patients (≥18 years old) with SSD were evaluated.

Data Extraction: Study characteristics, demographic data, hearing (speech recognition in quiet and noise, sound source localization), tinnitus, and quality-of-life outcomes were collected.

Data Synthesis: From an initial search of 1147 articles, 42 studies that evaluated cochlear implant (CI) use in 906 unique adults with SSD (50.6 ± 23.3 years age of implantation) were included. The mean duration of deafness was 6.3 ± 9.6 years. Most adults showed 43% (95% CI, 39.7 to 47.3, P< 0.001, CNC) to 48% (95% CI, 42.4 to 53.2, P< 0.001, AzBio) improvement in speech recognition in quiet and 19-24% (P<0.001) in noise with significant variation in target-to-masker configurations. Sound source localization, quantified as root-mean-squared error, improved with CI use (Mean difference [MD] -17.6º; 95% CI, -20.3º to -14.9º, P<0.001). Patients experienced a significant reduction in Tinnitus Handicap Inventory scores (MD -28.5; 95% CI -34.2 to -22.8, P<0.001) and improvements in Spatial, Speech, and Qualities of Hearing scores (MD 2.1; 95% CI, -1.7 to 2.5, P<0.001).

Conclusions: Cochlear implantation offers significant reduction in tinnitus severity and enhancement of speech recognition in quiet and noise, sound source localization, and perceived quality-of-life in adults with SSD.

***Professional Practice Gap & Educational Need:** 1) Lack of comprehensive and up-to-date systematic review of the existing literature on outcomes of CI use in adults with SSD. 2) Most studies reporting outcomes of CI in SSD are non-randomized trials with a small sample size which interferes with the generalizability of the data and recommendations. 3) Need for well-defined clinical guidelines.

***Learning Objective:** 1) Attendees will understand the hearing benefits of cochlear implantation in adults with single sided deafness, particularly speech recognition in noise and sound localization. 2) Attendees will understand the benefits of cochlear implantation in improving tinnitus and quality of life associated with SSD.

***Desired Result:** To conduct a systematic review of existing literature and perform a meta-analysis of the pooled data on outcomes of CI in SSD, particularly CI effect on speech recognition in noise, sound localization, tinnitus suppression, and improvement of quality of life.

***Level of Evidence** – Level II

***Indicate IRB or IACUC**: Exempt.

NEUROTOLOGY FELLOW AWARD

Do Cognitive Impairment Screening Scores Correlate with Cochlear Implant Speech Outcomes?

Mallory J. Raymond, MD; Cheng Ma, BS.; Kara Leyzac, AuD, PhD, CCC-A
Elizabeth L. Camposeo, AuD, CCC-A; Shaun A. Nguyen, MD
Ted A. Meyer, MD, PhD; Theodore R. McRackan, MD, MSCR

Objective: Because age-related hearing loss is associated with cognitive impairment, many cochlear implant (CI) centers screen patients for cognitive impairment as part of the CI evaluation process. It is unknown if these screening results can validly be used to counsel patients regarding CI outcomes. This study seeks to determine whether there is a correlation between cognitive screening scores and post-operative CI speech recognition improvement.

Study Design: Retrospective review

Setting: Tertiary cochlear implant center

Patients: Seventy-seven adult CI recipients (aged 36-92)

Interventions: Cochlear implantation for patients with bilateral moderate to profound hearing loss

Main Outcome Measures: Preoperative Montreal Cognitive Assessment (MoCA) scores; pre-CI (aided) to 12-month post-CI CNC word/phoneme and AzBio sentences in quiet score improvement

Results: The mean MoCA score for the cohort was 25.1±3.6 (range:13-30). Thirty-five patients (45.5%) had scores suggesting mild cognitive impairment and three (3.9%) suggesting moderate cognitive impairment. Only two patients had previous diagnoses of cognitive impairment. There were no significant differences ($p>0.05$) in pre-CI to 12-month post-CI speech recognition improvements for patients who screened positive for cognitive impairment compared to those who did not (CNC phoneme [53.6±23.5 versus 43.3±26.2], CNC word [51.8±21 versus 37.3±23.7], and AzBio in quiet [52±34.7 versus 43.8±34.8]. In addition, MoCA scores demonstrated absent to weak correlations with improvement in speech recognition scores (*r* range=-0.17- -0.05).

Conclusions: While there is a high prevalence of patients screening positive for cognitive impairment during the CI evaluation process, the degree of post-CI speech recognition improvement does not appear to be different between those who do and do not screen positive for cognitive impairment.

***Professional Practice Gap & Educational Need:** Given the association of cognitive impairment and hearing loss, cognitive screening tests are being incorporated into evaluations of patients with hearing loss. Little is known of the relationship between screening scores and speech outcomes after cochlear implantation. Understanding the relationship between speech outcomes and cognitive impairment screening scores is important for preoperative patient counseling and setting realistic post-CI expectations.

***Learning Objective:** To state the prevalence of cognitive impairment as assessed by the MoCA in adults undergoing CI evaluation; determine the correlation between preoperative MoCA scores and speech outcomes; compare the change from pre- to 12-month postoperative speech scores between patients with and without cognitive impairment;

***Desired Result:** Attendees will: (1) understand the prevalence of cognitive impairment in adults with moderate to profound hearing loss who are seeking cochlear implant care; 2) appreciate the lack of correlation between preoperative cognitive impairment screening scores and 12-month postoperative change in aided speech outcomes after cochlear implantation; 3) utilize cognitive screening of adults undergoing CI evaluation as a tool to direct further comprehensive cognitive evaluation but not to limit cochlear implant candidacy

***Level of Evidence -** Level V

***Indicate IRB or IACUC :** Medical University of South Carolina IRB #Pro00073019, approved 12/20/2017

Further Evidence for Individual Ear Consideration in Cochlear Implant Candidacy Evaluation

Ankita Patro, MD, MS; Nathan R. Lindquist, MD; Jourdan T. Holder, AuD, PhD
Kareem O. Tawfik, MD; David S. Haynes, MD, MMHC
René Gifford, PhD; Elizabeth Perkins, MD

Objective: To report speech and quality-of-life outcomes after cochlear implantation (CI) for asymmetric hearing loss (AHL) and assess the influence of contralateral hearing.

Study Design: Retrospective review.

Setting: Tertiary referral center.

Patients: 168 adults undergoing CI for AHL from 2015-2020. Candidacy included pure-tone average (PTA) $\geq$ 70 dB HL and AzBio in quiet $\leq$ 60% in the implanted ear and AzBio in quiet > 40% in the contralateral ear.

Main Outcome Measures: PTA; CNC, AzBio scores; speech, spatial and qualities of hearing scale (SSQ-12).

Results: Mean preoperative PTA and AzBio in the implanted and contralateral ears were 85 and 67 dB HL and 22% and 69%, respectively. Average CNC in the implanted ear increased from 17% preoperatively to 45% ($p<0.0001$) at 6 months and 49% ($p<0.0001$) at 12 months. Mean AzBio in the implanted ear improved from 22% preoperatively to 60% ($p<0.0001$) at 6 months and 64% ($p<0.0001$) at 12 months. AHL patients demonstrated significant improvement in all SSQ-12 domains at 6 and 12 months. When comparing patients with preoperative contralateral AzBio above 60% versus 41-60%, no significant differences existed in postoperative CNC scores (6-month: 47% vs. 41%, $p=0.08$; 12-month: 50% vs. 46%, $p=0.25$). There were no significant differences in 6-month ($p=0.36$) or 12-month ($p=0.87$) CNC scores between AHL patients and 212 unilateral CI patients with preoperative contralateral AzBio $\leq$ 40%.

Conclusions: CI recipients for AHL derive significant speech and quality of life improvements, supporting individual ear consideration for CI candidacy and patient benefit outside of current Medicare criteria.

Define Professional Practice Gap & Educational Need: AHL is a more recent indication for cochlear implantation. Outcomes data for AHL patients, especially in comparison to traditional candidates, are sparse. These data are important for increasing access to CI care and improving patient counseling with regards to treatment options for AHL.

Learning Objective: To understand average speech and quality-of-life outcomes after cochlear implantation for asymmetric hearing loss as well as to determine the potential impact of contralateral hearing on CI outcomes.

Desired Result: Providers will have additional knowledge about postoperative speech perception and quality-of-life outcomes in the AHL population. These results can be utilized to support reassessment of Medicare preoperative CI candidacy criteria to allow more adults to benefit from this technology.

Level of Evidence: Level IV – Historical cohort or case-controlled studies.

Indicate IRB or IACUC: IRB Exempt (211355, Vanderbilt University).

ANS TRAINEE AWARD

Promontory Electrocochleography Recordings to Predict Speech-Perception Performance in Cochlear Implant Recipients

Amit Walia, MD; Matthew A. Shew, MD; Shannon M. Lefler, AuD
Cameron C. Wick, MD; Nedim Durakovic, MD
Jacques A. Herzog, MD; Craig A. Buchman, MD

Objective: To determine the relationship of electrocochleography (ECochG) responses measured on the promontory with responses measured at the round window (RW) and various intracochlear sites. Also, verify that promontory ECochG responses correlate with postoperative speech-perception performance using the cochlear implant (CI).

Study Design: Prospective cohort study

Setting: Tertiary referral center

Patients and Interventions: Ninety-six adult CI recipients with no cochlear malformations or prior otologic surgery

Main Outcome Measures: Acoustically-evoked ECochG responses were measured intraoperatively at both extracochlear and intracochlear locations. ECochG total response (ECochG-TR), a measure of residual cochlear function, was calculated by summing the fast Fourier transformation amplitudes in response to a range of frequency stimuli (250Hz–2kHz). Speech-perception performance (CNC) was measured at 6-months.

Results: There were strong linear correlations for promontory ECochG-TR with the ECochG-TRs measured at the RW (r = 0.95; p<0.0001), just inside scala tympani (r = 0.91; p<0.0001), and after full insertion (r = 0.83; p<0.0001). For an individual subject, the waveforms of the ECochG response were similar in character across all positions; however, the response amplitude increased from promontory to RW (~1.4-fold) to just inside scala tympani (~2-fold), with the largest response at full insertion (~2.5-fold). RW ECochG-TR independently explained 61.0% of the variability (r^2) in CNC at 6 months.

Conclusions: Promontory ECochG recordings are feasible in most CI recipients and explain a substantial portion of the variability in CI performance. These findings are a critical step in supporting translation of trans-tympanic ECochG into the clinic preoperatively to help predict postoperative CI performance.

***Professional Practice Gap & Educational Need:** Recognizing factors that affect CI performance at a preoperative candidacy level may have drastic implications on post-CI aural rehabilitation, device design and fitting, and surgical technique. Age at implantation, duration of hearing loss, and electrode positioning within the cochlea together explain less than 25% of the variability in speech-perception scores in quiet, making these poor indicators. ECochG responses, prior to implantation at the RW, account for ~50% of the variability in the same speech-perception measures. Prior studies have not investigated whether ECochG responses can be measured on the promontory, a more clinically accessible site.

***Learning Objective:** To determine whether acoustically-evoked ECochG responses measured on the promontory correlated with responses measured at other extracochlear and intracochlear sites. To assess whether ECochG responses can be used to explain the variability in postoperative CI performance.

***Desired Result:** Practitioners and researchers will further realize the feasibility and value of performing promontory ECochG recordings in CI patients, including those with no-response audiograms and understand the potential of using these responses to predict CI performance.

***Level of Evidence -** IV

***Indicate IRB or IACUC:** Washington University in St. Louis IRB #202007087.

Prospective, Observational Assessment of Factors Influencing Improvement of Quality of Life after Cochlear Implantation

Amit Walia, MD; James Bao, BS; Noel Dwyer, AuD
Susan Rathgeb, AuD; Jacques A. Herzog, MD
Craig A. Buchman, MD; Cameron C. Wick, MD

Objective: To prospectively measure the impact of cochlear implantation on quality of life using the novel Cochlear Implant Quality of Life (CIQOL-35) questionnaire. To determine audiologic and demographic factors influencing the CIQOL-35.

Study Design: Prospective observational study.

Setting: Tertiary referral center.

Patients: Thirty patients aged 31 to 96 years with sensorineural hearing loss

Interventions: Unilateral cochlear implantation

Main Outcome Measures: CIQOL-35 global score pre- and 6-months post-implantation. Physical function measured by the short form survey (SF-36), audiologic, and demographic variables.

Results: Speech-perception performance improved significantly across all patients with a mean CNC improvement of 45.1% (95% CI, 34.1 to 56.1). Likewise, the CIQOL-35 showed significant improvement from pre-implantation to 6-months post-activation with a mean difference of 14.9 points (95% CI, 11.3 to 18.5; $p < 0.0001$). Improvement in CIQOL-35 correlated linearly with age ($r = -0.63$; $p = 0.0004$) and improvement in CNC score ($r = 0.64$; $p = 0.0003$). Physical functional status, device usage, and performance in noise did not significantly correlate with CIQOL-35 global score outcomes ($p > 0.05$). Multivariate modeling using age and change in CNC score explained 64% of the variability measured by the CIQOL-35 global score.

Conclusions: This study is novel for pre- and post-implantation usage of the CIQOL-35. Cochlear implantation can be strongly recommended, not only for hearing rehabilitation, but also to improve quality of life. However, younger patients and those with a greater improvement in speech-perception performance are more likely to achieve a greater quality of life benefit.

***Professional Practice Gap & Educational Need:** Quality of life with cochlear implantation is perhaps the most important clinical outcome measure. Prior to the psychometrically validated CIQOL-35, there was poor correlation between patient reported outcomes and commonly obtained demographic variables or speech-perception outcomes. This study prospectively utilizes the CIQOL-35 to measure the quality-of-life effect size after implantation as well as determine which factors may influence CIQOL-35 outcomes.

***Learning Objective:** To understand quality of life improvement in patients after receiving cochlear implants. To assess the audiologic and demographic variables that contribute to the improvement in quality of life after cochlear implantation (CI).

***Desired Result:** Despite at times limited improvement in speech perception performance, practitioners and researchers will realize that the majority of patients receive significant improvement in quality-of-life metrics as measured by the CIQOL-35 global score after CI. Younger patients and those with a greater improvement in speech-performance metrics are more likely to experience a greater cochlear implant-specific quality of life improvement after CI.

***Level of Evidence -** IV

***Indicate IRB or IACUC:** Washington University in St. Louis IRB #201911035; 11/11/19

In Silico Localization of Perilymph Proteins Enriched in Meniere's Disease Using Mammalian Cochlear Single Cell Transcriptomics

Alexandra M. Arambula, MD; Shoujun Gu, PhD; Athanasia Warnecke, MD
Hinrich Staecker, MD, PhD; Michael Hoa, MD

Hypothesis: Proteins enriched in the perilymph proteome of Meniere's disease (MD) patients may implicate cochlear structures and cell types. Utilizing single cell transcriptome datasets from the mammalian cochlea, we hypothesize that these enriched perilymph proteins will localize to specific cochlear cell types.

Background: The limited understanding of human inner ear pathologies and their associated biomolecular variations hinder efforts to develop disease-specific diagnostics and therapeutics. Perilymph sampling and analysis is now furthering characterization of the cochlear microenvironment. Recently, enriched inner ear protein expression has been shown in patients with MD compared to patients with other inner ear diseases. Localizing expression of these proteins to cochlear cell types can further our knowledge of potential disease pathways and subsequent development of targeted therapeutics.

Methods: We compiled previously published data regarding differential perilymph proteome profiles amongst patients with MD, otosclerosis, EVA, SSNHL, and hearing loss of undefined etiology (controls). Enriched proteins in MD were cross-referenced against published single-cell/single-nucleus RNA-seq datasets to localize protein expression to specific cochlear cell types. Datasets included postnatal day 7 and 15 mouse organ of Corti and adult mouse spiral ganglion neurons, Schwann cells, and the stria vascularis.

Results: In silico analysis of single cell transcriptomic datasets localizes enriched perilymph proteins to specific inner ear cell types. We have also identified potential genetic targets within these cochlear regions, which may guide development of future treatment for MD.

Conclusions: Perilymph proteins enriched in MD are expressed by specific cochlear cell types based on in silico localization, potentially facilitating development of disease-specific diagnostic markers and therapeutics.

Define Professional Practice Gap & Educational Need: We lack knowledge of molecular processes and their pathologic variations within the inner ear, specifically as this relates to Meniere's disease (MD). We similarly lack reliable disease-specific diagnostic markers and therapies. Perilymph analysis has demonstrated multiple potential disease-specific biomarkers, though the cochlear cell type(s) producing these biomolecules remains to be elucidated.

Learning Objective: To appreciate: 1) that differentially enriched perilymph proteins in patients with MD localize to specific cochlear cell types based on in silico data analysis with previously published transcriptome datasets from the inner ear; 2) how this data can guide identification of potential genetic/protein targets for diagnosis and treatment of MD.

Desired Result: The audience will better understand perilymph protein expression unique to MD and these various proteins' localization to specific cells within the cochlea. We also aim for the audience to appreciate how this information can guide discovery of potential disease-specific diagnostics and therapeutics.

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

Indicate IRB or IACUC: Exempt

Hearing Aid Prevalence and Reported Hearing Difficulty in Americans with Subclinical Hearing Loss

Jacqueline M. Dragon, BA; Alexandria L. Irace, BA
Maeher R. Grewal, BS; Justin S. Golub, MD, MS

Objective: Subclinical hearing loss (SCHL, defined as a 4-frequency pure tone average [PTA] of 1-25 dB) has recently been associated with depressive symptoms and cognitive decline. This suggests that the common 25 dB adult cutpoint for normal hearing may not be sensitive enough. We aim to characterize real-world hearing difficulties, as measured by hearing aid use and self-reported hearing difficulty, among individuals with SCHL and borderline hearing loss (PTA4 of 21-25 dB).

Study Design: Analysis of biennial cross-sectional epidemiological survey (NHANES 1999-2012, 2015-2016)

Setting: Community

Subjects: Non-institutionalized U.S. citizens ≥12 years old, n=19,259

Main Outcome Measures: PTA4 (500, 1000, 2000, 4000 Hz), PTAhf (6000, 8000 Hz), subjective difficulty hearing, and hearing aid use

Results: Nearly 1 million Americans with SCHL wore hearing aids (~795,000, or 0.35%, 95% CI=0.23%-0.54%). 15.0% (13.9-16.3%; or 34.1 million) of those with SCHL reported at least "a little trouble" hearing, which increased to 41.8% for those with borderline hearing loss. Among those with SCHL who wore hearing aids, 80.8% had an abnormal PTAhf (i.e. PTAhf>25 dB). Among those with SCHL who reported at least "a little trouble" hearing, 50.4% had an abnormal PTAhf.

Conclusions: Despite hearing loss traditionally being defined by PTA4≤25, nearly 1 million adults and adolescents with SCHL (PTA4 of 1-25 dB) wore hearing aids, and nearly half with borderline HL (PTA4 of 21-25 dB) had subjective difficulty hearing. To better reflect real-world difficulties, stricter definitions of hearing loss should be explored, including a lower cutpoint for the PTA4 or by using the more sensitive PTAhf.

***Professional Practice Gap & Educational Need:** SCHL has recently been associated with cognitive decline and depressive symptoms. This raises the question of whether the traditional definition of hearing loss may be too insensitive. It is unclear whether those with so-called SCHL are truly asymptomatic.

***Learning Objective:** To understand the prevalence of hearing aid use and reported difficulty hearing among those with SCHL and borderline hearing loss.

***Desired Result:** Practitioners will understand that a substantial fraction of those with SCHL have reported difficulty hearing and a meaningful absolute number wear a hearing aid. Practitioners should recognize that the 25 dB PTA4 cutoff commonly used to define hearing loss may be too insensitive.

***Level of Evidence -** III

***Indicate IRB or IACUC:** Exempt

Otologic Manifestations after COVID-19 Vaccination: Long-term Symptomatic and Audiometric Follow-up

Helena Wichova, MD; Mia E. Miller, MD
John W. House, MD; M. Jennifer Derebery, MD

Objective: After reports of increased incidence of otologic manifestations after COVID-19 vaccinations, we present follow-up for newly symptomatic patients with longer follow-up.

Study Design: Retrospective chart review

Setting: Specialized otology ambulatory practice

Patients: All patients with available diagnostic codes, COVID-19 questionnaires and clinical follow-up of at least 30 days after initial visit

Interventions: Review of clinical treatment

Results: Out of 57 patients with reported post-vaccination symptoms, 31 (14 female and 17 male) had follow-up of at least 30 days post-treatment. The mean age was 56.6±14.5 years old. 16 received Moderna and 15 received Pfizer vaccine. At initial presentation, 17 patients had underlying otologic diagnosis, with 5 having active Meniere's disease or Autoimmune Inner Ear Disease. Initially, 24 patients (77.4%) noted hearing loss, 16 (61.3%) tinnitus, 9 (29%) dizziness, and 5(16%) vertigo. At last follow-up, symptoms resolved in 2 patients, improved in 17, worsened in 1, and no changes were noted by 11. Hearing loss (n=12) was the most commonly reported residual symptom followed by tinnitus (n=10). When available the initial and follow-up affected ear pure tone averages and word recognition scores were 49 dB/67% and 43 dB/72%, respectively. There were no abnormal retrocochlear findings on MRIs.

Conclusions: There are no definite correlations between COVID-19 vaccination and new or worsened otologic symptoms. Vaccinated patients with new or exacerbated otologic symptoms frequently improved over time. Cases of post-vaccination otologic symptoms should be reported to the CDC Vaccine Adverse Event Reporting System (VAERS) and patients should undergo prompt otolaryngology referral.

Professional Practice Gap & Educational Need: There is no long-term follow-up regarding initial reports of hearing loss and other otologic manifestations after covid vaccination. We present our data of patients who were monitored for more than 30 days (mean 101 day follow-up).

Learning Objective: To investigate the clinical and audiologic outcomes after vaccination.

Desired Result: To educate the community on no obvious correlation between COVID-19 vaccination and otologic manifestations.

Level of Evidence: Level VI

IRB: Approved, WCG IRB (#20203338).

White Matter Hyperintensities in Patients with Sudden Sensorineural Hearing Loss

Mehdi Abouzari, MD, PhD; Arash Abiri, BS; Ariel Lee, BS; Kotaro Tsutsumi, BA
Meleeka Akbarpour, MS; Beenish Patel, MS; Hamid R. Djalilian, MD

Objective: To compare white matter hyperintensities (WMHs) on T2-weighted magnetic resonance imaging (MRI) of patients with sudden sensorineural hearing loss (SSNHL) with an age-matched control group.

Methods: T2-weighted MRI scans of 150 patients with SSNHL were assessed for WMHs and compared with the data of 150 healthy age-matched adults. Assessments of WMHs included independent grading of deep white matter hyperintensities (DWMHs) and periventricular hyperintensities (PVHs). WMH severity was visually rated using Fazekas and Mirsen scales by two observers independently.

Results: Fazekas grades for PVHs ($p < 0.001$) and DWMHs ($p < 0.001$) of SSNHL patients were found to be significantly greater than those of healthy participants. The average Mirsen grades for DWMHs of healthy and SSNHL patients were evaluated to be 0.373 ± 0.550 and 2.140 ± 0.859, respectively. Mirsen grades for DWMHs of SSNHL patients were found to be significantly greater ($p < 0.001$) than those of healthy participants. The Mirsen scale was found to have higher sensitivity ($p < 0.001$) than the Fazekas scale in grading PVHs and DWMHs. No significant difference ($p = 0.24$) was found in specificities between the two scales.

Conclusions: Patients with sudden hearing loss have a much higher likelihood of having periventricular and deep white matter hyperintensities compared to age-matched controls. These findings indicate that sudden hearing loss patients are more likely to have microvascular changes in the brain, which may indicate a vascular origin to sudden sensorineural hearing loss.

REQUIRED:
Define Professional Practice Gap & Educational Need: The pathophysiology and management of SSNHL has remained subject of debate. Further investigation into discovering new and improved management solutions for better treating SSNHL has been called. For this reason, a need to educate otolaryngologists on new hypotheses for SSNHL etiology leading to new treatment strategies is warranted.

Learning Objective: To propose a new vascular etiology in SSNHL patients to ANS members which can relate this entity with other complex neurovascular disorders such as migraine. This can imply that SSNHL may have an underlying vascular or neurogenic inflammation pathophysiology similar to migraine offering new treatment strategies for SSNHL.

Desired Result: Informing neurotologists of a possible new pathophysiology for SSNHL that can be a stepstone for future treatment options in patients with SSNHL.

Level of Evidence - III

Indicate IRB or IACUC: The study has IRB approval from the UC Irvine

Cochlear Implantation and Programing Considerations in Children with Abnormal Cochleovestibular Nerves: The Project Talk Experience

Briana K. Ortega, MD; Omid Moshtaghi, MD, MS
Eric Y. Du, BS; Joan Hewitt, AuD; Elina Kari, MD

Objective: Describe the nuances regarding cochlear implant(CI) fitting and programming in children with cochleovestibular nerve(CVN) abnormalities.

Study Design: Retrospective case series examining patients with abnormal CVN with marginal benefit from CI, followed by reprogramming by an audiologist.

Setting: Outpatient.

Patients: Pediatric CI patients with abnormal CVNs and with unsatisfactory hearing outcomes.

Interventions: Following CI, patients underwent reprogramming and adjustment with an audiologist.

Main Outcome Measures: Clinical features, hearing data, imaging, and CI settings.

Results: Nine CI patients(16 ears) were included. Imaging data was available for four patients(7 ears). Mean imaging age was 8 months(range 4-12). Five had an abnormal modiolus and all had a normal cochlea. Six (85%) ears had an absent CVN within the internal auditory canal. Mean implantation age was 40 months (range 12-138). Nine ears had preprogramming by an outside audiologist prior to reprogramming by audiologist (J.H.). In all patients, all electrodes were activated across all frequencies. Following reprogramming, all CIs had stimulation reduced. Five (56%) had a pulse-width reduction. Additionally, 5(28%) had all electrodes activated, 6(33%) had low frequencies deactivated, 4(22%) had high frequencies deactivated, and 1(6%) had a mixture of frequencies deactivated. Following reprogramming, hearing perception was available for 8 CIs. The average speech recognition threshold was 35 (range 25-50). An open-set word list was used for 6(75%) ears. Word percentile perception was over 50% in 3(38%) CIs.

Conclusions: All patients benefited from CI, despite many having an absent CVN. Aside from the surgical pitfalls associated with implantation, this subset of patients may require nontraditional CI programming with specific electrode frequency activation to maximize hearing benefit.

Define Professional Practice Gap & Educational Need: The canonical thought is that CIs are ineffective or have unpredictable response in patients with abnormal CVN and hearing loss; thus, these patients often do not undergo implantation. We present a case series demonstrating that bilateral implantation and CI programing strategies improved hearing outcomes in this population.

Learning Objective: Illustrate that pediatric patients with abnormal CVNs can benefit from CIs, and clarify the nuances in their CI settings.

Desired Result: Encourage physicians and audiologists encountering patients with abnormal CVNs to consider bilateral cochlear implantation, and a corresponding reprograming methodology. We hope to bring awareness to the CI programming modifications specific to this population.

Level of Evidence - Level V

Indicate IRB or IACUC: University of California, San Diego IRB #190938: Congenital hearing loss

HiRes Ultra Series Recall: Failure Rates and Revision Speech Recognition Outcomes

Nathan R. Lindquist, MD; Nathan D. Cass MD; Ankita Patro MD
René H. Gifford, PhD; David S. Haynes MD, MMHC
Elizabeth L. Perkins MD; Jourdan T. Holder, AuD, PhD

Objective: To report Advanced Bionics Ultra and Ultra 3D (V1) cochlear implant (CI) electrode failures and revision speech recognition outcomes for patients at a large CI program.

Study Design: Retrospective case series.

Setting: Tertiary referral center.

Patients: Patients who underwent cochlear implantation with HiRes™ Ultra (v1) or Ultra 3D (v1).

Interventions: CI, documented device failure, speech recognition testing.

Main Outcome Measures: Failure rate, revision surgery, speech recognition scores.

Results: As of September 21, 2021, 65 (21.1%) of the 308 implanted devices were known failures, with 61 (19.8%) definitively associated with the recent voluntary field corrective action (FCA). The overall failure rate for adults (18.6%) was lower than the pediatric (26.9%) failure rate ($p = 0.127$). Average time to device failure was 2.2 ± 1.1 years. 47 patients (77%) completed revision surgery. For adults, there was no significant difference ($p = 0.96$) between best pre-revision speech recognition scores (median CNC = 62%, SD = 23%) and most recent post-revision performance (median CNC = 54%, SD = 27%). 79% of patients recovered to within 15 percentage points of their pre-revision scores at last follow-up (median = 7.1 months).

Conclusions: A significant number of patients were identified with hard failures of the Ultra (v1) and Ultra 3D (v1) devices. This may be due to our institution's diligent use of electrical field imaging (EFI) to confirm device failure, which is not ubiquitously available. Despite the high failure rate, the majority of patients achieve speech recognition scores similar to pre-failure performance after revision CI surgery.

***Professional Practice Gap & Educational Need:** Manufacturer initiated CI device recalls are relatively uncommon, with the majority of reliability and failure data only available through post-explant data through manufacturer device analysis and reliability reporting. Consequently, clinical data regarding active recalls and device failures may improve patient counseling with regards to failure rate and post-revision speech recognition outcomes.

***Learning Objective:**
For the recent HiRes Ultra and Ultra 3D series recall:

1. Quantify and characterize such CI failures at a large CI center, and
2. Understand the post-revision speech recognition outcome scores for improved clinical decision making and patient counseling.

***Desired Result:** Surgeons and audiologists will use these clinical data from the recent HiRes Ultra and Ultra 3D series to quantify and characterize this type of CI failure and implement their knowledge regarding post-revision speech recognition outcome scores for improved clinical decision making and patient counseling.

***Level of Evidence -** Level V

***Indicate IRB or IACUC :** Vanderbilt University Medical Center IRB# 211355

Image Quality and MRI Artifact Reduction of a Multi-Magnet Cochlear Implant

Arianna R. Winchester MD; Emily Kay-Rivest, MD, MSc; Mary Bruno
Mari Hagiwara, MD; Daniel Jethanamest, MD, MSc

Objective: To determine if metal reduction MRI sequences and changes in implant placement minimize artifact from cochlear implants (CI) and improve visualization of intracranial structures.

Study Design: Cadaveric study.

Setting: Tertiary referral center.

Patients: Five cadaveric heads.

Interventions: Specimens were implanted with Advanced Bionics HiRes Ultra3D devices at nasion-external ear canal (EAC) angles of 90, 120, 160 degrees; and distances from the EAC of 9 or 12cm. Standard brain/internal auditory canal (IAC) sequences with metal artifact reducing technique were acquired in a 1.5-T scanner.

Main Outcome Measures: The primary outcome was visibility of 14 intracranial structures graded on a 4-point scale (1: structures <50% visible, 2: >50% visible with some areas nonvisible from artifact, 3: artifact present but adequate for diagnosis, and 4 high-quality). Scores were determined by an experienced head and neck radiologist and compared with one-way ANOVA.

Results: Imaging sequences included axial 5mm whole-brain turbo spin echo (TSE) T2 and fluid-attenuation inversion recovery high bandwidth, axial 5mm whole-brain slice-encoding metal artifact correction (SEMAC), axial IAC constructive interference in steady state (CISS), and axial 3mm T1 IAC with and without fat saturation. In all cases, SEMAC (mean:3.7,SD:0.7) was superior to TSE (mean:3.5,SD:0.8) for ipsilateral cortex and brainstem/cerebellum, and equivalent for the inner ear and cerebellopontine angle. CISS and T1 with fat saturation were poor for ipsilateral structures ($p=0.03$, $p<0.01$). The 120°/9cm position afforded visualization of ipsilateral structures except the brainstem/cerebellum, where 120°/12cm was best ($p<0.01$).

Conclusions: SEMAC sequence provides artifact suppression while retaining excellent image quality. Different placement angles didn't confer improvement in visualization, although placement distances provided slight advantages for some structures.

***Professional Practice Gap & Educational Need:** Many patients with CIs require advanced imaging after implantation, whether related to their hearing loss or another indication. With the prevalence of MRI-compatible devices, improving the quality of neuro imaging obtained with the device in place in these patients is important.

***Learning Objective:** Review recent technological advances in MRI metal artifact suppression for CIs. Determine an improved proposed MRI protocol for artifact reduction and discuss the role of implant positioning for a contemporary MRI compatible CI.

***Desired Result**: Discuss how to adapt implantation techniques to suit potential future imaging needs and develop a CI-specific MRI protocol.

***Level of Evidence -** Level III

IRB: Exempt

Twelve-Month Outcomes of Simultaneous Translabyrinthine Resection and Cochlear Implantation

Karl W. Doerfer, MD; Christian G. Fritz; Sandra L. Porps, AuD; Christopher A. Schutt, MD
Robert S. Hong, MD, PhD; Jeffrey T. Jacob, MD; Seilesh C. Babu, MD

Objective: Describe outcomes in patients undergoing simultaneous translabyrinthine resection of cerebellopontine angle (CPA) tumors and cochlear implantation (CI) 12 months following surgery.

Study Design: Prospective, nonrandomized study

Setting: Tertiary care neurotology center

Patients: Patients undergoing simultaneous translabyrinthine resection of CPA tumors and CI between 1/2019 and 1/2020.

Interventions: CI

Main Outcome Measures: AZ Bio Sentence Test; Consonant Nucleus Consonant (CNC) testing; Speech, Spatial and Qualities of Hearing Scale (SSQ) scores; Tinnitus Handicap Inventory (THI) scores.

Results: Thirteen patients underwent simultaneous CI with translabyrinthine tumor resection (vestibular schwannoma: 12; meningioma: 1). AZ Bio, CNC, SSQ, and THI scores were obtained at 1, 3, 6 and 12 months postoperatively. All modality measurements for AZ Bio testing showed statistically significant improvement at 3 months (In Quiet, $p = 0.039$; +10 SNR, $p = 0.021$; +5 SNR, $p = 0.003$), with the largest gains seen in +5 SNR scores (mean: +15%, range: +3-52%). There was no significant change in AZ Bio scores between 3 and 12 months, suggesting durable improvement. CNC test results showed statistically significant improvement at 3 months (mean: +27%, $p = 0.016$). Overall, comparing preoperative CNC results to those at 12 months revealed a statistically significant improvement (mean: +35%, $p = 0.004$). SSQ Speech subscore showed a statistically significant improvement at the 3 months ($p = 0.023$). This initial improvement was not maintained at 12 months ($p = 0.171$). THI scores showed statistically significant improvement at 3 months (mean: -23, $p = 0.002$). This initial improvement was maintained at the 12-month timepoint, as there was no significant change between 3 and 12 months ($p = 0.958$). Overall, comparing pre-operative THI scores to those at 12 months revealed a statistically significant improvement (mean: -22, $p = 0.014$).

Conclusions: Simultaneous CI with translabyrinthine tumor resection provides durable improvement in speech perception and tinnitus reduction one year following surgery.

***Professional Practice Gap & Educational Need:** Simultaneous CI and translabyrinthine tumor resection is an evolving strategy for managing expected hearing loss. Long-term outcomes are not well described in the literature.

***Learning Objective:** Participants will understand the potential durable hearing benefits provided by simultaneous cochlear implantation and translabyrinthine tumor resection.

***Desired Result:** For participants to incorporate consideration of simultaneous CI and translabyrinthine resection when managing patients with vestibular schwannoma or other CPA lesions.

***Level of Evidence:** III

***Indicate IRB:** #1349609, Ascension, Southeast Michigan

Fluorescein-guided Microsurgical Resection of Vestibular Schwannoma: A Prospective Feasibility Study

Stephen A. Chan, MD; Robert J. Macielak, MD; Brian A. Neff, MD; Colin L.W. Driscoll, MD
Jamie J. Van Gompel, MD; Michael J. Link, MD; Matthew L. Carlson, MD

Objective: To evaluate the optimal dose and timing of administration of fluorescein sodium (FS) for selective fluorescence of vestibular schwannoma (VS) during microsurgery with the YELLOW 560 nm microscope filter (YE560) and characterize the benefit, as determined from surgeon assessments.

Study Design: Prospective cohort study

Setting: Tertiary referral center

Patients: Adult patients undergoing VS microsurgery

Interventions: Intraoperative intravenous administration of FS and visualization with the YE560.

Main Outcome Measures: Time to peak fluorescence, duration of fluorescence, correlation of fluorescence of VS with electrostimulation and white light microscopy visual assessment, and likelihood of surgeons to use FS with the YE560 in future cases.

Results: Novel use of FS and YE560 during microsurgery achieved selective fluorescence of VS with capabilities to differentiate nerve fascicles and tumor. Nuances of FS administration and timing are discussed. Correlation of differential uptake of FS by VS with electrostimulation and white light microscopy was judged to be high by surgeons. Representative images and videos utilizing YE560 and FS are presented.

Conclusions: FS and YE560 may be used in VS microsurgery to visually differentiate VS from surrounding nerves and evaluate for residual tumor capsule.

Professional Practice Gap & Educational Need: FS has been used in the neurosurgical resection of intracranial neoplasms but has only been reported in 2 VS cases. There is educational need in understanding how FS can be routinely implemented in VS microsurgery.

Learning Objective: Attendees will become familiar with a protocol for safe and effective use of IV FS in VS microsurgery and will understand the tissue differentiation achieved.

Desired Result: Attendees will consider the use of fluorescence in VS microsurgery.

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

Indicate IRB or IACUC: Approved (2/21/20), IRB #19-005178, Mayo Clinic

Spontaneous Volumetric Tumor Regression During Wait-and-Scan Management of 952 Sporadic Vestibular Schwannomas

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Jacob B. Hunter, MD; Christine M. Lohse, MS
Douglas Kondziolka, MD, MSc; Matthew L. Carlson, MD

Objective: Spontaneous tumor shrinkage during wait-and-scan management of sporadic vestibular schwannoma is generally considered an uncommon phenomenon. However, most data informing this understanding stem from single-slice linear tumor measurements taken in the axial imaging plane. The objective of current work was to characterize the regression capacity of sporadic vestibular schwannomas using volumetric tumor measurements.

Study Design: Retrospective cohort study using slice-by-slice, three-dimensional volumetric tumor measurements on serial MRI studies.

Setting: Three tertiary referral centers.

Patients: Patients with sporadic vestibular schwannoma.

Interventions: Wait-and-scan.

Main Outcome Measures: Regression-free survival rates where regression is defined by a decrease of ≥20% of the tumor volume.

Results: Among 952 patients undergoing observation, 123 experienced volumetric tumor regression following diagnosis at a median of 1.2 years (IQR 0.6-2.9). Volumetric regression-free survival rates (95% CI; number still at-risk) at 1, 3, and 5 years following diagnosis were 94% (92-95; 662), 86% (83-89; 275), and 78% (73-82; 132), respectively. Neither age at diagnosis (HR 1.05; p=0.54) nor volume at diagnosis (HR 0.94; p=0.31) was significantly associated with tumor regression. Among 405 patients who demonstrated an initial period of tumor growth but continued wait-and-scan management, 48 experienced subsequent volumetric regression at a median of 1.2 years (IQR 0.8-2.6) following initial growth. Subsequent volumetric regression-free survival rates at 1, 3, and 5 years following initial growth were 94% (92-97; 260), 84% (79-89; 99), and 75% (67-83; 43), respectively.

Conclusions: Spontaneous regression in volumetric tumor size during wait-and-scan management occurs more frequently than suggested by prior studies using linear tumor measurements and can even occur following previous episodes of documented tumor growth.

Professional Practice Gap & Educational Need: Current understanding of the natural history of sporadic vestibular schwannoma growth during observation is predominantly informed by studies employing single-slice linear tumor measurements in the axial imaging plane. The current study examines the natural history of sporadic vestibular schwannoma in a large cohort of patients at three tertiary referral centers across the United States using sensitive slice-by-slice volumetric measurements, showing that more tumors exhibit periods of shrinkage than previously reported.

Learning Objective: Describe the capacity for sporadic vestibular schwannomas to undergo periods of tumor shrinkage following diagnosis, as well as following periods of previously documented growth in patients who elected continued observation.

Desired Result: When considering definitive treatment of sporadic vestibular schwannoma during wait-and-scan management, practitioners would account for the potential that not all tumors that exhibit growth continue to grow, and tumors can regress in size during continued observation following previous episodes of documented growth.

Level of Evidence: III

Indicate IRB or IACUC: IRB approval was obtaining from each participating center prior to data collection (IRB numbers,15-008224, 112016-040, and S13-00063, respectively).

Systematic Review and Meta-Analysis for Surgery Versus Stereotactic Radiosurgery for Jugular Paragangliomas

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Tracy Truong, MS; Hwanhee Hong, PhD
Maragatha Kuchibhatla, PhD; David M. Kaylie, MD

Objective: Comprehensively analyze tumor control and treatment complications for jugular paraganglioma patients undergoing surgery versus stereotactic radiosurgery (SRS)

Data Sources and Study Selection: EMBASE, Medline, and Scopus were searched for English and Spanish manuscripts from 1/1/1995-1/1/2019 for studies reporting tumor control and treatment side effects regarding patients with jugular paraganglioma treated with surgery or SRS.

Main Outcome Measures: Short-term and long-term tumor recurrence, and post-intervention complications

Data Synthesis, and Results: We identified 10,952 original abstracts, 705 eligible studies, and 107 studies for final data extraction. There were 3,498 patients—2,215 surgical patients and 1,283 SRS patients. Bayesian meta-analysis was applied to the extracted data, with tau measurements for study heterogeneity. SRS tumors were larger (3.9 cm3 vs 8.1 cm3). Meta-analysis results demonstrated low rates of long-term recurrence for both modalities (surgery: 15% recurrence, SRS: 7%), with SRS demonstrating lower rates of post-intervention CSF leak, dysphagia, and Vll, lX, X, Xl, or Xll palsies.

Conclusions: This is the largest analysis of jugular paraganglioma treatment with surgery or SRS. It demonstrates excellent tumor control by both modalities, and lower intervention morbidities with SRS for many complications.

Professional Practice Gap & Educational Need: Provide an updated systematic review and meta-analysis for surgical versus SRS treatment of jugular paraganglioma.

Learning Objective: Provide high level evidence regarding outcomes and complications for surgical and SRS treatment of jugular paragangliomas.

Desired Result: Analysis of tumor control and outcomes for treatment of jugular paragangliomas substantiated by a large systematic review and meta-analysis.

Level of Evidence - Level III

Indicate IRB or IACUC : Deemed exempt by Duke IRB

Electrically Evoked Vestibulo-ocular Reflex in a Patient with a 23-year History of Bilateral Vestibular Hypofunction

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Kelly E. Lane; Celia Fernandez Brillet, BS; John P. Carey, MD
Charles C. Della Santina, MD, PhD

Objective: To characterize the early eye movement responses to vestibular stimulation in a patient implanted with an investigational vestibular implant 23 years after onset of ototoxic bilateral vestibular hypofunction (BVH).

Study Design: Case Report

Setting: Tertiary care center as part of a first-in-human clinical trial.

Patients: 1

Interventions: Unilateral vestibular implantation with an investigational multichannel vestibular implant in a 55-year-old male with a well documented 23-year history of aminoglycoside induced bilateral vestibular hypofunction.

Main Outcome Measures: Electrically evoked vestibulo-ocular reflexes (eeVOR).

Results: Three-dimensional video-oculography during canal specific stimulation shows eeVOR elicited eye movements that approximately aligned with each semicircular canal stimulated. The magnitude of the eeVOR response increased with increasing stimulus pulse frequency and current amplitude. Response alignment and magnitude were similar to those observed for patients who underwent vestibular implantation less than ten years after BVH onset.

Conclusions: Vestibular implantation and electrical stimulation of the semicircular canal afferent nerves can drive canal-specific eye movement responses in a patient with >20 years of vestibular loss.

***Professional Practice Gap & Educational Need:** Limited understanding of the use of vestibular implants in patients with long-term bilateral vestibular hypofunction.

***Learning Objective:** Improved understanding of which patients may benefit from a vestibular implant.

***Desired Result:** Demonstrate that vestibular implantation and stimulation can drive canal-specific eye movements in patients with a prolonged duration of vestibular loss.

***Level of Evidence -** V

***Indicate IRB or IACUC :** Johns Hopkins School of Medicine IRB: NA_00051349

ANS TRAINEE AWARD

Examination of Saccade Patterns in Compensated and Uncompensated Unilateral Vestibular Hypofunction

Hunter L. Elms, MD; Kristal M. Riska, PhD, AuD

Objective: To determine if corrective saccade patterns during video head impulse testing (vHIT) may provide a biomarker for physiologic compensation relative to rotary chair findings in patients with unilateral vestibular hypofunction (UVH).

Study Design: Retrospective cohort study

Setting: Tertiary referral center, academic hospital

Patients: 229 Adults >18 years old with evidence for UVH (defined by >25% caloric asymmetry) who also underwent rotary chair and vHIT testing.

Interventions: Vestibular laboratory results were extracted. Patients were characterized as demonstrating evidence for physiologic compensation of eye movements if there was no asymmetry during rotary chair testing, in addition to, an absence of spontaneous and positional nystagmus.

Main Outcome Measures: Corrective saccade parameters (latency, amplitudes, clustering scores)

Results: 36 patients were identified as having an uncompensated UVH, while 193 showed evidence for compensation on rotary chair. Compensated UVH patients had lower dizziness handicap scores relative to uncompensated UVH ($F=4.83$, $p=0.029$). Among patients with corrective saccades during vHIT, there was a difference in overt saccade latency ($F=7.74$, $p=0.006$), and in percent of impulses generating overt corrective saccades ($F=1.50$, $p=0.001$) between uncompensated and compensated patients. Trends toward differences in amplitudes of corrective saccades (covert & overt) and average VOR gain did not reach significance. No differences were seen between group for any covert corrective saccade parameters.

Conclusions: Patients characterized as having a compensated UVH showed statistically significant differences in overt compensatory saccade patterns compared to those with an uncompensated UVH. This may provide evidence for vHIT saccades as a biomarker for compensation status.

***Professional Practice Gap & Educational Need:** The role of corrective saccades as a marker of compensation has not been systematically compared to other measures of compensation in the vestibular laboratory test battery in a large cohort of patients with unilateral vestibular hypofunction.

***Learning Objective:** Describe vHIT corrective saccade patterns based on classification of compensation status using standard clinical laboratory measures.

***Desired Result:** Identification of an objective biomarker of physiologic compensation in UVH on vestibular laboratory testing that is more accessible than rotary chair.

***Level of Evidence -** IV

***Indicate IRB or IACUC :** Exempt

NICHOLAS TOROK VESTIBULAR AWARD

Vestibular Migraine Confounds Management of Superior Canal Dehiscence Syndrome

Miriam R. Smetak, MD, MS; Nathan D. Cass, MD; Nauman F. Manzoor, MD
Kelsey Hatton, AuD, CCC-A; Matthew R. O'Malley, MD
Marc L. Bennett, MD, MMHC; David S. Haynes, MD, MMHC

Objective: To investigate the prevalence of vestibular migraine (VM) in a cohort of patients with radiologic confirmation of superior canal dehiscence (SCD) and to compare management of superior canal dehiscence syndrome (SCDS) in patients with and without comorbid VM.

Study Design: Retrospective review of a SCD database

Setting: University-based tertiary medical center

Patients: 91 patients identified with SCDS from 2008 to 2017

Interventions: None

Main Outcome Measures: Coincidence of VM and SCD, resolution of symptoms

Results: Ninety-one patients with SCD met inclusion and exclusion criteria. VM was diagnosed in 36 (39.6%) patients. Of those receiving medical therapy for VM alone, 5 (45.5%) reported symptom resolution, 5 (45.5%) reported partial improvement, 1 (9.1%) had no change, and none worsened. Fifteen patients (41.7%) were treated with both surgery (for SCD) and medical therapy (for VM). Seven (46.7%) reported symptom resolution, 7 (46.7%) reported partial improvement, and 1 (6.7%) worsened. There was no statistically significant difference in symptom resolution between SCD+VM patients who were treated medically compared with those treated with medical therapy and surgery ($p = 0.95$). There was no significant difference in symptom resolution after surgery between SCD+VM and SCD-only cohorts ($p = 0.29$).

Conclusions: This is the first study describing the incidence of VM in a cohort of patients with SCDS. The symptoms of VM confound those of SCDS and unrecognized or undertreated VM may contribute to surgical failure in SCDS. Therefore, we recommend a high index of suspicion for VM in patients with SCDS and a trial of medical therapy in the setting of suspected VM.

***Professional Practice Gap & Educational Need:** A significant number of patients with SCDS in this cohort have a comorbid diagnosis of VM. Many have persistence of symptoms after surgical correction of SCD. Part of this treatment failure may be related to co-existence of VM in this patient population.

***Learning Objective:** To better understand the patient-specific factors that may lead to failure of surgical treatment for SCD, specifically the high prevalence of comorbid VM.

***Desired Result:** A high level of suspicion should be maintained for the coexistence of VM in patients with radiographic finding of SCD.

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

***Indicate IRB or IACUC:** Vanderbilt University Medical Center, IRB #201632 (approved 08/15/2020).

Different Phenotypes of Vestibular Migraine Based on Visually Enhanced Vestibulo-Ocular Reflex (VVOR) Results

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Natalie Sienko, BS; Adam Gardi, BS; Jeffrey D. Sharon, MD

Objective: Compare the characteristics of patients with vestibular migraine (VM) who had elevated visually enhanced vestibulo-ocular reflex (VVOR) to those of patients with VM who had normal/low VVOR.

Study Design: Retrospective chart review of 217 consecutive English-speaking adult patients between October 2016 and April 2019.

Setting: Tertiary referral center.

Patients: Retrospective cohort of 129 patients who had VVOR testing and a neurotology evaluation

Interventions: We reviewed patients' symptom questionnaires, notes, and vestibular testing results.

Main Outcome Measures: We stratified VM patients by their VVOR results and compared demographics, triggers, associated symptoms, and vestibular test results.

Results: In a cohort of 217, 129 had VVOR testing. Of the 217, 101 patients (47%) had VM. Among 56 VM patients with VVOR testing, 22 patients (39%) had elevated VVOR. Elevated-VVOR VM patients were younger than those with normal/low VVOR (43 vs. 53, p=0.037). A higher proportion of elevated-VVOR VM patients had symptoms triggered by scrolling through a screen (23% vs. 3%, p=0.019). Elevated-VVOR VM patients experienced associated headache (62% vs. 32%, p=0.029) and showed caloric weakness (14% vs.42%, p=0.027) less frequently than normal/low-VVOR VM patients. There was no difference in dizziness handicap index (DHI) between the two groups (45 elevated-VVOR vs. 48 normal/low-VVOR, p>0.05).

Conclusions: Elevated-VVOR VM patients have an earlier onset of symptoms that are triggered more easily by scrolling on a screen than normal/low-VVOR VM patients. The differential rates of associated headaches and caloric weakness suggest that separate processes may mediate the two types of VM.

***Professional Practice Gap & Educational Need:** Although VVOR elevation has been linked with VM, VVOR is not universally elevated in all VM patients. The field has a limited understanding of how elevated-VVOR VM patients may present differently from those with normal/low VVOR.

***Learning Objective:** Describe the different presentations of VM depending on VVOR results.

***Desired Result:** Clinicians will recognize that VVOR can provide an insight into how a particular patient's VM may present.

***Level of Evidence:** III

***Indicate IRB or IACUC:** Approved 2/12/19, UCSF IRB 18-25365

Fixation Stability during Moving Visual Stimulation in Persistent Postural-Perceptual Dizziness

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Shinsuke Ohshima, MD, PhD; Shuji Izumi, MD, PhD
Kuniyuki Takahashi, MD, PhD; Arata Horii, MD, PhD

Objective: To examine the fixation stability in patients with Persistent Postural-Perceptual Dizziness (PPPD) when presented with moving visual stimuli that may exacerbate their vestibular symptoms.

Study Design: Cross-sectional study.

Setting: Tertiary referral center.

Patients: 25 patients with PPPD and 7 with unilateral vestibular hypofunction (UVH) showing chronic vestibular symptoms (> 3 months).

Main Outcome Measures: Three different moving visual stimuli ((1) checkerboard stimulus reversed in contrast at 12 Hz, (2) optokinetic stimulus by black-and-white vertical stripes, (3) radial optic flow stimulus with white dots expanding, and stationary white screen as the control) were presented on a PC screen for 30 seconds each. The subjects were instructed to fixate on the center of the screen, and their fixation stability was measured using a computed eye tracking system. Mann-Whitney U tests were conducted on the number of fixations, mean duration of fixation, saccades count, and bivariate contour ellipse area (BCEA) between the two groups. The BCEA represents the area of the ellipse where the fixation point is detected with a certain probability, thus lower BCEA-values indicate higher/better fixation stability.

Results: The BCEAs during checkerboard and optokinetic stimulation were significantly higher in the PPPD group than those in the UVH group. There were no significant differences in fixation stability during optic flow stimulation and stationary white screen between the two groups.

Conclusions: Patients with PPPD cannot fixate on the center of the screen during checkerboard and optokinetic stimulation, which would result in an exacerbation of vestibular symptoms by moving visual stimuli in PPPD.

Professional Practice Gap & Educational Need: The core vestibular symptoms of PPPD are exacerbated by upright posture/walking, active or passive movement, and exposure to moving or complex visual stimuli, with exacerbation by visual stimulation being the most characteristic. However, the mechanism of exacerbation by visual stimuli is not known. In the first place, there are no reports that have examined the fixation stability in patients with PPPD.

Learning Objective: To learn about the fixation stability unique to PPPD when compared to UVH, which is considered difficult to differentiate from PPPD.

Desired Result: 1. To gain a better understanding of the pathogenesis of PPPD. 2. To improve the ability to differentiate and accurately diagnose PPPD from other chronic vestibular disorders.

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

Indicate IRB or IACUC: This study was approved by the IRB of Niigata University Medical and Dental Hospital on September 14, 2020. (#2020-0242)

Comparison of vHIT with Caloric and Rotary Chair Measurements in Adult Patients with Balance Complaints

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Objective: The role of recently introduced vestibular testing is unclear, and may yield differing results than traditional diagnostics. To reconcile these results, we sought to characterize the relationship between rotary chair (RC), caloric, and video head-impulse (vHIT) measurements in our multidisciplinary vestibular clinic.

Study Design: Retrospective chart review

Setting: Tertiary academic center

Patients: 277 symptomatic adult patients seen in a multidisciplinary vestibular clinic between 1/1/2019 and 12/31/2019.

Interventions/Outcome Measures: Correlations between vHIT, RC, and caloric testing measurements

Results: vHIT gains were more correlated with vestibulo-ocular reflex (VOR) gain on RC at low-to-mid frequencies (0.01-0.04Hz, r=0.12-0.26;p<0.0001-0.0425) than at medium-to-high frequencies (0.26-0.32Hz, r=0.06-0.10;p=0.0899-0.3166). vHIT gain was also better correlated with VOR phase at low-to-mid (r=-0.21;p=0.0004) than mid-to-high frequencies (r=-0.10-0.02;p=0.0964-0.7469). When compared to calorics, vHIT gains demonstrated weak correlations for warm (r=0.11-0.19) and cold (r=0.16-0.18). Similar to vHIT, cold calorics were better correlated with VOR gains at low frequencies (r=0.27-0.47;p=<0.0001) than high frequencies (r=0.06-0.19;p=0.0014-0.3335). Lastly, the presence of catchup saccades was best correlated with vHIT gain and slope (r=0.25-0.43) compared to all other vestibular testing modalities (low-frequency VOR, r=0.08-0.27; calorics, r=0.20-0.22).

Conclusions: While laboratory data suggests that vHIT reflects high-frequency vestibular physiology, these results show that vHIT values best correlate with low-to-mid frequency RC gain and phase in our symptomatic population. vHIT also displays a weak-to-moderate correlation with caloric measurements. These data may be useful to guide interpretation of mixed results from vestibular testing. Further study is needed to further contextualize vHIT data compared to RC and caloric results in specific vestibular conditions.

***Professional Practice Gap & Educational Need:** vHIT is a relatively new addition to the neurotologist's armamentarium that utilizes high-acceleration vestibular stimulation, and is marketed as equivalent to existing vestibular testing modalities like RC and caloric testing. The correlation of vHIT values with more traditional caloric and RC measurements is not yet understood.

***Learning Objective:** To understand where vHIT interpretation fits into existing and widely accepted vestibular function testing modalities—can vHIT serve as a substitute test, particularly at institutions without the infrastructure for RC, or should it only be used as adjunctive data?

***Desired Result:** To describe the role and integration of vHIT information in vestibular testing.

***Level of Evidence:** Level IV

***Indicate IRB or IACUC:** Approved by the University of Pennsylvania Institutional Review Board. Approval #831279. Approval Date 9/28/2021.

Visuospatial Cognitive Deficits in Patients with Vestibular Disorders

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Objective: Patients with peripheral vestibular loss have been shown to have deficits in certain cognitive domains. Herein, we aim to better characterize the type of cognitive impairment in patients with vestibular disorders and determine whether a correlation exists between Patient-Reported Outcome Measures (PROMs) and performance on neuropsychological tests.

Study Design: Cross-sectional cohort.

Setting: Academic medical center.

Patients: Fifty-two age-matched subjects were recruited: 15 patients with bilateral vestibular loss (BVL), 7 patients with unilateral vestibular loss (UVL), 15 patients with vestibular migraine (VM), and 15 healthy control subjects.

Interventions: Subjects completed neuropsychological tasks to assess auditory working memory (Digit Span Test [DST]) and visuospatial working memory (Corsi Block Tapping Test [CBTT]). Subjects also completed PROMs to assess severity of vestibular dysfunction (Dizziness Handicap Inventory [DHI]) and cognitive impairment (Cognitive Failures Questionnaire [CFQ] and Cognitive Function - Quality of Life in Neurological Disorders [CF-Neuro-QOL]).

Main Outcome Measures: Scores on PROMs and performance on neuropsychological tests.

Results: BVL and UVL patients performed significantly worse on the CBTT compared to control subjects and VM patients ($p<0.01$ and $p<0.05$, respectively). All subject cohorts performed similarly on the DST. BVL, UVL, and VM patients scored significantly higher on the DHI compared to normal controls. VM patients scored significantly higher on NeuroQOL surveys compared to normal controls ($p<0.05$). PROMs were not significantly correlated with CBTT or DST performance.

Conclusions: Patients with peripheral vestibular loss demonstrate impairments on tasks of visuospatial working memory, but not auditory working memory. Novel surveys are needed to screen for patients with vestibular disorders for cognitive impairment, particularly visuospatial ability.

Professional Practice Gap & Educational Need: 1) Lack of in-depth knowledge of cognitive impairment and, in particular, visuospatial working memory deficits, in patients with vestibular disorders. 2) Need for improved screening tools to identify patients with vestibular disorders who are at risk for cognitive impairment.

Learning Objective: 1) Attendees will understand that peripheral vestibular loss, including both bilateral vestibular and unilateral vestibular loss, is associated with deficits in visuospatial ability. 2) Attendees will appreciate that improved screening methods are needed to characterize visuospatial deficits in vestibular disorders

Desired Result: A greater understanding of the degree, severity and type of cognitive impairment in patients with vestibular disorders.

Level of Evidence - III

IRB: 2019P000438, Massachusetts Eye and Ear