Headaches and Tinnitus

By Dennis A. Colucci, AuD, MA, ABAC, F-AAA

The occurrence of chronic migraine (CM) and chronic tension-type headaches (CTTH) is 3%-4% in the general population.[1] Other headache types occur less frequently but are not necessarily less impactful. Headaches among patients with hearing loss, tinnitus, and hyperacusis occur for various reasons, including noise exposure, diseases, syndromes, injuries, and psychiatric disorders. The pathophysiological between tinnitus and headaches is not always understood, although research has shown a clear relationship between the two conditions.

There are several headache classifications and over 200 subtypes. The interactions are very complex, involving physiological and psychological domains. Some of them are rare and, to the audiologist, noncontributory to treatment. However, the presence of recurrent headaches can be significant when conducting a differential diagnosis, considering amplification, sound therapy, or counseling because headaches impinge on homeostasis, light and sound tolerance, auditory processing[2], cognition[3], sleep, balance, and other functions. As audiologists, concerns over the well-being of individuals are paramount and understanding the patient's health complexities is part of audiological health care, including how headaches may affect individual treatment and outcomes.

Acoustic trauma and noise exposure can result in tinnitus, hearing loss, hyperacusis, headaches, insomnia, and other comorbidities. Sometimes, noise triggers underlying conditions that exacerbate tinnitus, ear pain, and dizziness. For others, underlying conditions initiate a headache that produces or aggravates tinnitus. In the case of headaches, the pathophysiological mechanism which causes tinnitus may not be purely coincidental but has a common link.[4]

HEADACHES

According to The International Classification of Headache Disorders (ICHD) 3rd edition, headaches are classified as *primary*, *secondary*, and *neuropathies/facial pains*.[5] Primary headaches are disorders unto themselves and not associated with other conditions. Primary headaches include migraine, tension-type headaches, trigeminal autonomic cephalalgias (TACs, e.g., cluster headaches), and others. In the "other" primary headache subcategories, activities such as coughing, exercising, cold stimulation (e.g., ice cream headache), external pressure exposure (e.g., flying), or headaches associated with sexual activity are linked. Some have specific sensations

Dr. Dennis A. Colucci is a clinical and forensic audiologist in private practice in Laguna Hills, CA.

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such as stabbing (icepick pain), nummular (small coin-size temple pain), thunderclap (sudden onset-like thunder), and others present with temporal aspects such as hypnic (occurring only during sleep) and a new class of "daily persistent" headaches. These unusual circumstances are real and can significantly impact patients and how they manage their tinnitus, hyperacusis, and hearing loss or follow treatment recommendations.

Many headache types are rare and short-lived (e.g., ice cream headache), while others can be episodic or chronic such as migraine or tension headaches lasting hours to days, with some becoming very persistent. Headache sensations can vary from piercing, throbbing, pulsing, dullness, focal, unilateral, or global, and can be accompanied by neck and shoulder pain.

Headaches can have other effects, such as vomiting, seizure, photophobia, phonophobia, vertigo, hearing loss, smell and taste deviations, fever, tingling, speaking issues, or disorientation, requiring a complete diagnostic evaluation and specific treatments. The physician of choice is a neurologist specializing in headaches and sleep disorders.

For most, headaches associated with tinnitus result from primary or secondary classifications. Of the classifications, migraine and tension-type headaches have a distinct relationship with tinnitus and are the most prevalent. Further, headaches and tinnitus occur from secondary classes such as head trauma, temporomandibular joint dysfunction, whiplash, medications, toxic exposures, and others that audiologists routinely investigate. Migraine and tension-type headaches have specific epidemiology, characteristics, and treatments most relevant to audiology practice. However, trigeminal autonomic cephalalgias and secondary classification headaches should not be overlooked.

MIGRAINE

Migraine headaches are the most prevalent of all ICHD categories. According to the American Migraine Prevalence and Prevention Study, the incidence of migraine or probable migraine is estimated at 16.2%, which is two to three times more common in younger women.[6] Fortunately, the occurrence of migraine decreases with age. Migraine ranks as one of the top five reasons for emergency department visits and a top 20 cause for outpatient visits.[7] Migraine headaches generally last between four and 72 hours with a throbbing sensation due to neurovascular pathogenesis. Migraines come with several sensory and motor abnormalities. In addition, vertigo, dizziness, hearing loss, and tinnitus result from audio-vestibular auras, but the addition of nausea, photophobia, and phonophobia are the primary diagnostic findings. The comorbid factors are what separate migraines from other headaches. Several mechanisms of migraine formation, such as hormone imbalance, genetic and epigenetic impacts, and cardiovascular, neurological, and autoimmune illness, are suggested.[8] Further, the sensations may vary between patients but also within a patient's ensuing episodes. Migraines do not universally cause hearing loss, vertigo, or tinnitus, but when present, the audiogram can be a reverse curve or flat sensorineural hearing loss and tinnitus may be pulsatile. Half of the patients with a vestibular migraine aura will deny an associated headache.[9]

Migraine treatment has been developing in recent years. Depending on the individual needs, acute, preventive, and prophylactic treatment options are available, but less than 13% take prophylaxis.[7] With a better understanding of the biological mechanisms of formation, trials with new medications have shown great promise. Major therapeutic classes of 5-HT1F agonists, calcitonin gene-related peptides (CGRP) antagonists, and glurants, mGlu5 modulators have been developed.[9] Being able to target the receptor systems and enzymes responsible for the biochemistry of migraine has brought science forward.

TENSION-TYPE HEADACHES

Tension-type headaches are the most common type of all headaches affecting 60%-80% of the population. A band of pressure around the head with a dull aching sensation characterizes them. In addition, this type of headache can be associated with scalp, neck, and shoulder tenderness. However, when a headache is no longer mild to moderate, becomes severe and pulsatile, and worsens with physical activity, they are no longer tension-type but are considered a migraine. Risk factors include anxiety, stress, and poor sleep, with tension headaches more common in younger patients. Tension-type headaches can be divided into episodic or chronic. Chronic tension-type headaches (CTTH) affect up to 4% of the population and are more prevalent in women (up to 65%).[10] CTTH is diagnosed when a patient has headaches 15 times a month or more for at least three months. Some tension-type headaches are accompanied by tinnitus, eye pain, and other effects. Treatment for tension-type headaches depends upon the frequency, with the goal of addressing the underlying causes. In some cases, this includes over-the-counter or prescription medication and cognitive behavioral therapy. Remarkably, NSAIDs and other medications can result in overuse headaches and should be used under the care of a specialist.

TRIGEMINAL AUTONOMIC CEPHALALGIA

TACs include cluster headaches, affecting one in 1,000 individuals. These headaches are very disabling and widely described as the most painful human experience. The headaches unilaterally occur in attacks lasting approximately 15-180 minutes.[12] The location of the pain is only unilateral in the supraorbital, retro-orbital, temporal regions. The attacks can occur every other day at the onset but increase up to several times a day as the bout continues.

The most common type of TAC is the cluster headache. In normal practice, they are infrequent, and because of the symptoms, many have a delayed diagnosis. The patients will be seen by a few general practitioners and possibly dentistry and otolaryngology before being referred to a neurologist for the correct diagnosis and management. Cluster headaches are more prevalent in men. Treatment is very different from that of migraine, with a variety of options depending upon attack phenotype and patterns.[12] Episodic patterns have bouts lasting 6-12 weeks, with 3-month breaks, while chronic cluster headaches do not have breaks.

SECONDARY HEADACHES

Secondary headaches develop as a symptom resulting from another condition. These include trauma or head and/or neck injury, cranial/cervical vascular disorders, nonvascular intracranial disorders (e.g., CSF pressure, neoplasms, seizure, or Chiari malformation 1), substance abuse or withdrawal, infections (e.g., meningitis), homeostasis such as intracranial hypertension (e.g., diving, sleep apnea, dialysis), disorders of the cranium, neck, eyes, ears, nose, sinuses, teeth, mouth, other facial or cervical structures, and psychiatric disorders.[5] In some cases, a diagnosis of primary and secondary headaches is warranted depending on the causation, symptoms, and severity.

NEUROPATHIES/FACIAL PAINS

The facial pains and other headaches classifications result from lesions or disease, neuralgia, syndromes, and neuropathies. These include trigeminal or glossopharyngeal neuralgia/neuropathy, occipital neuralgia, optic neuritis, central neuropathic pain from multiple sclerosis, and post-stroke pain.[5] These complications are of particular interest because they could interfere with the use of amplification and other devices. For example, using a hearing aid or telephone can be painful and discomforting for a patient with neuropathy about the face and head. In this case, a near field speaker alternative is helpful.

CONNECTING THE DOTS

The connection between hearing loss and tinnitus comes from our knowledge concerning the pathophysiological mechanism. The reduced neural activity caused by hearing loss results in a downregulation of cortical inhibition, ultimately leading to hyperexcitability in the auditory cortex.[11] As postulated, recognition of

tinnitus is further amplified in the cortex within the higher-order networks, including the limbic system. In patients, tinnitus can be lateralized to an ear or perceived in both, which always begs the question of the site of lesion and causation.

Langguth and colleagues examined the relationship between tinnitus and headaches based on both disorders' laterality and temporal interaction.[4] In their study, 489 out of 1,817 patients reported having headaches on the Tinnitus Case History Questionnaire. Participants were between 18 and 90 years old, with 60.6% being female. Responses were collected from 225, or 46%, resulting in 193 datasets that were analyzed, with 44.6% having migraine, 13% having tension-type headaches, and 5.7% having both. Seventy-nine patients suffered from unilateral or predominantly unilateral tinnitus. After analyzing the datasets, headache laterality, and tinnitus laterality were significantly correlated. The symptom severity also followed the majority of tinnitus and headache fluctuations, with tinnitus and headaches getting better or worse together in 43.4% of the patients, and only 4.8% reported the opposite relationship. Further, they overwhelmingly reported that headaches usually preceded tinnitus, but tinnitus could also trigger headaches. They concluded that tinnitus and headaches were not coincidental and that both disorders have a common pathophysiological mechanism.

In a study by Chen and colleagues in 2019, 43,294 non-migraine patients were studied to determine the occurrence of sudden deafness in non-migraine headache individuals.[13] The control group consisted of 173,176 individuals without headaches. Subgroup analysis revealed a significantly higher risk for tinnitus (aHR 3.05; 95% CI, 2.91-3.29; $P < 0.0001$), sensorineural hearing loss (aHR 1.89; 95% CI, 1.74-2.05; $P < 0.0001$), and sudden deafness (aHR 2.24; 95% CI, 1.77-2.59; $P < 0.0001$) in the headache cohort than controls. These findings suggest that non-migraine headaches are associated with an increased risk of tinnitus, hearing loss, and sudden deafness. This study supports the importance of understanding complaints of headaches and best practice recommendations for medical interventions.

There are instances when tinnitus is one of the presenting complaints in special populations. For example, idiopathic intracranial hypertension occurs at the rate of 1-2 per 100,000 per year. In obese women, the rate is much higher, affecting 19-21 per 100,000.[14] Obese women in their 20s are most susceptible, although men also suffer from this disorder at a much lower rate. The symptoms include headaches, vision loss, diplopia, nausea, and tinnitus. The tinnitus may be throbbing or pulsatile, but the headache is not. In this case, hypertension is the cause, the headaches fall in the secondary classification, and tinnitus is a symptom. The goal of treatment in this case is to prevent vision loss.

In unilateral pain hyperacusis, which defines a peripheral origin, the medial olivary complex nociception feedback loop fails to modulate noxious stimuli from the outer hair cells.[15] Instead of responding to sound, the damaged neurons respond like somatosensory neurons without limits. In some cases, shocking ear pain coincides with a severe non-pulsatile headache with loud tinnitus that lasts for hours. This is an example of a secondary headache that arises from an ear disorder caused by injury.

Meniere's disease is one of the most prominent conditions that audiologists frequently encounter. Although hearing loss, tinnitus, and vertigo complaints are typical, variations do exist. There has been considerable speculation over many years about the connection between migraine and Meniere's disease, starting with Prosper Meniere in 1861, who first suggested the pathophysiology creating Meniere's disease is closely related to migraine. According to Brooke and associates, up to 51% of individuals with Meniere's disease have migraine headaches compared with 12% in the general population.[16] It has been reported that patients who complain of cochlear and vestibular migraine are those with cochleovestibular migraine or Meniere's disease. As audiologists, the co mplaint of tinnitus should not always be attributed to well-known causations but be a red flag for considering other disorders or injuries, especially when noise exposure or age are not apparent contributors. Being mindful of the connection between headaches and tinnitus to a variety of causes and complaints, directing the patient to the appropriate specialist, and using best practices to help the patient succeed are always paramount. The relationship between headaches and tinnitus is not coincidental.

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