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Audiologic and Vestibular Testing and Interpretation of Outcome Data: A Case Series

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Table of Contents

Abstract 1

Introduction: Nonorganic hearing loss is not typically associated with a detectable pathology. Both adults and children can present to the clinic with nonorganic hearing loss. It is often the result of psychosocial stressors and is more common in children, specifically 6 to 19 years old. **Case Presentation:** An 11-year-old child presented to the clinic with bilateral mild to moderate sensorineural hearing loss, but prior exams showed unilateral hearing loss on the left side. **Discussion:** Audiologists need to obtain a detailed case history, determine any underlying complications, inquire about additional auditory diagnoses, and employ objective testing to ascertain test reliability. **Conclusion:** Adolescents may experience psychosocial stressors that influence their audiometric responses. Early intervention is key if nonorganic hearing loss is suspected, and, in most cases, a detailed case history, follow-up, and examination of prior test data is recommended for an accurate diagnosis.

Elevated Hearing Thresholds: A Case Report

Introduction

Nonorganic hearing loss (NOHL), also identified as elevated hearing thresholds, pseudohypacusis, and functional hearing loss, can be described as hearing loss without a detectable corresponding pathology in the auditory system (Schmidt et al., 2013). Nonorganic hearing loss is common in school-age children but may also be found in adults. This may be the result of stressors or other psychosocial and emotional indications such as problems at school, problems at home, attention-seeking behavior, anxiety, and feelings of inadequacy (Mehta & Martindale, 2005).

Psychosocial issues such as behavioral, emotional, and educational problems have been identified in a quarter of children ages 5 through 15 in the general population. These issues can range from mild, temporary problems to severe problems that qualify children for direct mental health services (Brugman et al., 2001). Although psychosocial issues have proven to have a significant impact on an adolescent's everyday life, many children do not receive desirable mental health services. If these problems are not addressed early, they may worsen as the child ages and incur additional detrimental behaviors (Mehta & Martindale, 2005). In cases of NOHL with psychosocial issues, individuals may be misdiagnosed with a condition that they do not have and continue to receive inappropriate intervention.

The rate of NOHL for the pediatric population is reportedly 5 to 7% and is most common between 6 and 19 years of age with peak occurrence around 11 years of age (Sarve et al., 2019). When NOHL is suspected, a variety of clinical tests may be employed to determine a person's true behavioral thresholds. Among some of the most common clinical tests are observation and case history which includes determining if one is exaggerating their extent of difficulty. This can

include normal vocal intensity, degree of eye contact, and discrepancies within case history. Additionally, a clinician may perform a variety of pure-tone audiometry tests and techniques to confirm hearing thresholds, including ascending-descending techniques, detection of delayed responses, incongruence between perceived disability and audiometric thresholds, positive Stenger test results, and disagreement between speech and pure-tone audiometry. Also, clinicians may observe a difference in hearing thresholds between behavioral audiometry and objective tests such as evoked potential testing and otoacoustic emissions testing (Mehta & Singh, 2000).

Case Presentation:

An adolescent child, presented to the clinic for a central auditory processing disorder (CAPD) evaluation for a concern from the parents and school multidisciplinary team. A case history review identified a need to obtain audiometric thresholds. Several years prior, the child was diagnosed with unilateral hearing loss in the left ear. Pure tone air- and bone-conduction audiometry for that exam revealed normal audiometric thresholds in the right ear from 250 to 8000 Hz. In the left ear, a mild mostly sensorineural hearing loss from 250 to 1000 Hz with normal hearing through 8000 Hz. The child had excellent word recognition, bilaterally, and agreement between pure-tone averages (PTAs)and speech recognition thresholds (SRT). Reliability was marked as *good*. For both ears, tympanometry suggested normal middle ear function while imaging studies and genetic testing produced inconclusive results.

The child was prescribed a hearing aid for the left ear and, three years later, a significant worsening of hearing thresholds was observed on the audiogram in both ears (**Figure 1.1**) with a mild-to-moderate sensorineural hearing loss from 250 to 2000 Hz, sloping to moderate from 4000 to 8000 Hz in the right ear. The left ear showed a flat moderate hearing loss from 250

through 8000 Hz and word-recognition performance was excellent at elevated intensity levels in both ears (**Table 1.1**). As a result, a hearing aid was prescribed for the right ear, and the family was advised that their child may need cochlear implants in the future. A second opinion was requested. This examination (**Figure 1.2**) revealed normal hearing thresholds bilaterally with mild sensorineural hearing loss from 250 to 1000 Hz in the left ear. An ascending testing technique was employed, and the child proved reliable. Word recognition was excellent bilaterally, at normal conversational intensity levels (**Table 1.2**), and otoacoustic emissions data (not shown) validated behavioral responses that were obtained. The audiogram was repeated at a third clinic with concurrent results (per (**Figure 1.2** and **Table 1.2**). Central auditory processing testing was inconclusive. Hearing aid verification and counseling were performed, and monaural hearing aid use, rather than binaural hearing aid use, was recommended.

Discussion

When deciding on appropriate treatment plans for a child's audiologic care, it is important that the family feels confident about the care received. If a family doubts a diagnosis, treatment plan, or quality of care, they might seek out a second opinion to verify the diagnosis (Patient Association Foundation, n.d.). Obtaining a second opinion might permit a family to be made aware of alternative treatment opinions, confirm a new diagnosis, and answer additional questions that may be related to the diagnosis (Cincinnati Children's, n.d.). Our case received several hearing assessments, which allowed the family to be counseled on multiple perspectives.

Because childhood trauma, stress, anxiety, and further psychosocial issues may contribute to malingering, they may persist into adulthood and cause a lifetime of mental health problems (Mehta & Martindale, 2005). Objective measures and subjective test techniques, such

as the Yes-No Technique, Ascending Technique, and Stenger Test, may be added to an audiological test battery to confirm unreliability. Additionally, to classify unreliability, a thorough case history and follow-up evaluation may inform a definitive diagnosis (Mehta & Martindale, 2005). Hence, if NOHL is suspected, it is important to employ these measures, generate appropriate referrals to providers, and initiate conversations with parents about all underlying issues (Mehta & Martindale, 2005). This approach is critical to avoid mismanagement of hearing disorders and is critical for a family's peace of mind.

Conclusion

When unreliable hearing thresholds are suspected, it is important to address underlying psychosocial case evidence that may plausibly explain auditory symptomology. For adolescents between ages 6 to 19 who are having trouble at home or school, and demonstrating personal problems, including anxiety, clinicians should acknowledge that these factors may influence a child's behavioral responses. It is important to synthesize data from a detailed case history, previous assessments, and follow-up appointments to establish an accurate diagnosis for a suitable management plan.

Abstract 2

Introduction: Vestibular migraines are among the most common diagnoses of vertigo in adults. Males and females can both be affected by this condition; however, it is more commonly seen in females. The presentation of symptoms and triggers for vestibular migraine varies among individuals, which contributes to mismanagement of symptoms. **Case Presentation:** A 33-year-old female presented to the clinic with intermittent vertigo episodes happening seasonally for the past eight years. **Discussion:** Middle-aged women, especially those within the peri- or post-menopausal stages, are at an increased risk for vestibular disorders, including vestibular migraines. This may be due to sex hormone fluctuations and simultaneously altered neural and vascular pathways correlating with migraines. **Conclusion:** Vestibular migraines are often misdiagnosed or mismanaged. Physician awareness and further research are critical in determining individualized management plans for both men and women. Women may need increased individualized treatment plans based on menstrual cycle and pathophysiological differences.

Vestibular Migraine in an Adult Female: A Case Report

Introduction

Vestibular migraines are the second-most common cause of vertigo in adults affecting up to 3% of the population (American Migraine Foundation, 2020). Although common, this condition is often underdiagnosed or misdiagnosed under more familiar diagnoses such as Meniere's disease, benign paroxysmal positional vertigo (BPPV), and transient ischemic attacks (TIA) (Johns Hopkins Medicine, n.d.). On average, 40% of migraine patients have accompanying vestibular symptoms; however, 50% of these patients are mismanaged or misdiagnosed (Vestibular Disorders Association [VeDA], n.d.).

Vestibular migraine is typically described as a "pounding or throbbing headache" in combination with vestibular and balance symptoms including vertigo, imbalance, nausea, and vomiting. Nevertheless, vestibular migraines can occur without a headache (American Migraine Foundation, 2020). Many individuals do not simultaneously have dizziness and headache or fail to attribute what they are experiencing to a headache (VeDA, n.d.). Vestibular migraines more often coincide with any history of migraines, headaches, motion sickness, benign paroxysmal vertigo of childhood (BPVC), and family history (American Migraine Foundation, 2020; VeDA, n.d.). Presentation and triggers of vestibular migraines vary in individuals; however, common triggers (**Table 2.1**) include weather changes, stress, lack of sleep, foods (caffeine, chocolate, alcohol), menstrual cycle, and lights (John Hopkins Medicine, n.d.) Symptoms include headache, nausea or vomiting, sensitivity to light, smell, or noise, vertigo, unsteadiness or imbalance, motion sickness, and visual aura (John Hopkins Medicine, n.d.).

The exact cause of vestibular migraines is unknown; however, it is thought to be caused by overlapping pathways of pain and vestibular inputs (John Hopkins Medicine, n.d.). Due to the

nature of the pathways affected, migraines are thought to have a combination of altered vascular and neural processes (VeDA, n.d.). Middle-aged females are especially at risk for this condition with five times more females being affected than men (American Migraine Foundation, 2020). Levels of sex hormones (estradiol, progesterone, testosterone, and serum prolactin), specifically in peri- and post-menopausal women, are thought to play a key role in causes of migraines and related vestibular disorders (Tang et al., 2021).

Although no test can definitively diagnose this condition, additional imaging, and vestibular testing are recommended to rule out other vestibular disorders or central pathologies such as lesions or stroke (*"*Vestibular Migraines," 2022). Test outcomes occasionally observed in vestibular migraine have been displayed in **Table 2.2**. Treatment of this diagnosis varies by lifestyle changes to medication, including antihistamines, and over-the-counter and prescription medications (*Vestibular Migraines*, n.d.). One of the most common recommendations for management is the SEEDS (sleep, eat, exercise, dairy, and stress) lifestyle adjustment (Mayo Clinic, 2021). Although treatment efficacy varies by person, the best practice for the management of vestibular migraine may be a blend of medications, vestibular rehabilitation, and modification of lifestyle (VeDA, n.d.).

Case Presentation

An adult female experiencing episodic vertigo, that occurred during the same month in Winter for the past eight years, presented to the clinic for videonystagmography (VNG) testing. The patient described episodes that lasted three days and were accompanied by the room spinning, nausea, an inability to focus, posterior head pressure, and an incapacity to walk straight. Significant medical history included hysterectomy, classification as pre-diabetic, back

and pelvic floor pain, and a history of headaches without a formal migraine diagnosis. The patient was previously prescribed Meclizine and steroids; however, relief was reportedly minimal. Prior VNG testing yielded normal results, however recent bedside tests performed by her physical therapist indicated right-side vestibular hypofunction, spontaneous nystagmus, and a positive Dix Hallpike maneuver.

For our clinical evaluation, the patient reported no dizziness or audiological symptoms and audiologic testing revealed normal middle ear function and hearing thresholds. No spontaneous or gaze nystagmus was evident. Videonystagmography data were within normal limits, except for reduced right-side optokinetic results for targets at 40 degrees per second, with mild ocular flutter during positional testing with head to the left and vision-denied. In addition, there was intermittent end-point nystagmus toward leftward smooth pursuit targets. These test results indicated abnormal vestibular functioning consistent with a central origin. Based on the VNG data, previous test results, and the patient's case history, a probable diagnosis of vestibular migraines was discussed extensively. A follow-up consultation with a neurologist was recommended and the patient was asked to return for a VNG in 12 months. Finally, the patient was counseled on the SEEDS lifestyle adjustment and other supplements and medications that were being recommended for migraines, specifically vestibular migraines.

Discussion

Females are at increased risk for migraines and vestibular disorders, especially when levels of sex hormones are unstable. This risk has been correlated with specific reproductive stages throughout life such as menopause (Tang et al., 2021; Smith et al., 2019). Menopause is typically characterized by onset between age 40 and 50 (Mayo Clinic, 2023). This age group is

representative of our case. Furthermore, our case presented with an onset of menopause due to a hysterectomy, a procedure in which your uterus and/or ovaries are removed, an additional risk factor for vestibular migraine (Mayo Clinic, 2023). Depending on the classification of a patient's hysterectomy, it can lower estrogen levels and place the person at additional risk for vestibular migraines (Mayo Clinic, 2023; VeDA, n.d.). Estrogen level fluctuations and low estrogen levels play a key role in migraine association (Tang et al., 2021; Smith et al., 2019). These hormonal fluctuations have been found to trigger activation of the same pathways thought to contribute to vestibular migraines (Delaruelle et al., 2018). These hormonal fluctuations, specifically the lack of estrogen, can occur throughout all stages of a menstrual cycle across the lifespan but are specifically common during the late peri-menopausal stages (Delaruelle et al., 2018). Not only are these fluctuations associated with migraines, but perimenopausal women also report dizziness as a primary symptom (Delaruelle et al., 2018).

In addition to migraine symptoms, post-menopausal patients are also at a higher risk for developing vestibular disorders including BPPV, vestibular migraines, and Meniere's disease (Tang et al., 2021; Smith et al., 2019). With this predisposition in the female population, audiologists should be aware of the risk factors and etiologies of vestibular migraines that call for individualized treatment plans for women during specific stages of the menstrual cycle (Gillies & McArthur, 2010).

Conclusion

Although vestibular migraines are common in the adult population, many patients are often misdiagnosed or mismanaged. Although otolaryngologists and other physicians are becoming more familiar with this condition, there is still a significant population of patients who

need evaluation and treatment (VeDA, n.d.). Due to the highly variable clinical presentation of symptoms and triggers for vestibular migraines, such as presenting to the clinic without a headache, providers and patients may not assign their symptoms to a diagnosis of vestibular migraine (Delaruelle et al., 2018; VeDA, n.d.). An improved understanding of sex differences, pathophysiological variances, and individualized treatment plans, specifically for the female population of reproductive age, is necessary to not only properly diagnose individuals, but to develop a suitable vestibular migraine care plan (Delaruelle et al., 2018).

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Figure (Case 1)

Figure 1.1 Pure tone air- and bone-conduction audiometric thresholds for the right and left ear.

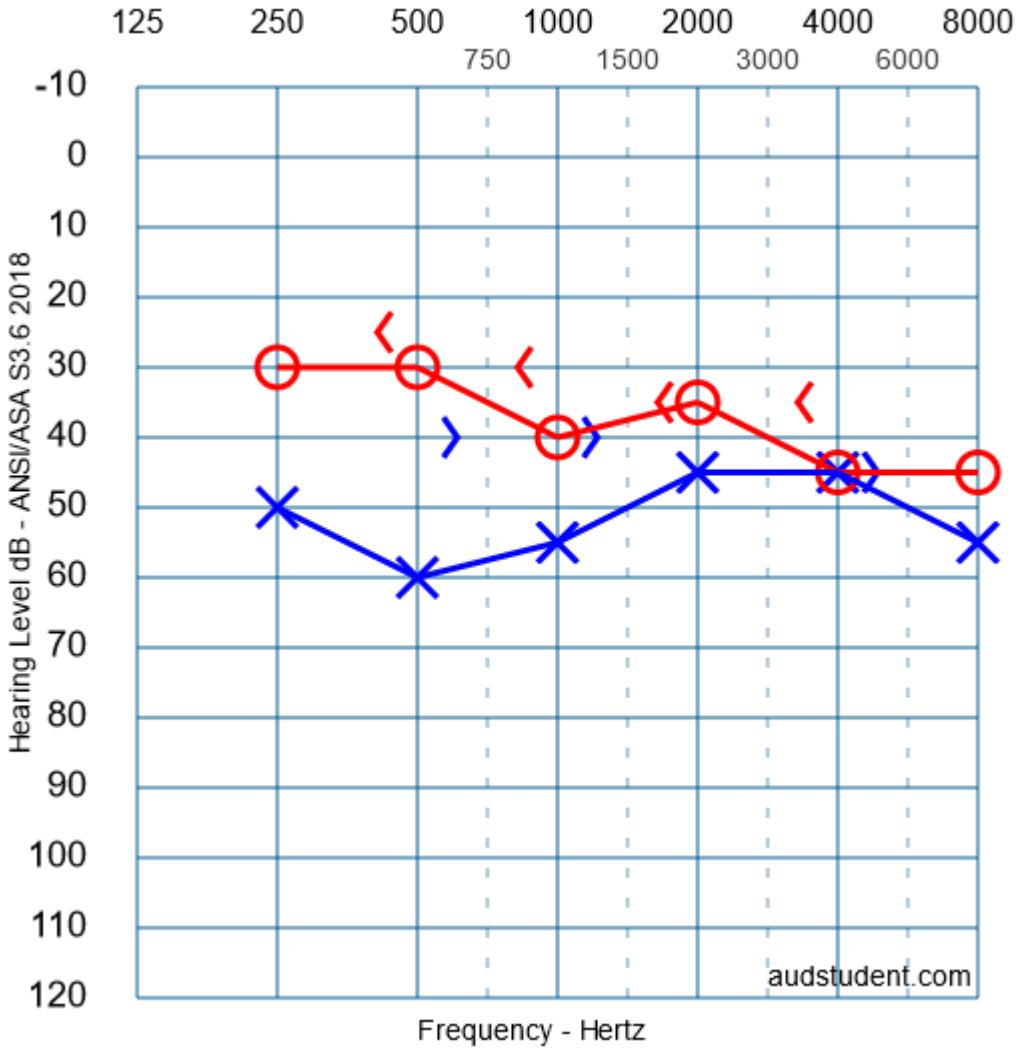

Table (Case 1)

Table 1.1 Word recognition score and presentation levels (dBHL) for right and left ear.

	Word recognition score (%)	**Presentation Level (dBHL)**
Right Ear	100	80
Left Ear	100	80

Figure (Case 1)

Figure 1.2 Pure tone air- and bone-conduction audiometric thresholds for the right and left ear.

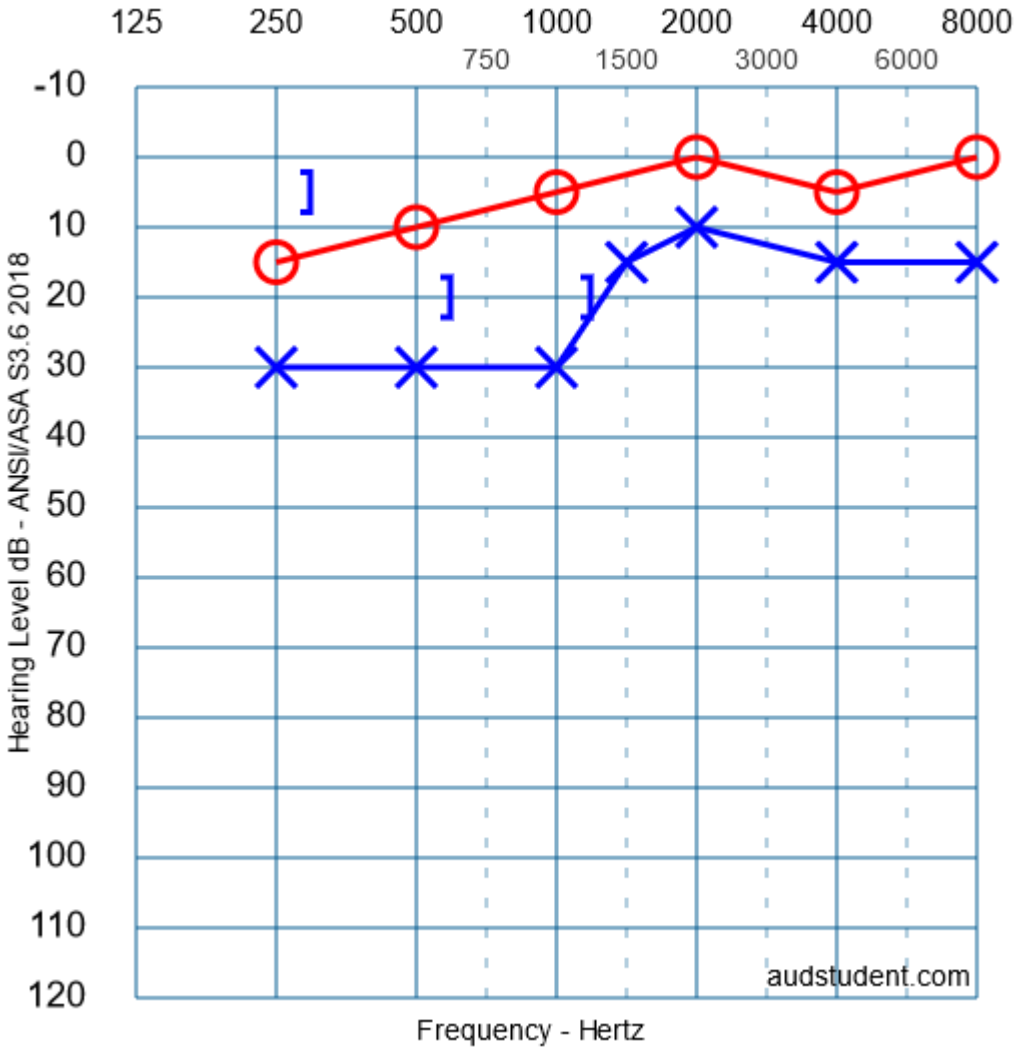

Table (Case 1)

Table 1.2 Word recognition score and presentation levels (dBHL) for right and left ear.

	Word recognition score (%)	**Presentation Level (dBHL)**
Right Ear	88	55
Left Ear	88	55

Table 2.1 (Case 2)

Table 2.1 List of triggers for migraine and other vestibular problems (adapted from VeDA, n.d.)

Food	Aged or ripened cheeses
	Foods containing large amounts of monosodium glutamate (MSG) or "flavor enhancer 621"
	Smoked, cured, or processed meats (bacon, ham, salami, sausage, pepperoni, hot dogs)
	Food prepared with meat tenderizer, soy sauce, vinegar, or yeast extract
	Pickled, fermented, or marinated food
	Pea pods and pods of broad beans (lima beans and navy beans)
	Onions
	Olives
	Alcohol (especially red wine, port, sherry, scotch, gin, and bourbon)
	Certain dairy items (sour cream, buttermilk, and yogurt)
	Bread, coffee cake, and doughnuts
	Aspartame and other artificial sweeteners
	Chocolate, cocoa, and carob products
	Nuts
	Certain fruits (figs, avocados, raisins, plums, passion fruit, papaya, banana, and citruses)
	Excessive tea, coffee, and cola
Hormonal Fluctuations	
Barometric-pressure variations *(weather changes)*	
Stress	
Sleep Disturbances	
Medications	

Table 2.2 (Case 2)

Table 2.2 Possible vestibular test results for patients with vestibular migraines (adapted from VeDA, n.d.).

Possible Vestibular Test Results
Poor gaze stability with ocular drift and spontaneous up- or down-beating direction nystagmus *(unsuppressed with visual fixation)*
Unilateral or bilateral gaze-induced lateral nystagmus
Reduced ability to cancel or inhibit vestibulo-ocular reflex function
Postural stability may be affected
Abnormal smooth pursuit
Positive postural instability with head motions occurs during computerized dynamic posturography testing
Rebound nystagmus may be observed
Negative Dix Hallpike *(unless BPPV is simultaneously present)*
Hyperactive vestibular-evoked myogenic potential results
Torsional bilateral nystagmus may be observed during positional or gaze testing