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Case Reports of Two Patients with Sudden Hearing Loss: Idiopathic and Traumatic Brain Injury (TBI)

Lucas D. Lamont
Illinois State University, llamont@ilstu.edu

Lucas Lamont

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Illinois State University, Normal, IL

Title: Case Reports of Two Patients with Sudden Hearing Loss: Idiopathic and Traumatic Brain Injury (TBI)

Advisor: Scott Seeman, PhD, CCC-A

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Abstract 1

Introduction: Sudden sensorineural hearing loss (SSNHL), commonly known as sudden deafness, is an unexplained, rapid loss of hearing either all at once or over a few days. Regardless of the cause, delayed medical attention for patients with SSNHL can lead to permanent outcomes.

Case presentation: A 56-year-old female presented with reduced hearing sensitivity in her right ear beginning the day of the appointment.

Discussion: Many factors influence a patient's probability of a complete recovery from SSNHL. Understanding these factors can aide in counseling a patient with realistic expectations.

Conclusion: Patients with SSNHL require immediate medical attention. Prompt medical care gives the patient the best opportunity for recovery.

Case Presentation 1

(Unilateral Sudden Sensorineural Hearing Loss)

Introduction:

In the United States, SSNHL affects between 5-27 per 100,000 people each year, with approximately 66,000 new annual cases. Although individuals of all ages can be affected, the peak incidence is between the fifth and sixth decade of life (Tanna et al., 2022). A variety of disorders affecting the ear can cause SSNHL, but only 10 percent of people diagnosed with SSNHL have an identifiable cause. Some conditions include infections, head trauma, autoimmune diseases, exposure to certain drugs that treat cancer or severe infections, blood circulation problems, neurological disorders (ex. multiple sclerosis), or disorders of the inner ear (ex. Meniere's disease) (NIDCD, 2018). Nearly all cases of SSNHL are unilateral with less than 2% of patients experiencing bilateral involvement. Accompanying symptoms include tinnitus (41% to 90%) and dizziness (29% to 56%) (Byl, 1984; Fetterman et al., 1996; Huy & Sauvaget, 2005; Xenellis et al., 2006). Many patients report first noting their hearing loss on awakening (Chau et al., 2010).

When diagnosing a patient with SSNHL, it is important to rule out conductive hearing loss (hearing loss due to an obstruction in the ear), such as fluid or cerumen (ear wax). An audiologist will complete a comprehensive audiological evaluation to determine the type, degree, and configuration of hearing loss, if present. There is no exact criteria for diagnosing SSNHL but it is often defined as an increase in pure tone threshold of greater than 30 decibels (dB) in at least three adjacent frequencies occurring within 72 hours (Lloyd, 2013).

SSNHL is a medical emergency and requires prompt medical attention. Untreated or delayed treatment for SSNHL may lead to permanent and devastating consequences (ex. permanent hearing loss). Prompt recognition and management of sudden sensorineural hearing loss may improve hearing recovery and patient quality of life (Chandrasekhar et al., 2019). According to the National Institute on Deafness and Other Communication Disorders (NIDCD), although about half of people with SSHL recover some or all their hearing spontaneously (usually within one to two weeks from onset), delaying diagnosis and treatment (when warranted) can decrease treatment effectiveness (NIDCD, 2018).

Treatment options for SSNHL are myriad and include systemic and topical steroids, antiviral agents, hyperbaric oxygen therapy (HBOT), rheologic agents, diuretics, other medications, herbal and other complementary and alternative treatments, middle ear surgery for fistula repair, and observation alone. The current standard treatment for SSNHL is a tapered course of oral high-dose corticosteroids to increase circulation to the inner ear (Schreiber et al., 2010). Intratympanic steroid injections has been shown to be as effective as oral steroid and are considered a good option for patients who cannot take oral steroids (patient's with diabetes, hypertension, and gastritis) or want to avoid side effects . Many factors contribute to predicting the recovery of patients identified with SSNHL including the age of the patient, the time of initiating treatment, the severity of hearing loss prior to diagnosis, the severity of vertigo prior to diagnosis, and many others. Research by Xenellis et al. (2006) found that younger age, male sex, the shorter time elapsed from the onset of hearing loss to the beginning of treatment, and upward sloping audiogram contours were related to better hearing outcomes.

Case Presentation 1

A 56-year-old female was seen for a comprehensive audiological evaluation following a perceived, significant reduction in hearing acuity in her right ear after waking up earlier that morning. She had no history of hearing loss (no previous audiograms), aural surgery, or vertiginous symptoms. The patient reports experiencing recurrent otitis media in her childhood and was diagnosed with type 2 diabetes in 2015. Along with reduced hearing acuity, the patient reported “slight dizziness” while driving herself to the appointment as well as mild nausea. Previously, she has experienced bilateral, intermittent tinnitus which she described as “non-bothersome;” she denied noticing any perceived changes to her tinnitus. The patient denied otalgia, otorrhea, and otalgia.

Otologic examination revealed a clear canal and translucent tympanic membrane, bilaterally. Immittance testing was performed to assess outer and middle ear integrity and function, and results were consistent with normal tympanic membrane mobility in both ears. Pure tone air and bone conduction audiometry was performed to establish type and severity of hearing sensitivity. Results under insert earphones revealed a moderately-severe sensorineural hearing loss rising to normal hearing sensitivity in the right ear. Testing in the left ear revealed normal hearing sensitivity from 250-8000 Hz (Figure 1). Speech recognition thresholds (SRTs) were obtained as a cross-check for pure tone reliability and to determine speech recognition abilities using monitored live voice presentation of spondee words. SRTs were obtained at 35 dB HL in the right ear and 15 dB HL in the left ear. Word recognition scores were obtained to evaluate speech understanding in quiet, using the NU-6 Ordered by Difficulty word lists, and revealed 80% correct when presented at 65 dB HL in the right ear with 45 dB HL of contralateral masking and 100% (10/10) correct in the left ear.

Based on the audiometric results coupled with the patient's perceived reduction in hearing acuity in her right ear, the patient's primary care physician was immediately contacted for a more thorough evaluation; the patient was seen by her primary care physician 2 hours following her audiogram. A follow-up audiometric evaluation was scheduled for the following week to monitor the patient's audiometric thresholds. The patient was encouraged not to drive if she continued to feel dizzy.

When the patient returned for her follow-up audiometric examination 7 days later, she explained that her primary-care physician prescribed 60 mg of oral corticosteroids to be taken for five days. Since her last appointment, the patient reported a significant improvement in hearing acuity in her right ear and denied experiencing vertiginous symptoms.

Otologic examination revealed a clear canal and translucent tympanic membrane, bilaterally. Pure tone air and bone conduction audiometry were performed in the right ear only under insert earphones, revealing normal hearing sensitivity from 250-8000 Hz (Figure 2). Word recognition scores in quiet revealed 90% correct when presented at 45 dB HL in the right ear.

Discussion

Although symptoms of SSNHL can be improved through treatment, many factors influence a patient's probability of a complete recovery. It's important that audiologists provide realistic expectations to these patients based on influential factors. Understanding patients' expectations can enhance their satisfaction level. Knowing the expectations of our patients can help avoid negative reactions, enhance their healthcare experience, and reduce exposure to liability (Lateef, 2011).

Research by Frederick Byl Jr., M.D. studied patients diagnosed with SSNHL and analyzed their speed of onset, severity, degree of recovery, and quality of recovery following treatment. 225 patients from the age of 9 to 82 years (mean age was 48.6 years) received treatment following a diagnosis of SSNHL and were observed over the eight-year prospective study. Of patients seen within 7 days, 56% had normal or complete recovery whereas only 49% of those seen 30 days or later had no recovery. Of patients with mild initial hearing loss, 83% had normal or complete recovery; only 22% of patients with profound initial hearing loss had a normal or complete recovery. Of the patients reporting no vertigo or balance disturbance on their initial visit, 55% had a normal or complete recovery and 29% of those initially seen with severe vertigo had a normal or complete recovery. Important prognostic indicators were found to be: the severity of initial hearing loss, the severity of vertigo, time from onset to initial audiogram, and elevated erythrocyte sedimentation rate (ESR). Other important prognostic factors included age over 60 years or less than 15 years, an upsloping or mid-frequency hearing loss configuration, and hearing status of the opposite ear.

Conclusion

SSNHL is a rapid loss of hearing either all at once or over a few days which requires immediate medical attention. This case highlights the importance of identifying a sudden decrease in hearing acuity and understanding which steps should be taken to give the patient the best opportunity for recovery. It is important to understand that SSNHL can vary in severity (ranging from cerumen impaction to Meniere's disease) which is why it is critical that audiologists take a thorough case history from the patient and recognize audiologic test result patterns. Following medical management, audiologists are responsible for monitoring the patient's audiometric thresholds. If a hearing loss is severe and/or does not respond to treatment, amplification in the form of hearing aids or cochlear implants may be considered.

Abstract 2

Introduction: Ossicular chain dislocation occurs following head trauma. It usually results in conductive hearing loss, which persists for more than 6 months.

Case presentation: A 33-year-old male presented with reduced hearing sensitivity in his right ear following head trauma to his right temporal lobe.

Discussion: CT scans of the temporal bone are the gold standard for diagnosing ossicular chain dislocation, however, audiologists can utilize common audiometric tests to identify this malformation. Audiologists may be the first to recognize this concern.

Conclusion: It's important that audiologists understand the signs and symptoms associated with ossicular chain dislocation through case history and audiometric test patterns in order to make appropriate referrals.

Case Presentation 2

(Unilateral Sudden Sensorineural Hearing Loss following Head Trauma)

Introduction:

A traumatic brain injury (TBI) is defined as disruption in normal brain function caused by external forces. In 2013, the Center for Disease Control reported 2.5 million TBI-related hospitalizations and 56,000 TBI-related deaths. The most common causes of TBI are falls, strikes by a blunt object, and motor vehicle crashes. Any bump, blow or jolt that makes the head and brain move rapidly back and forth can make the brain bounce or twist within the skull, triggering chemical changes. TBIs can result in loss of function in cognitive, sensory, perceptual, psychological, speech and language capacities. Classification of TBIs ranges from mild to moderate to severe based on the duration of loss of consciousness or mental status change (Glasgow Coma Score), post-traumatic amnesia, and imaging results, although the exact criteria for each level of TBI is not standardized across studies.

Hearing loss is often associated with TBI cases, either because the traumatic injury damages the inner ear or because there is damage to the part of the brain that processes sound. An undiagnosed case of hearing loss can interfere with the effectiveness of medical and rehabilitation for TBI patients. Auditory problems could be mistaken for signs of cognitive deficits attributed to TBI. Factors associated with both hearing loss and TBI, such as attention, cognition, neuronal loss, and noise toxicity, can lead to misdiagnosis. Hearing loss following head injury is a common clinical finding, although typically delayed in its presentation due to the immediate investigation for more significant injuries.

It has been estimated that up to 50% of temporal bone fractures result in ossicular injury. Hearing loss is reported in up to 75% of patients in the first week following a head injury, dropping to 37% after 3 to 6 weeks. For those with residual conductive hearing loss at 6 weeks post-injury, the likely cause is ossicular chain dislocation. These patients represented 4% of those presenting with head trauma. The majority of patients with ossicular chain dislocation are young males aged between 16 and 30 years old but can occur across all age groups and sexes. In patients with ossicular discontinuity following trauma, primary investigations are usually performed to rule out a more significant head injury. A CT of the head will normally be performed, and if a temporal bone fracture is present, it is important to note whether it is otic capsule-sparing or otic capsule-violating, as this is the most reliable predictor of underlying injuries to the middle and inner ear. The most common site for dislocation is the incudostapedial joint because the weight difference between the incus (27 mg) and the stapes (3 mg) adds extra stress to the joint. Once the patient is medically fit, an audiogram should be obtained as soon as possible to allow for a baseline measurement of hearing loss. Hearing loss can be conductive, sensorineural, or mixed. When conductive hearing loss persists more than 6 weeks after injury, ossicular chain dislocation must be considered. Tympanometry may show increased compliance, suggesting discontinuity of the ossicular chain.

The conservative treatment plan for ossicular chain dislocation would include a hearing aid (or hearing aids) on the effected side while a more aggressive approach would involve surgery such as an ossiculoplasty. Surgical intervention can be delated; the average interval between injury and surgery is over 5 years (Yetiser et al., 2008). The success rate of ossicular chain dislocation repair depends on the status of the stapes (Tos, 2007). If the stapes is intact, the rate of “good hearing” recovery is about 75%. If the stapes is not intact, the rate of “good hearing” recovery is about 50%.

Case Presentation 2

A 33-year-old adult male was seen for a comprehensive audiological evaluation at an off-site location. He reported a sudden decrease in hearing acuity in his left ear following an incident 6 months prior. The incident involved blunt-force trauma to the patient’s left temporal lobe. The report documenting the event described the injury as a “left temporal bone contusion” which required no medical assistance. Following the incident, the patient reported reduced hearing in his left ear which never improved. The reduction in hearing acuity in his left ear greatly impacted his ability to concentrate, communicate, and enjoy social events. Along with the perceived hearing loss in his left ear, the patient began experiencing constant, bilateral tinnitus (seemingly worse in the left ear) and left-sided otalgia. The patient reports having a history of noise exposure including the use of recreational firearms and occupational noise exposure without hearing protection. The patient denied having a family history of hearing loss, no previous aural surgeries, no diagnosis of otitis media, no history of hearing loss and is not a hearing aid user.

Testing was initially completed following the incident. An otologic examination revealed a clear canal and translucent tympanic membrane, bilaterally. Immittance testing was not performed during this assessment. Pure tone air and bone conduction testing under insert earphones revealed a mild sensorineural hearing loss from 250-1000 Hz, rising to borderline normal hearing sensitivity in the right ear. Testing in the left ear revealed moderate sensorineural hearing loss from 250-4000 Hz rising to mild sensorineural hearing loss at 8000 Hz (Figure 3). Speech recognition testing was obtained at 35 dB HL in the right ear and 40 dB HL in the left ear. Word recognition scores were 100% correct when presented at 75 dB HL, bilaterally.

Otologic examination completed two months following the incident revealed a clear canal and translucent tympanic membrane, bilaterally. Immittance testing was performed to assess outer and middle ear integrity and function, and results revealed normal tympanic membrane mobility in the right ear and a hypermobile tympanic membrane in the left ear. Pure tone air and bone conduction audiometry were performed to establish the type and severity of hearing sensitivity. Results under insert earphones revealed normal hearing sensitivity from 250-8000 Hz in the right ear and a flat, moderate conductive hearing loss in the left ear (Figure 4). A Stenger test was performed to confirm the reliability of air conduction thresholds; results revealed a negative Stenger. Speech recognition thresholds (SRTs) were obtained as a cross-check for pure tone reliability and to determine speech recognition abilities using monitored live voice presentation of spondee words. SRTs were obtained at 15 dB HL in the right ear and 40 dB HL in the left ear. Word recognition scores were obtained to evaluate speech understanding in quiet, using the NU-6 Ordered by Difficulty word lists, and revealed 100% (10/10) correct when presented at 55 dB HL in the right ear and 84% correct when presented at 80 dB HL with 60 dB HL of contralateral masking in the left ear. Twelve-frequency distortion product evoked otoacoustic emissions (DPOAE) testing including frequencies from 1500-12,000 Hz. DPOAEs were present and robust suggesting normal or near-normal cochlear function at the level of the outer hair cells for all frequencies tested in the right ear. DPOAEs were absent at all twelve frequencies tested in the left ear consistent with the conductive component obtained during pure tone testing.

Based on the audiometric results and information gathered from the patient's case history, the patient was referred to an otolaryngologist for further evaluation. High-resolution axial images through the temporal bone were completed. Results revealed ossicular dislocation of the left incudostapedial joint, presumably as a result of previous trauma.

Discussion

Although a CT scan is the gold standard, other audiometric test results can be used to diagnose ossicular chain dislocation. Common tests within a typical audiometric test battery including case history, immittance testing, and pure tone air and bone conduction testing, can all be used to identify patients with this malformation.

As described by Katz, traditional wisdom reveals two key ingredients to a correct differential diagnosis: An excellent case history and a thorough physical examination (Katz, 2015). Given these two key ingredients, the differential diagnosis "emerges" to the trained professional as the only clear answer or potentially a series of equally plausible diagnoses emerge, indicating multiple remaining questions and avenues to be explored and resolved. A common case history question for a patient possibly presenting with ossicular chain dislocation is “have you suffered any head trauma?” or “have you been diagnosed with a skull fracture, specifically a temporal bone fracture?”.

Approximately 70-80% of temporal bone fractures are longitudinal, resulting from a blow to the temporal or parietal region of the skull. These fractures follow the path of least resistance, which usually leads through the petrosquamous suture line and continues to the otic capsule (Patel and Groppo, 2010). The specific lesion sites impacted by longitudinal fractures include the external auditory canal, tympanic membrane, middle ear cavity (including ossicular chain), facial canal (geniculate or tympanic segments), carotid canal, and the tegmen tympani. The common clinical findings associated with longitudinal temporal fractures include hemotympanum, facial paralysis, stenosis, pseudoaneurysm of the internal carotid artery, and cerebrospinal fluid otorrhea (Kurihara et al., 2020).

Tympanometry must always be performed following a temporal bone fracture, as this examination reflects the impedance of the middle ear, allowing the hearing loss to be attributed to the filling of the middle ear or an ossicular lesion (Aussedat et al., 2017). An extremely flaccid tympanic membrane, as seen in patients with ossicular chain dislocation, will yield very high compliance in the presence of normal middle ear pressure (type Ad tympanogram). Acoustic reflex is a sensitive indicator of middle ear lesions and is not usually observed in such cases of conductive hearing loss. However, a study by Sakamoto et al. in 2014 found that ossicular dislocation can also show at least present acoustic reflexes under certain conditions, including an intact transmission pathway from the head of the stapes to the tympanic membrane, replacement of the long process of the incus by a fibrous band, spontaneous myringostapediopexy, and a fibrous union between the stapes and the tympanic membrane. Nevertheless, it is quite rare that ossicular dislocation shows nearly intact acoustic reflexes because a fibrous band cannot completely transmit an impedance change to the tympanic membrane, which is caused by the contraction of the stapedius muscle.

As previously mentioned, patients with ossicular chain dislocation may present with sensorineural hearing loss but conductive or mixed hearing loss is more common. A complete ossicular chain dislocation is described as no contact between the disconnected ends of the dislocation whereas a partial dislocation is normal contact at an ossicular joint or along a continuous bony segment of an ossicle is replaced by soft tissue or simply by contact of opposing bone (Farahmand et al., 2016). Complete ossicular chain dislocation typically results in an audiometric pattern of a large, flat conductive hearing loss. In contrast, in cases where otomicroscopy reveals a normal external ear canal and tympanic membrane, high-frequency conductive hearing loss has been proposed as an indicator of partial ossicular chain dislocation.

Conclusion

Ossicular chain dislocation is a loss of normal alignment between the three middle ear ossicles and is most associated with temporal bone trauma. This malformation commonly leads to gradual hearing loss (may be sensorineural, conductive, or mixed) and tinnitus on the affected side. In patients with ossicular chain dislocation, primary investigations are usually performed to rule out a more significant head injury. A head CT will normally be performed to confirm or rule out a temporal bone fracture. Although a CT scan is the primary diagnostic tool used to diagnose ossicular chain dislocation, an audiologist could potentially be the first to identify and recognize the patient’s symptoms. It’s important that audiologists take a thorough case history, recognize the audiometric test result patterns associated with ossicular chain dislocation, and understand when a referral should be made.

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Case 1

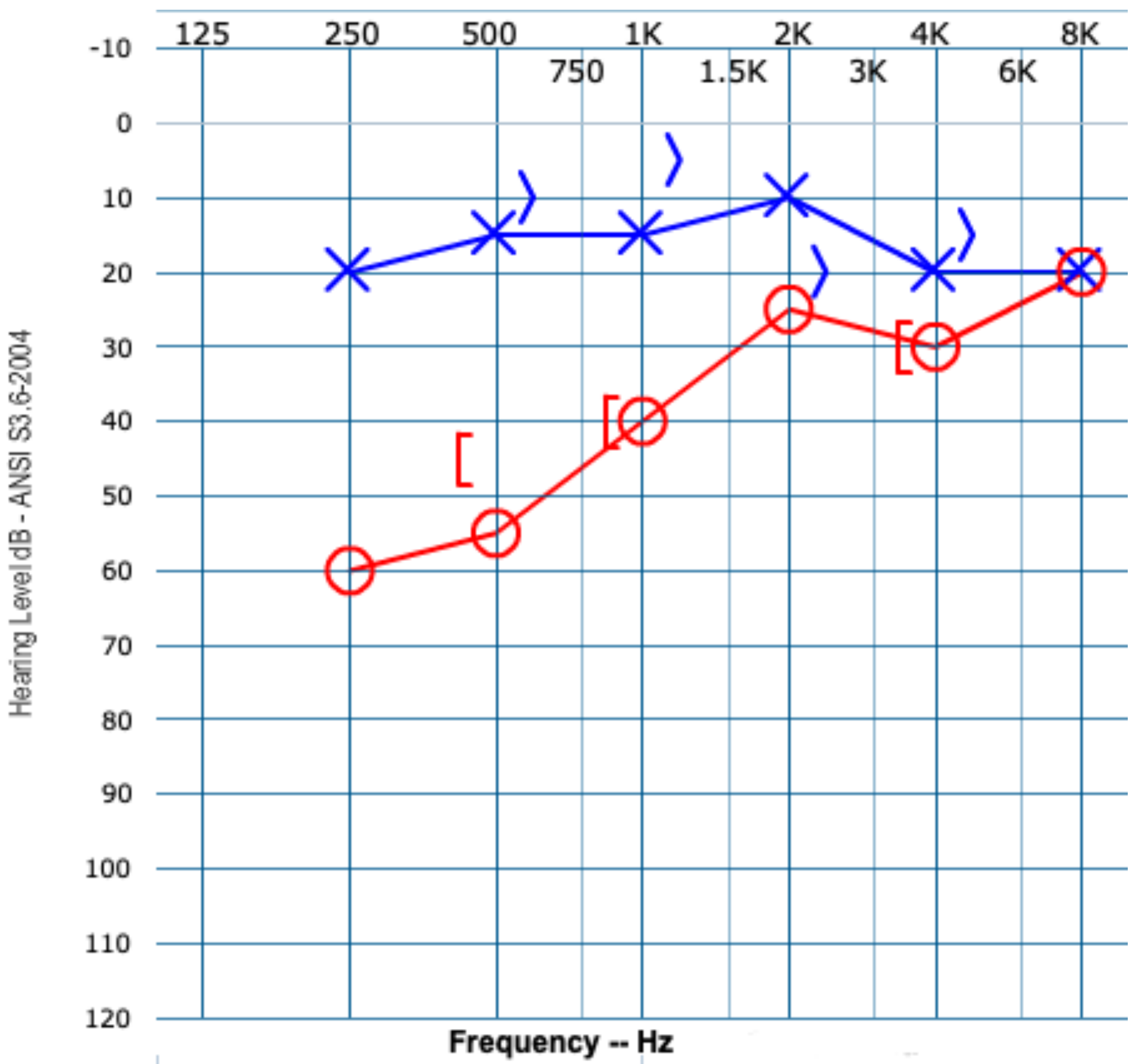


Figure 1. Initial pure tone air and bone conduction thresholds. The reliability of test results was deemed good.

Case 1

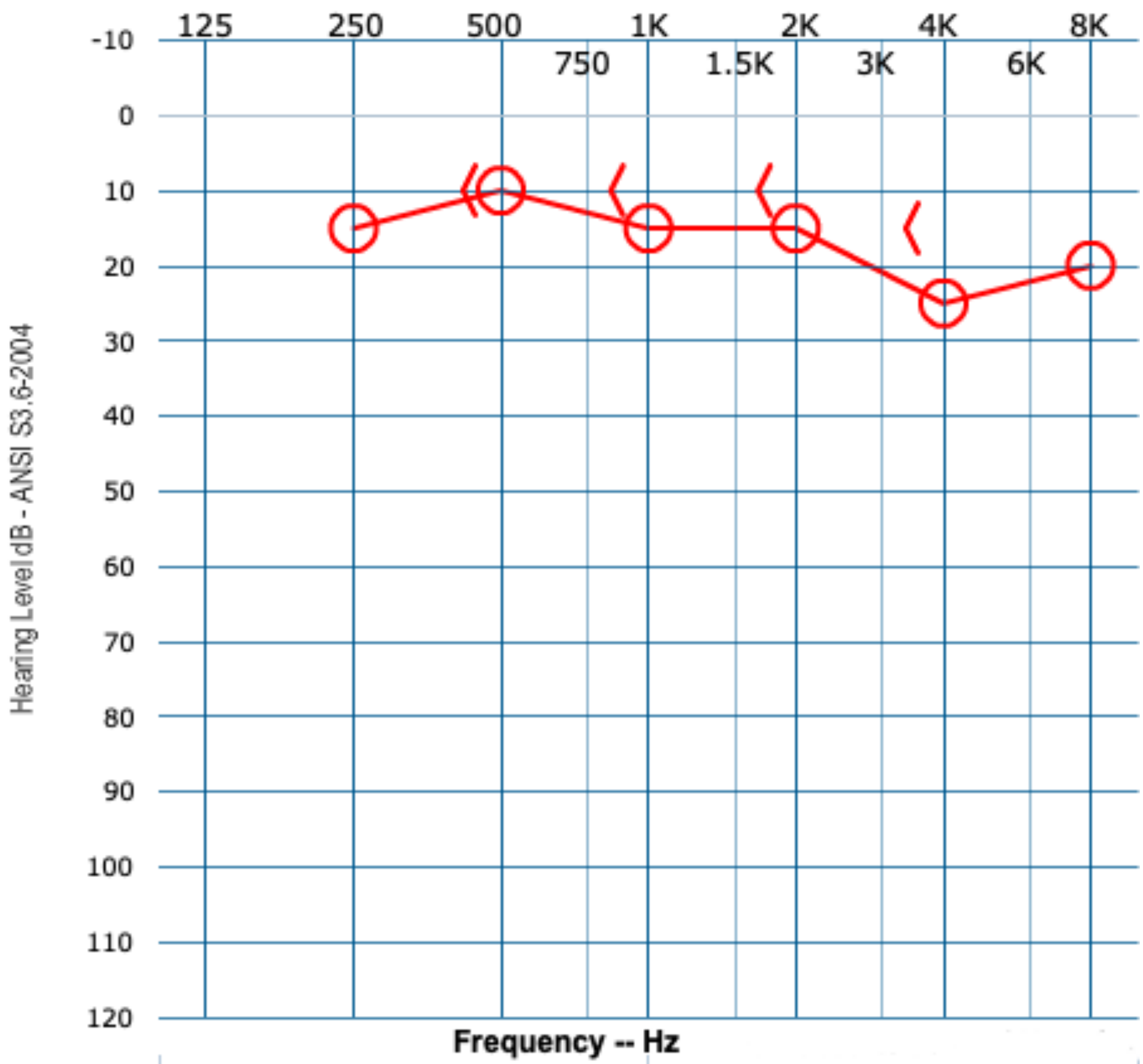
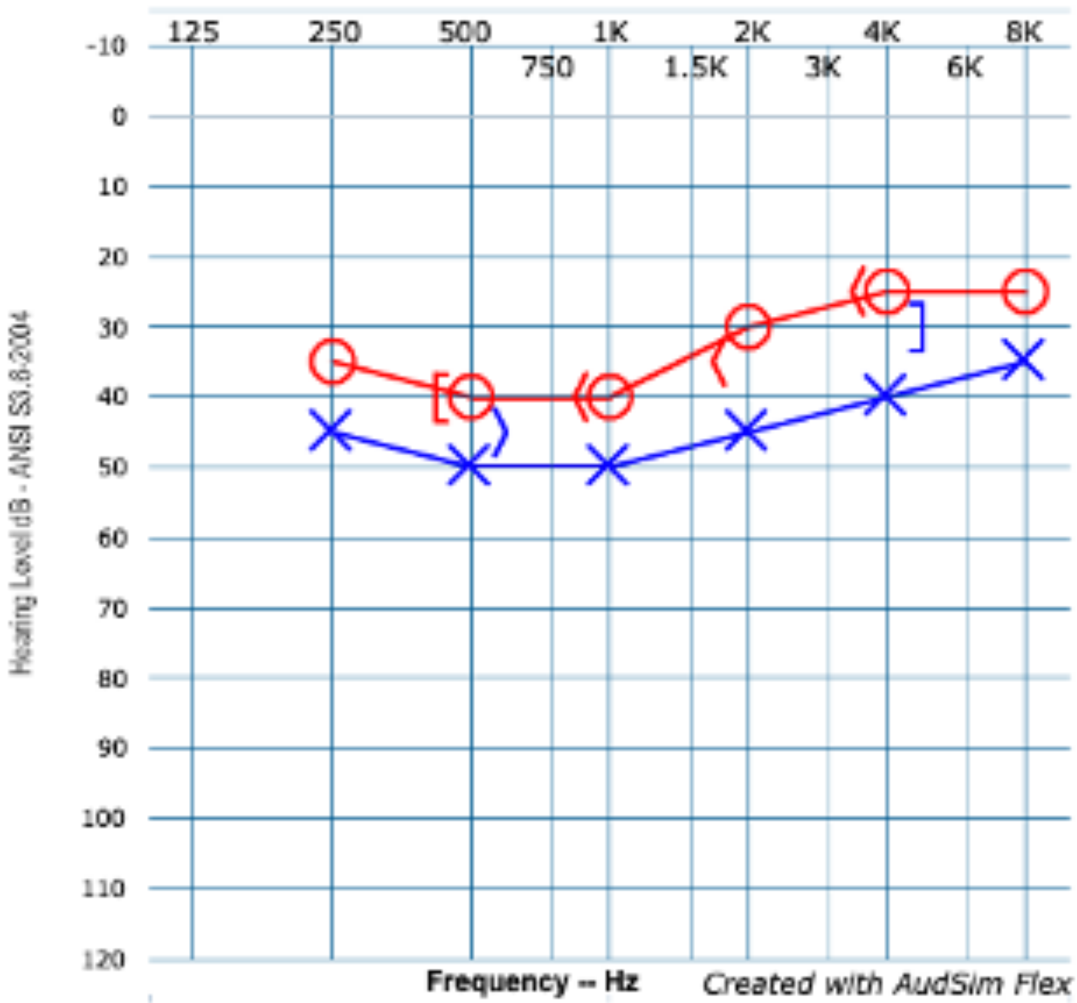
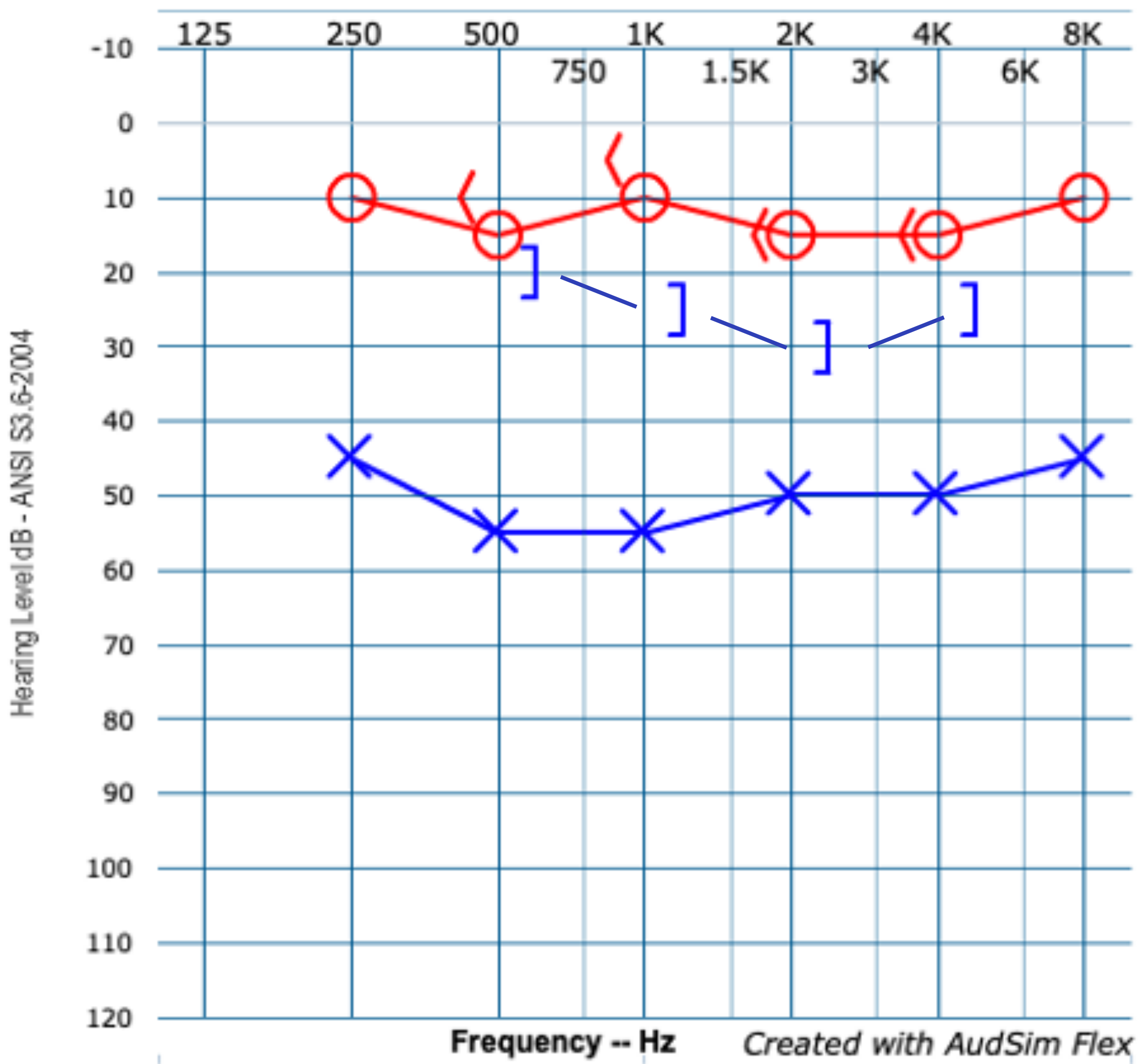


Figure 2. Follow-up (7 days after initial testing) pure tone air and bone conduction testing in the right ear. Reliability was deemed good.



Case 2

Figure 3. Initial pure tone air and bone conduction testing following the incident. The reliability of test results was deemed fair (completed at an outside clinic).



Case 2

Figure 4. Follow-up pure tone air and bone conduction testing under insert earphones. The reliability of test results was deemed good.