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# A Young Female with Chronic Debilitating Tinnitus and a Middle-aged Male with Life-Long Noise Exposure and Bothersome Tinnitus

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# A Young Female with Chronic Debilitating Tinnitus and a Middle-aged Male with Life-Long Noise Exposure and Bothersome Tinnitus

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## Table of Contents

# A Young Female with Chronic Debilitating Tinnitus

## Abstract

Introduction: Tinnitus is characterized by a sporadic or constant ringing, chirping, buzzing, or related characteristics that are perceived auditorily and can range in intensity. Case Presentation: A young adult female with normal hearing sensitivity presented to the clinic with constant unilateral pulsatile tinnitus in the right ear that was intensified with physical activity and caffeine. It was reported as sudden in onset and classified as severely debilitating. After extensive audiologic testing, personalized counseling, and a thorough medical evaluation, the patient received an open-fit monaural hearing aid to promote safe sound therapy and tinnitus habituation. Discussion: Thorough audiologic and medical evaluation, counseling, discussion of intervention options, and monitoring is essential when assisting individuals with tinnitus. Patients should be educated and assured that there are methods to assist in reducing the perception and emotional burden of their tinnitus. Conclusion: Audiologists and related professionals should explore a variety of tinnitus intervention strategies to best serve individuals in need.

# A Young Female with Chronic Debilitating Tinnitus

## Introduction

Tinnitus is characterized as a perceived involuntary sound that originates from within the head (1). An estimated 10% of the population in the United States experience tinnitus annually, and, from that group, 36% have reported constant tinnitus (2). Hearing loss, noise exposure, medications, and various concomitant medical conditions can play a role in the development of tinnitus; however, a variety of individuals experience tinnitus without a specified cause, which is classified as idiopathic. Tinnitus is thought to develop due to cochlear hair cell damage, where it is then detected by subcortical structures, perceived by the auditory cortex, and evaluated with attached meaning through the autonomic nervous system and limbic system (1). Appropriate referrals and medical evaluations should be made in order to determine the pathological origin and medical or surgical management of tinnitus. Current ancillary non-pharmacological treatment options include tinnitus habituation or reduction of the perception and negative association of the tinnitus by use of amplification devices, sound therapy, relaxation techniques, and various counseling approaches (1).

## Case Presentation

A young female presented for constant pulsatile *wooshing* tinnitus in the right ear that matched her pulse rate. Her tinnitus became louder with physical activity and caffeine intake and was reportedly sudden in onset. The patient explained that her tinnitus began during the process of moving between cities. It had become debilitating, negatively impacting her close relationships, ability to work, and motivation to exercise. She performed the Valsalva Maneuver and streamed brown noise through headphones for most of the day to mask her tinnitus. She described a history of childhood otitis media without pressure equalization tubes, asthma,

attention deficit hyperactivity disorder (ADHD), polycystic ovary syndrome (PCOS), and exposure to loud music.

An initial audiologic evaluation was performed that revealed normal hearing thresholds in both ears (Figure 1). Nine months later, a follow-up audiologic evaluation and comprehensive tinnitus evaluation was performed that showed normal hearing thresholds from 250-12500 Hz, bilaterally. Distortion product otoacoustic emissions (DPOAEs) were present in both ears from 750-5000 Hz, indicative of normal outer hair cell function in this range (Figure 2). Her otoacousic emissions are relatively poor at 6000 Hz and higher frequencies, which may be evidence of outer hair cell dysfunction. Uncomfortable loudness levels obtained for both ears were consistent with normal sound tolerance.

Tinnitus pitch and loudness matching procedures were performed in the right ear, as the patient reported no perception of tinnitus in the left ear. The patient's tinnitus was pitch-matched to a 1000 Hz narrow-band noise tone at a 58 dBSL (sensation level). Using broad-band noise, a minimum masking level (MML) was obtained at 45 dBHL for the right ear, masking the right-ear tinnitus. Residual inhibition was conducted in the right ear, revealing that her tinnitus returned approximately two seconds after cessation of the white noise stimulus. A Tinnitus Handicap Inventory (THI) was administered twice, each revealing a score of 100, indicative of a *catastrophic* tinnitus handicap. The Patient Health Questionnaire (PHQ-9) was administered, resulting in a score of 24, which suggests the presence of major depression. The patient indicated that she had already communicated with her primary care physician about her depression. She was encouraged to seek further support from a mental health provider for her depression.

A month later, the patient was assessed by an otolaryngologist and an audiologic evaluation was ordered that revealed normal hearing thresholds, bilaterally. Afterwards,

computed tomography (CT) and magnetic resonance imaging (MRI) were administered, which revealed no significant plaques, lesions, temporal bone fractures, or structural abnormalities. She was cleared to be fitted with hearing aids by her medical provider.

**Management**

Individualized counseling was provided on test results, in addition to the neurophysiological theory of tinnitus, tinnitus habituation, and sound therapy. A monaural Oticon OPN 3 miniRITE (receiver in the ear) size 60 right hearing aid with a double-vented dome was selected, as an open fit should allow the choice of a variety of high-quality sounds for streaming through Oticon's Tinnitus SoundSupport system (Oticon Inc.) while maintaining natural passage of sound. Real ear measures were conducted to verify that the device provided no gain or minimal insertion loss or gain. Four sound therapy programs were added to the device, including a limited-range volume control. Further detailed educational counseling was provided about tinnitus habituation and partial masking, hearing loss prevention and safe sound therapy levels, patience with habituation, cognitive behavioral therapy, and the importance of returning for follow-up encounters for audiologic monitoring.

**Discussion**

Patients with chronic debilitating tinnitus are likely to experience personality traits consistent with anxiety and depression (3). Less than half of those afflicted with tinnitus reveal their condition to a physician, and only 10% of patients with tinnitus are made aware of non-pharmacological treatment options such as utilizing amplification and sound therapy (2). Individuals with distressing tinnitus may exhibit a comorbid connection with anxiety and depression (3). Proper tinnitus evaluation should include measures such as the PHQ to detect incidences of depression and anxiety, along with individualized counseling and a referral to

mental health, if necessary (2). Audiologists should educate patients on the comorbid nature of tinnitus and mental health, and its potential impact on successful habituation. Additionally, audiologists should obtain a thorough case history and audiologic assessment to classify the tinnitus and determine medical cause or rehabilitation (2). Following diagnostics and supporting referrals, it is essential to educate patients on all available tinnitus treatment options to help establish reasonable expectations and ensure proper rehabilitation.

**Conclusion**

This case of a young female patient emphasizes that identifying and managing mental health should be a part of tinnitus management. Chronic, debilitating tinnitus can cause distress for individuals within a range of ages and audiometric profiles. Hence, audiologists should remain abreast of tinnitus habituation protocols in order to provide the most individualized and effective care.

# An Extensive History of Life-Long Noise Exposure

## Abstract

Introduction: Noise-induced hearing loss (NIHL) is a prevalent, yet preventable, condition that can be incurred through various occupational, recreational, and environmental noise exposures. Case Presentation: A middle aged male presented to the clinic with perceived hearing difficulty, tinnitus, and an extensive history of noise exposure. Discussion: Individuals may experience debilitating auditory and non-auditory health consequences related to noise exposure. For workers who are exposed to hazardous occupational noise, hearing conservation programs must be in place to prevent NIHL. For the general public, hearing loss prevention is lacking. Conclusion: Audiologists should engage in community outreach, proactive education, audiometric monitoring, and advise individuals in the community about proper and consistent use of hearing protection devices (HPDs) to expand prevention of NIHL for the public.

## An Extensive History of Life-Long Noise Exposure

### Introduction

An estimated 22 million adults between the ages of 20 and 69 years in the United States have permanent hearing loss that is attributed to recreational or occupational noise exposure, technically classified as Noise-Induced Hearing Loss (NIHL) (5). Sound has the potential to cause irreversible damage at intensity levels of 85 dBA and greater (6). Noise-induced hearing loss can present as a temporary threshold shift (TTS) or a permanent threshold shift (PTS), occurring from an acute traumatic acoustic event or by repeated or continuous exposure to high-intensity sound (5). Characteristic audiometric profiles of NIHL include a *notching* pattern marked by worsening hearing thresholds for high frequencies (3000-6000 Hz), with hearing thresholds from 250-2000 Hz remaining within normal limits (5). Advanced cases of NIHL display *sloping* audiometric patterns as mid-frequency hearing subsequently declines with longstanding noise exposure and increasing age (5).

In 1983, the United States Occupational Safety and Health Administration (OSHA) finalized a federal mandate enforcing mandatory hearing conservation programs (HCPs) for workers exceeding a time-weighted average (TWA) of 85 decibels over the course of an 8-hour workday (8). Notable components of regulated HCPs include mandatory notification of employee noise exposure levels, enrollment in an annual audiometric monitoring program with follow-up referrals as medically appropriate, fitting of appropriate hearing protection devices, and mandatory participation in a training program related to the effects of noise exposure, and the purpose of audiometric monitoring and hearing protection devices (8).

**Case Presentation**

A middle-aged male presented with concerns of a perceived bilateral hearing loss in addition to bothersome bilateral tinnitus. The patient expressed frustration with his tinnitus, stating that it had increased in intensity and was reportedly contributing to frequent headaches and sleeplessness. Further discussion revealed an extensive history of noise exposure to loud sports-racing events, power tools, firearms, and farm equipment as a young adult. Hearing protection devices (HPDs) were used only while at the shooting range and when attending racing events. Communication problems were his primary complaint, particularly difficulty hearing while on the telephone and when participating in group gatherings. He emphasized a reliance on speech reading in order to comprehend conversation and reported a diminished social life related to his communication problems.

Comprehensive audiologic testing was performed that revealed normal hearing thresholds for 250-500 Hz, and a sloping moderate sensorineural hearing loss from 1000 through 8000 Hz in both ears (Figure 1). Tympanometry identified normal ear canal volume, static compliance, and tympanometric pressure in both ears. Speech reception threshold, most comfortable loudness level (MCL), and word recognition performance testing were conducted for the left and right ear. Word recognition testing resulted in *good* performance in the left ear and *fair* performance in the right ear for monosyllabic words presented in quiet. This suggested that the patient was not fully understanding spoken information, even when it occurred at a comfortably loud level. In both ears, MCL levels were recorded at 70 dBHL, roughly 20 dB higher than what is considered average conversational speech intensity level (e.g., 50 dBHL) (refer to Table 1). The patient's MCL levels suggested that he might benefit from customized amplification.

## Management

Individualized counseling was provided on test results, NIHL, tinnitus origins, and treatment. While the patient's audiometric thresholds were inconsistent with typical NIHL threshold patterns, noise exposure should not be excluded as a contributing factor to his hearing loss, given his auditory history. Binaural Starkey Livio 2400 receiver-in-the-canal (RIC) hearing aids with 50-gain receivers and 9mm open domes were physically sampled in the clinic by the patient. He subsequently ordered these instruments after expressing satisfaction with the sound quality and a reduction in tinnitus perception. The Starkey Livio instruments were enabled for Bluetooth streaming to his smartphone and then equipped with a limited-range volume control. During educational counseling, style and consistent use of HPDs were explained in detail, placing emphasis on removing the hearing aids and wearing HPDs when exposed to hazardous occupational, environmental, and recreational noise. Empathetic counseling was provided to generate realistic expectations, continued audiologic rehabilitation, and educate the patient on the importance of follow-up care.

## Discussion

Individuals with loud noise exposure may experience a host of non-auditory and auditory health consequences such as disruptions in concentration and sleep, headaches, tinnitus, depression, and increased stress (7). Further, frequent exposure to loud noise may be associated with higher rates of cardiovascular disease, deficits in cognition, and reduced standardized test scores (7). Hearing threshold shifts can lead to listening problems and difficulty understanding communication. Deficits in communication can create safety hazards, contribute to social withdrawal, and cause diminishing self-esteem (5).

The Occupational Safety and Health Administration (OSHA) and Council for Accreditation in Occupational Hearing Conservation (CAOHC) mandate and enhance hearing conservation programs for workers who are at risk for NIHL (5). Greater effort must be made to educate noise-exposed workers and the general public. Community outreach measures, coupled with early education about loud noise, NIHL, and HPDs, are needed to raise awareness and improve public health (5). Care must be taken to ensure HPDs are providing adequate protection while being used always when exposed to hazardous levels of noise (6). Finally, routine audiometric testing should be performed on individuals with NIHL to monitor and prevent further auditory injury (5), especially when hearing technology has been prescribed, exposure to hazardous chemicals is in effect, or ototoxic treatments are in use, including over-the-counter medications.

**Conclusion**

Hearing conservation intervention should be expanded beyond that which has been mandated by OSHA. The Occupational Safety and Health Administration provides information at a general level but is not sufficient for the individualized counseling and management of those longitudinally exposed to noise. Audiologists should engage in community outreach, including early education, routine audiometric monitoring, and HPD selection. As shown in this case, the HCP does not offer services that are sufficient for the worker's clinical and communication needs.

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**Figure 1 (Case 1)**

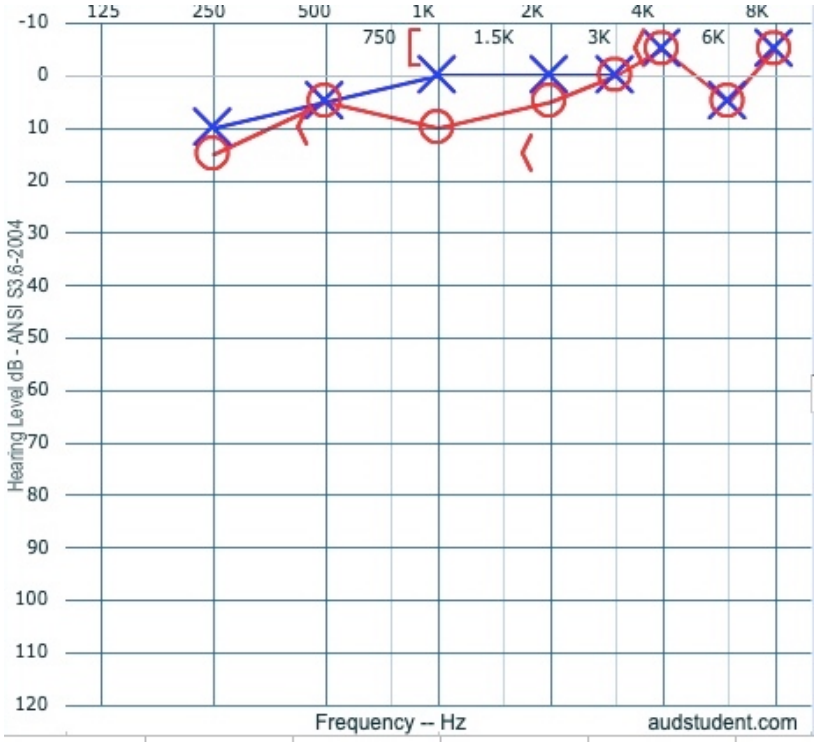


**Figure 1.** Audiometric data for left and right ear, including air and bone conduction thresholds.

**Figure 2 (Case 1)**

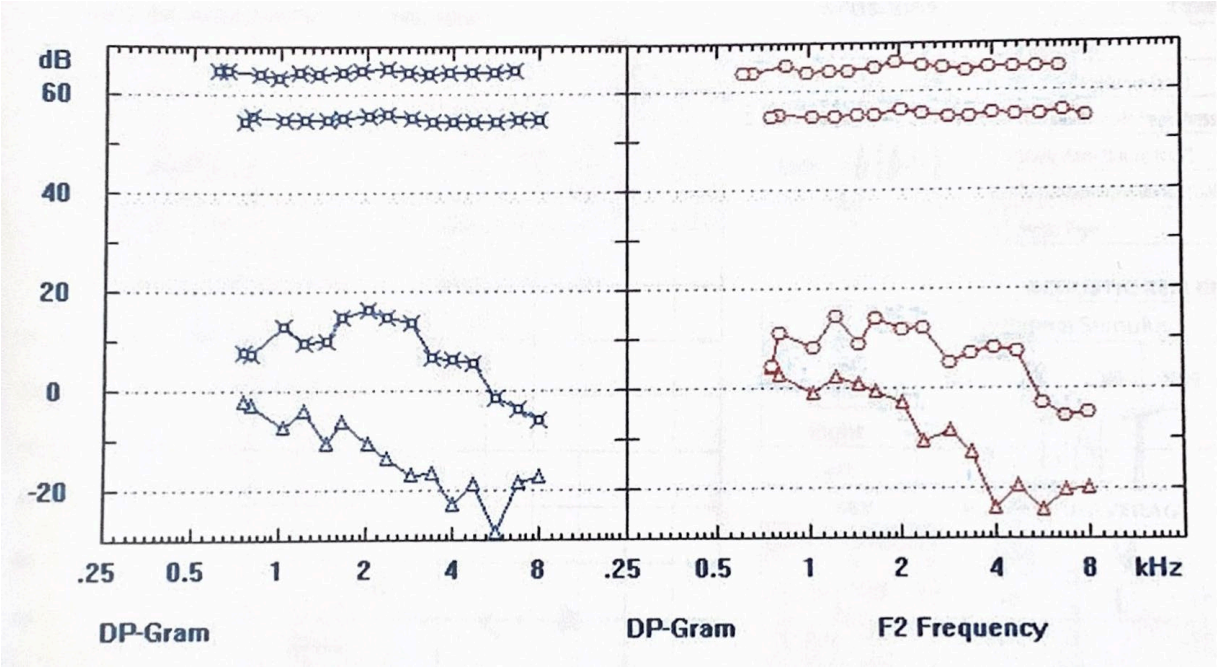


**Figure 2.** Twelve-Frequency Distortion Product Otoacoustic Emissions (DPOAEs) for the left and right ear.

**Figure 1 (Case 2)**

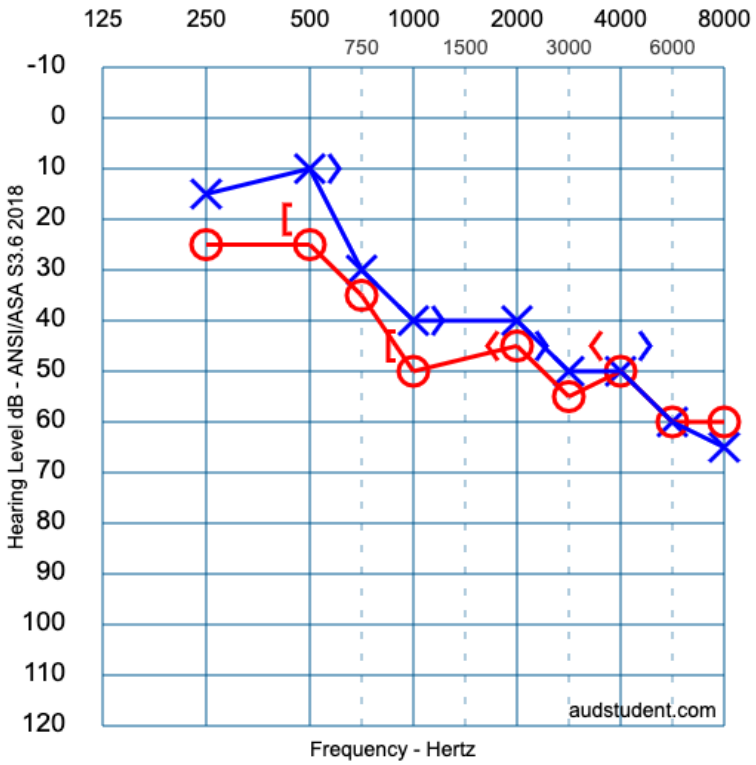


**Figure 1.** Audiometric data for left and right ear, including air and bone conduction thresholds.

**Table 1 (Case 2)**

| | **SRT** | **MCL** | **WRT** | **WRT** ***Percent Correct*** |
|---|---|---|---|---|
| **Test Ear** | **Intensity Level (dBHL)** | | | |
| **Right** | 40 | 70 | 70 | *72%* |
| **Left** | 35 | 70 | 70 | *80%* |

**Table 1.** Speech reception threshold (SRT), most comfortable loudness level (MCL), and word recognition testing (WRT) findings for the left and right ear. Masking for WRT was delivered to the non-test ear at 50 dBHL.