Approaches to Tinnitus Management and Treatment

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ABSTRACT

Tinnitus continues to challenge patients from all walks of life and clinicians from a variety of disciplines. The lack of an evidence base to support a specific treatment confounds efforts to provide consistent benefit to patients and in many instances creates in the patient the impression that nothing can be done to improve their situation. Part of the problem is that although patients rarely experience complete elimination of a tinnitus signal, they often experience relief when receiving effective counseling, specific coping strategies, and sound therapy. Although in most clinical activities the tinnitus remains (i.e., it is not cured), its influence may wane as the patient learns to manage their environment, activities, and ultimately their response to tinnitus. At the same time, several medical interventions target reduction of the tinnitus sound, an approach more consistent with what patients expect as a cure. Therefore, the majority of clinical activity directed at care for patients with tinnitus typically targets either elimination of the tinnitus sound (tinnitus treatment) or modification of the patient's response to the sound (tinnitus management). This review distinguishes and offers examples of both treatment and management programs employed clinically for patients with tinnitus.

KEYWORDS: Tinnitus, sound therapy, auditory training, cognitive behavioral therapy, neuromodulation

Learning Outcomes: As a result of this activity, the participant will be able to (1) distinguish tinnitus treatment objectives from tinnitus management objectives and (2) provide patients with information regarding intervention strategies, goals, and their anticipated outcomes.

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Because tinnitus is an unusual sensory experience, the perception of a sound with no corresponding environmental event, its effect on patients is difficult to predict and manage. Tinnitus affects ~10 to 15% of the population in most demographic studies, and therefore it is likely that tinnitus affects more than five hundred million people worldwide.[1] Tinnitus sounds may take many forms, such as high-pitched tones, buzzing, insect sounds, and whistling, among many others. Although clinicians lack an evidence base for settling on specific tinnitus interventions, the possibility that a patient with tinnitus can experience substantial relief even as the sound experience persists, encourages clinicians to provide a variety of options for patients who seek services for their problem.

Clouding the audiologist's approach to tinnitus management is the observation that although decades of research indicated that the majority of patients with tinnitus experience some degree of hearing loss, there is no clear relation between tinnitus distress and auditory sensitivity.[2] Additional findings confirm that at least 50% of all patients with tinnitus suffer from comorbid psychological injury (such as posttraumatic stress disorder) or psychological illness (such as depression, anxiety, or obsessive-compulsive disorder).[3,4] There is no cure for the majority of patients who struggle with the tinnitus sensation, and it is often the case that an intervention deemed successful for one person will fail when applied to a different person. Therefore, the terminology used to discuss tinnitus interventions must be carefully chosen to differentiate tinnitus "treatment" from strategies that promote the patient's "management" of their response or reaction to the tinnitus sound. This idea is not new, as Tyler distinguished objectives of tinnitus interventions with respect to amelioration of the response from reduction of the sound.[5]

The current state of tinnitus intervention strategies may be appreciated by a reading of the Cochrane Reviews related to tinnitus. At present, there are 14 Cochrane Review articles outlining different tinnitus interventions (see http://www.cochrane.org/search/site/tinnitus for full list)[6] including such diverse approaches as biofeedback, tinnitus retraining therapy (TRT), antidepressants, hyperbaric oxygen treatment, ginkgo biloba, and hearing aids. None of the Cochrane Reviews indicate an intervention approach to be more effective than placebo in a controlled randomized trial. Yet hundreds of clinics advertise tinnitus therapy/management services, and thousands of patients with tinnitus have benefitted from interventions over the years. Although the evidence base for specific tinnitus interventions is lacking, anecdotal reports and responses of patients on tinnitus handicap scales across numerous studies confirm that, indeed, patients can navigate through their tinnitus disruption and find durable benefit from techniques that have not yet been shown to outperform placebo interventions in controlled trials.

This article will review clinical strategies that purport to "treat" tinnitus, as well as those whose focus centers on improving the patient's reaction to bothersome tinnitus. Within each category (treatment and management) the strategies will be described and summarized. Although an all-encompassing review of tinnitus interventions is beyond the scope of this article, some of the more effective and commonly employed strategies are presented. It is hoped that this representative sample will assist clinicians in their decision making and interactions with patients whose tinnitus challenges patient and practitioner alike.

TREATMENT VERSUS MANAGEMENT

Ideally, tinnitus interventions would provide clear and unambiguous relief from the experience by eliminating its perception. Unfortunately, a patient's tinnitus is rarely abolished consistently or long term, and even when bothered by tinnitus, the patient may observe moments of relief interspersed with moments of distress regardless of their chosen tinnitus intervention. Additionally, patients who seek tinnitus treatment are often confounded by the myriad counseling and sound therapy approaches that cannot promise a "cure." Perhaps one way to begin addressing this situation is to differentiate the terms *tinnitus treatment* from *tinnitus management*. In our definition, an intervention that purports to provide *tinnitus*

treatment must have as its objective a substantial decrease or the elimination of the tinnitus sound. By comparison, an intervention that targets the patient's response to the tinnitus or their reaction to its presence would more reasonably be called a *tinnitus management strategy*. Differentiating these terms is important to address both the expectations of the patient as well as the goals of the clinician. If a patient and their clinician are in clear agreement on the objectives of the intervention, then both parties will be able to identify strategies that reduce tinnitus distress and annoyance while reducing the frustration that arises when confronting the well-known lack of a cure for most tinnitus cases.

TINNITUS TREATMENTS

Approaches that require the label of tinnitus treatment include those strategies that interfere with or eliminate the neural activity associated with tinnitus. For example, surgery for otosclerosis, placement of deep brain implants, or repetitive transcranial magnetic stimulation (rTMS) would qualify for treatments in this scheme as they are interventions that target specific otologic problems associated with tinnitus or neural generating sites of tinnitus signals.[7,8] Cochlear implants also may be categorized with these treatments, although the use of the cochlear implant for tinnitus relief is typically secondary to the provision for the patient of auditory input.[9] Drugs and supplements may also be considered tinnitus treatments when their administration is intended to eliminate the sound rather than targeting primarily psychological distress.

Medical Interventions

Due to its potential complicating conditions and adverse effects, medical intervention for tinnitus is indicated in a minority of patients. Such interventions may be divided into two categories: pharmacological and surgical. In both categories, the nature of the treatment depends upon co-occurring conditions and/or the tinnitus source. Intratympanic injections of drugs, surgical sectioning of the VIIIth nerve, or other otologic procedures have been ineffective or worse in several cases, and consequently are no longer conducted on patients for subjective tinnitus unless an otologic disease, such as otosclerosis, exists.[8,10] Recommended use of psychotropic agents is now limited primarily to those individuals with comorbid psychological disorder to maximize the ratio of benefit to risk.[11] Therefore, it is essential to triage patients with tinnitus thoroughly to determine the potential benefits of referral to a psychologist/psychiatrist, as well as to identify those patients for whom aggressive medical intervention is indicated.[12]

Surgical Intervention

Kleinjung indicated that surgery has a "definite role" as an option for the management of tinnitus when the tinnitus is linked to specific pathological conditions.[7] For example, when surgery is performed to improve hearing, as in cases of conductive hearing loss, then the patient may observe reduction of tinnitus. Surgery in cases of dangerous vascular disorders or malformations may reduce the effects of objective (usually pulsatile) tinnitus.[13] Patients with Meniere's disease may notice changes in tinnitus following surgery; similarly patients with temporomandibular joint syndrome may observe postsurgical reduction in tinnitus.[8] Several newer, invasive interventions that utilize electrode implants require surgery, and are reviewed later. For the most part, however, because tinnitus generation occurs at central rather than peripheral sites, surgery focused on the ear or the VIIIth nerve for decades has failed to reduce tinnitus more often than not.

The strongest indications for surgery address pathological conditions that produce tinnitus as a secondary effect. Patients with middle ear disease such as chronic perforation or otosclerosis experience reduction or abolition of the tinnitus signal at rates from 30 to 80%.[6] In cases of Meniere's disease, a variety of surgical techniques have been employed, and success rates vary depending upon the procedure's objective. For example, Meniere surgery often prioritizes reduction of vertigo, and any tinnitus-related improvements would be coincidental. Labyrinthectomy with VIIIth nerve section was shown to eliminate vertigo in nearly 100%

of cases, whereas tinnitus severity was decreased in 70%.[14] Microvascular decompression surgery may reduce tinnitus severity; however, the benefits related to restoration of normal head and neck vascular activity outweigh resulting changes to tinnitus.[15] Indeed, as is the case with all surgical approaches, the risk of infection, exacerbation of hearing loss, or other adverse reactions confirm that surgery intended primarily to reduce tinnitus should be undertaken in only the most handicapping cases.

Another example of surgery designed to improve auditory system function that may produce benefit for patients with tinnitus is cochlear implantation. Several studies have demonstrated tinnitus reduction in nearly 90% of implant patients.[16] In cases of bilateral tinnitus, unilateral implantation reduces tinnitus severity in 12 of 14 patients (86%), whereas the remaining two reported an increase.[17] It is unclear whether the change in tinnitus severity is related to the masking of tinnitus through activation of the auditory pathway or whether an alternate mechanism is involved. In any case, implant candidates with bothersome tinnitus may experience benefit from surgery in addition to the restoration of audibility.

Some recent surgical approaches involve functional magnetic resonance imaging (fMRI)-guided or neuronavigated electrode implantation intended to provide auditory cortex stimulation that has the potential to suppress tinnitus.[18,19] The process requires that two problems be addressed. First, the specific location in the auditory cortex associated with tinnitus must be determined; typically, the region will be investigated by assessing results compared between tinnitus pitch matching tasks and the auditory cortex regions related to the perceived tinnitus sound. This may be accomplished using fMRI or a process known as *magnetoencephalography*. Second, the results from the imaging of cortical activity must be analyzed for hyperactivity in areas outside the primary auditory cortex. The specific cortical areas identified during the scanning procedures may be targeted noninvasively through the use of transcranial magnetic stimulation. If the patient observes a reduction in tinnitus when transcranial magnetic stimulation is applied, then the prognosis for improvement as a result of an implant is good. In those cases in which implantation would be indicated, the electrode is activated by a pulse generator, similar to a pacemaker, whose output characteristics can be controlled remotely. Results from those patients completing the electrical stimulation process demonstrated complete tinnitus amelioration.[18]

The electrode placement technique is of course highly invasive. Three different placement methods have been described: extradural placement immediately overlying secondary auditory cortex; intradural placement, on the surface of the brain, in a groove or sulcus of the primary auditory cortex; or intradurally, inside the brain itself, similar to a deep brain implant. Complications from the implant surgery are rare but can be severe, including seizures (3 of 43 patients). Intradural implants in a study of four patients produced intracranial bleeding and associated speech disturbances in one patient. Less severe side effects may include vertigo, feelings of intoxication, or localization difficulties, as well as feelings of aural fullness.[18]

Repetitive Magnetic Stimulation and Neuromodulation

Although specific causes of tinnitus may remain obscure, one overriding event must be associated with its persistence as a perceivable event: there must exist in the patient some degree of altered and ongoing neural activity in the central nervous system in general, and in the central auditory pathway in particular.[20–22] As changes in firing rates, cortical maps, neural synchrony, and spectrotemporal coding have been associated with tinnitus generation and maintenance, it is often the case that many different brain areas or networks are associated with the tinnitus signal. Therefore, treatment strategies should target normalizing the changed neural activity. According to Langguth and De Ridder,[23] this can be accomplished in two ways. The first is to restore audibility through the use of hearing aids, cochlear implants, or auditory implants. Such an approach does not directly modify existing pathways so much as it restores the representation of external sounds in the auditory cortex. The second is to directly influence pathway activity through

electrical stimulation, such as transcranial direct current stimulation (tDCS) or rTMS.

When rTMS or tDCS are employed the result is a modulation of neural activity that can be controlled by an experimenter or clinician. Suppressive effects on neural activity have been shown using both techniques, and although the optimal stimulus characteristics for each patient must be identified, the procedures provide the potential for long-term tinnitus amelioration.[23–27] The two procedures differ with respect to the mode through which stimulation is provided; however, both are reasonably safe and may be implemented in a clinical setting, albeit with costly equipment. At this time, rTMS has received far more attention in the literature.

Patients who undergo treatment with rTMS experience a strong electromagnetic field applied to the brain through magnetic coils placed on the head. The effects of rTMS persist beyond the period of time through which the stimulus is provided; therefore, the potential exists for the amelioration of tinnitus to endure. The electromagnetic field serves to reduce the effectiveness of synapses in neural circuits, some of which would presumably be associated with tinnitus.[27] Several investigations, for example De Ridder et al, indicated stimulus parameters associated with effective tinnitus reduction.[28] If the neural circuitry implicated in tinnitus generation and persistence is altered, then the tinnitus signal should be affected. In several studies reviewed by Meng et al,[29] the technique has produced generally positive results in a variety of patient groups. Side effects include involuntary muscle twitching, as well as mild discomfort at location on the skull on which the coils are centered or at which the magnetic field is directed. Although rTMS can produce seizures when administered incorrectly, the procedure's risk has been greatly reduced through the development of safety guidelines.

Pharmacological Intervention

Historically, the use of drugs for the treatment of tinnitus has been driven by the high rate of comorbid psychological disorder in the tinnitus population. If a drug can be prescribed specifically for depression, for example, and if the patient's tinnitus is ameliorated to some degree as the medication acts on their depression, then it is tempting to credit the drug with not only addressing the depression, but the tinnitus as well. Unfortunately, drug trials have consistently failed to demonstrate more effectiveness than placebo in randomized controlled trials of patients who have tinnitus without diagnosed psychological disorder.[30,31] It is therefore difficult to determine conclusively whether the drug ameliorated tinnitus or whether it ameliorated the effects of a psychological condition that exacerbated tinnitus.

Antidepressants that have been used for tinnitus include several families of drugs, including selective serotonin reuptake inhibitors, benzodiazepines, and tricyclic antidepressants. All of these drugs have well-documented side effects that should limit their use; nevertheless, they are prescribed often to patients with tinnitus due to their effects on anxiety, depression, and sleep.

Anticonvulsants were thought to have potential with regard to tinnitus amelioration due to their effect on burstlike activity in the central nervous system.[32] Because tinnitus is associated with such activity, the drugs, which are used primarily for patients with epilepsy, have been tested for reduction of tinnitus. As with other drug groups, results have been inconsistent; their use specifically for the amelioration of tinnitus is not recommended. An interesting finding reported by Levine in 2006, reviewed by Elgoyhen and Langguth,[33] indicated that anticonvulsant medication could reduce annoyance produced by tinnitus associated with a vascular cause, in this case, clicking or "typewriter" tinnitus.

An important exception to the inconsistent benefits demonstrated in drug studies relates to treatment of tinnitus associated with sudden hearing loss. Systemic or intratympanic steroid, vasodilators, or antiviral administration remains the preferred treatment in such cases. Recovery of hearing loss and reduction of tinnitus occur in some patients; however, when sudden hearing loss is not treated, patients do not recover as consistently.[34]

The lesson to take from drug studies is that although no drugs consistently outperform placebo, some drugs may be effective for specific subgroups of patients. The identification of

patient subgroups whose tinnitus arises from identifiable sources and is affected by specific pharmacological agents could facilitate more efficacious use of drugs for tinnitus in the future.

Audiologic/Sound-Based Interventions

Several protocols purporting to treat tinnitus incorporate the use of masking sound to reduce tinnitus awareness. Strategies include delineating masker spectra to promote, or limit, modifications in the central auditory pathway's tinnitus-related activity. Unfortunately, the myriad approaches to the putative therapeutic use of sound in many cases contradict one another conceptually, thereby clouding the clinician's interpretation of data. Rather than focus on specific products, this review will highlight the different theoretical approaches to sound therapy as applied to patients with tinnitus. Enriched acoustic environments influence the amount of cortical reorganization that occurs in noise-exposed animals.[35] As cortical reorganization may be a predisposing condition to tinnitus development, the benefits of sound therapy also should be viewed with respect to their influence on long-term auditory system stability. If we consider noise exposure as a potential cause of tinnitus generation, and if cortical reorganization is a predisposing condition for bothersome tinnitus to persist, then the finding that an enriched acoustic environment minimized such plasticity has great implications for tinnitus treatment, particularly for those patients at risk for, or suffering the immediate effects of, noise trauma.

Enriching the environment acoustically is consistent with the advice provided for most patients with tinnitus: avoid silence. In Noreña and Eggermont's work,[35] however, the value of sound enrichment is not to distract a patient, or to mask tinnitus, rather it is to minimize changes in the auditory system's response to noise damage. It remains to be determined whether such an approach will have a durable influence on the development of tinnitus-related auditory pathway events in humans. Their data, reported through the past several years, provides compelling results from animal subjects.[35]

A more direct masking effect observed through the past several decades is the phenomenon of residual inhibition (RI), which refers to the postmasking reduction or abolition of a tinnitus signal.[36] The effect is typically short-lived, on the order of 1 to 10 minutes depending on masking stimulus characteristics. Although it is possible for some patients to observe a complete or partial reduction in tinnitus loudness, the effect is fleeting and inconsistent. It most typically appears during clinical evaluation following the so-called minimum masking level test, in which the masker level required to mask tinnitus is assessed. Upon the offset of the masker, the patient may report that the tinnitus is no longer audible. For most patients, the sound either gradually or suddenly returns to its prior level[36]; and therefore RI does not generate enthusiasm among researchers.

TINNITUS MANAGEMENT

With regard to the current clinical state of affairs, it must be acknowledged that the vast majority of tinnitus interventions, and certainly the least invasive, target the improvement of a patient's tinnitus management skills. Management strategies may be counseling based and individualized to each patient's particular needs, such as cognitive behavioral therapy (CBT),[37,38] self-efficacy training,[39] or patient-centered approaches.[40] Others may focus on the development and delivery of therapeutic sound with varying degrees of counseling, and there are many "canned" sound programs that fit this description. Other management strategies, such as TRT[41] and Neuromonics Tinnitus Treatment© (NTT) (Neuromonics, Inc., Westminster, CO),[42] utilize both sound enrichment and a more thorough, although not necessarily individualized, counseling element. Additionally, methods such as biofeedback that are employed for many different health issues target specific ways in which a patient can train themselves through imaging and monitoring body activity (such as respiration rate and heart rate) to foster a sense of relaxation even when experiencing stress.

Audiologic/Sound-Based Interventions

Other than palliative care, the use of external sounds intended to interfere with a person's ability to perceive tinnitus likely represented the first technique employed to reduce tinnitus suffering. Early efforts to mask tinnitus were described by Stephens,[43] and although the methods by which masking could be achieved have been studied and improved, the tinnitus signal obstinately remained an attentional target for the distressed patient. Sound-based interventions are typically used to foster a patient's ability to manage the response to tinnitus; they do not eliminate tinnitus, they remove it as a detectable symptom for the time during which they are used.

It must also be noted that sound therapy in isolation, without concurrent counseling, was less effective than when offered with counseling.[44] This situation reinforced the notion that sound alone is not enough to reduce tinnitus severity and that disruption caused by tinnitus relies to a large part on the patient's understanding of tinnitus as well as their psychological response to the sound.

An additional benefit of using sound has emerged following the discovery that cortical representations of sound undergo plastic modifications following damage to peripheral mechanisms. This finding indicated that the primary auditory cortex organization maintains the potential to change beyond those parameters established during early development. The process of masking, then, is more accurately described as one of auditory training. As reviewed by Roberts and Bosnyak,[45] the provision of external sounds that would serve auditory training objectives may be presented using four paradigms: (1) masker energy could either overlap the tinnitus pitch region; (2) it could stimulate frequencies other than those associated with the tinnitus sound; (3) either type of masker then could be presented as a target of active listening, for example in an auditory discrimination task; or (4) passive listening, as with a background noise. Because tinnitus represents a change in auditory pathway function, and because training influences the organization and activity in the pathway, the use of sound to influence activity in the pathway prioritizes the conditions that modify or reduce tinnitus-related activity. Sound enrichment for patients with tinnitus therefore serves two purposes: sound may provide temporary relief or foster relaxation as it influences the activity in the auditory pathway associated with tinnitus maintenance.

Sounds used for tinnitus relief typically employ one of three strategies[46]: (1) masking sounds that may reduce the contrast between tinnitus and external sounds, thereby promoting habituation; (2) specific sounds that the patient finds soothing or relaxing may promote a sense of relief from the anxiety or stress caused by tinnitus; and (3) sounds that are interesting or attention grabbing may provide relief as they distract the patient from a bothersome tinnitus sound. It is also the case that for some patients, the presentation of a masking signal may produce a temporary decrease or elimination of the tinnitus sound, a RI of the tinnitus-related neural activity. As indicated previously, although RI is intriguing, there are no conditions under which it can be maintained for more than a few minutes.

These three types of sound enrichment are utilized in progressive tinnitus management (PTM), which is a comprehensive clinical protocol employed at dozens of Veteran's Affairs Medical Centers. Henry et al described PTM in great detail, from triage to use of sound supported by counseling.[12,46] The triage element, in particular, is of great value to clinicians as it provides intake criteria that indicate the need for interdisciplinary care and referrals to related professions, such as otolaryngologists, mental health, and emergency care. Based upon intake information, patients should be able to access appropriate professionals and services.

Central to PTM is the determination of a patient's level of handicap or need for intervention. For example, some patients require only basic information and an audiologic evaluation that can be completed in a single visit. Others require more attention and information, perhaps in a group setting with other patients similarly affected. This approach is a form of stepped care,[47] which is intended to organize access to health care based on the degree of patient need. As patients receive these different levels of care they are either released from the clinic or passed to another level of interaction

with the tinnitus team members. Sound therapy devices and extensive individual counseling sessions may be employed for those patients who experience severe tinnitus handicap. The PTM protocol is explained in a "cookbook" fashion that is employed in many Veteran's Affairs facilities. The program's objective is to provide patients with information and specific strategies so that they can manage the effects of their tinnitus effectively.

The number of distinct, commercial sound-based approaches suggests that no single strategy addresses tinnitus severity in a manner that satisfies adequately patients and clinicians. Additionally, some approaches employ masking sounds whose spectra overlap the tinnitus pitch (i.e., white noise, narrowband noise centered on the tinnitus pitch, music), whereas others (notched noise) deliberately remove energy from the tinnitus pitch region to promote auditory system activity in neighboring, and presumably less-impaired, frequency regions. Clinicians should be aware that these two seemingly different approaches are not mutually exclusive, nor does benefit achieved with one approach indicate that the other approach lacks value.[45]

Hearing aids provide a method by which sound may be delivered therapeutically in a manner that highlights both of the objectives stated above. Hearing aids amplify environmental sounds, many of which are relaxing or provide information that allows the patient to feel more secure in their surroundings. Hearing aids also may restore audibility in frequency regions associated with deprivation-related changes in pathway activity.

Searchfield provided helpful and flexible guidelines for the effective use of hearing aids in patients with tinnitus and hearing loss.[48] The logic was clear and similar to the rationale for surgery: if an intervention improves hearing or restores audibility, it should be implemented. Searchfield recommended setting hearing aids to facilitate both communication as well as amplification of low-level environmental sounds. Consider an aid with multiple programs; the first program could employ gain based upon the prescriptive method of the clinician's choice. The patient would choose this setting as a default in most situations, with directionality, noise suppression, and to restore audibility of speech sounds. A second setting would be used when the patient was in quiet environments, and would provide substantial gain at low level inputs, high compression ratios across frequency, omnidirectional microphone, and no noise suppression. Searchfield recommended open-fit devices whenever possible, again to allow environmental sound to be used as masking energy and to minimize the occlusion effect. Patients fit with hearing aids would benefit from a thorough hearing aid orientation, information regarding tinnitus mechanisms and effects, and, as with any fitting, counseling regarding realistic expectations.

Another sound-based regimen that has received attention in the literature and in practice is the NTT.[42] Several studies have been conducted using this acoustic desensitization protocol that tailors the sound presented to patients with the intent of promoting relaxation/distraction from tinnitus, as well as habituation to the tinnitus signal. Acoustic desensitization relies upon measures of sensitivity and loudness tolerance that provide to NTT's proprietary processing algorithm a patient's optimal device settings. The NTT devices should produce both relaxing sound levels for the patient as well as stimulation of auditory pathway components affected by hearing loss and/or tinnitus-related activity. It prioritizes reversing the effects of deprivation on the auditory pathway. The protocol's developers have contributed the majority of NTT studies and there remains a need for independent investigations. The uncertain long-term effects and lack of head-to-head comparisons with other sound-therapy regimens have tempered enthusiasm for NTT and reinforce the need to counsel patients extensively regarding realistic expectations. Some reports indicate that the sound-based intervention promotes, in addition to distraction from tinnitus, habituation to the tinnitus signal manifested as reductions in perceived tinnitus handicap as well as reduction in tinnitus loudness.[42,49]

Nutraceuticals/Supplements

Pharmacological agents such as the antidepressants identified above, could be designated as

treatments in the unusual case that they would be prescribed specifically to reduce the perception of tinnitus. Although these medications do not exert substantial influence on auditory system activity, they may address problems caused by comorbid psychological disorders, such as depression or anxiety, as well as psychological injury such as posttraumatic stress disorder. Similarly, nutraceuticals, such as ginkgo biloba and different vitamin supplements can be administered with the intent of addressing a patient's physical condition, and, by doing so, influencing the handicap produced by tinnitus. Although none of these agents have been shown to outperform placebo in controlled studies, anecdotal evidence and uncontrolled studies suggest that some patients receive benefit from their use.[50,51]

Despite the plethora of complimentary medical interventions, a few supplements have received the majority of the attention for their potential as tinnitus modulators. Zinc, ginkgo biloba, antioxidants, and a few selected vitamins provide the most consistent promise and have garnered the most attention in the literature. Zinc, in particular, has been investigated in several studies.[52] Shambaugh reported that zinc deficiencies, particularly in elderly patients, were associated with bothersome tinnitus.[53] Zinc is concentrated in the brain at a higher level than elsewhere in the body, and it has been implicated in the activity in several brain areas known to be influenced by tinnitus, such as the hippocampus. Although an individual's zinc levels may be difficult to measure, hypozincemia has been compared across individuals with respect to hearing thresholds and tinnitus severity. In Mazzoli's review,[51] a 2003 study by Ochi et al was cited in which zinc levels were measured in patients with tinnitus and compared with both hearing thresholds and tinnitus severity. Their findings demonstrated that serum zinc levels were not correlated with sensitivity, but that they were associated with tinnitus. Because peripheral sensitivity did not appear to rely on zinc levels, the authors concluded that zinc deficiencies were consistent with tinnitus whose origin was central rather than otocentric. Several studies utilizing zinc have shown that the association between zinc levels and tinnitus suggest that for some patients its use as a supplement can support the concurrent use of other management strategies.[52,53]

Ginkgo biloba extract is one of the more ubiquitous therapeutic agents in the history of complementary medicine. With respect to its effect on tinnitus, ginkgo study outcomes were reported in a Cochrane Review.[54] Unfortunately, the majority of studies investigating ginkgo's effectiveness suffer from methodological problems that cloud interpretation of the results. Although no controlled studies have demonstrated consistent benefit, anecdotal reports indicated that some patients observed decrease in tinnitus severity following its use.[55] Because ginkgo's effects may be inconsistent and unproven, the potential benefits might not outweigh its side effects for some patients. The extract is a well-documented vasodilator and therefore may increase a patient's bleeding, particularly when taken concurrently with aspirin or other blood thinners.

Antioxidants have been suggested for use as prophylactic or rescue agents in cases of noise-induced or ototoxic damage.[56] Because tinnitus is often a side effect of such exposures, the use of agents that reduce or repair associated inner ear damage could have benefits that influence tinnitus severity. The generation of damaging reactive oxygen species in inner ear tissues results from a variety of sources: aminoglycoside antibiotics, chemotherapeutic agents, industrial solvents, and, of course, traumatizing noise levels. Several vitamins have antioxidant properties, such as vitamins A, C, and E. Other, stronger antioxidants such as D-methionine have been shown to provide inner ear protection or to reverse damage[56]; however, these agents have not consistently reduced tinnitus severity. Indeed, it is likely that the most benefit from antioxidants will be related to the prevention of damage that leads to tinnitus rather than to reduce tinnitus severity per se.

Counseling/Psych-Based Interventions

Recent reports,[38,57] as well as those completed decades ago,[37] indicated that CBT provided consistent and substantial benefit to patients with respect to the amelioration of psychological distress and quality-of-life measures. For the

most part, tinnitus loudness was not altered by CBT; rather, the patient's response to the tinnitus became more manageable and less handicapping. CBT centered in this work on a modification of inaccurate patient beliefs and the way these beliefs influenced patient behaviors. Its application included modules that provided education and counseling to patients with the goal of fostering relaxation and behavior modification. CBT has been used in a variety of clinical settings, often with other forms of psychoeducational training, mindfulness-based training, and for patients with tinnitus, sound therapy.

Cima et al completed a large randomized-controlled trial with 492 patients and demonstrated that patients receiving CBT showed significant improvement on quality-of-life measures as well as decreased levels of tinnitus impairment and severity.[38] The authors employed a multidisciplinary clinical team including clinical psychologists, social workers, audiologists, movement therapists, physical therapists, speech-language pathologists, and otolaryngologists. Patients in the experimental group completed a 12-week set of interactions with the audiologists and other team members, and their progress was measured at 3-, 8-, and 12-month intervals. Quality-of-life and tinnitus severity measures were clear: the patients benefitted from the CBT regimen more than from standard care.

Although a CBT program may be beyond the ability of most audiologists to provide on their own, these studies should serve as a reminder that tinnitus management services are most effective when presented in an interdisciplinary format. Oftentimes CBT is offered in group formats, although Cima et al employed both group and individual sessions.[38] Most patients receiving CBT complete an 8- to 12-week course during which time they are counseled and provided real-life examples of activities and target behaviors designed to minimize the influence of tinnitus as a detriment to quality of life.

CBT also may include an element of mindfulness-based training.[58] Mindfulness techniques include meditation, yoga, relaxation, and breathing practices designed to foster a sense of calmness. It can be practiced at any time providing the circumstances lend themselves to an intended shift in attention. Measurements from studies employing mindfulness exercises demonstrate that its effects change the balance between sympathetic and parasympathetic nervous system activity. These changes are consistent with a shift to greater parasympathetic activity and include heart rate variability and decreases of systolic blood pressure, pulse, and respiration rates.[59] Not surprisingly, it also was found to be therapeutic for chronic conditions such as depression, anxiety, and chronic pain.

Another tinnitus management protocol with links to CBT is TRT.[60] Both interventions use counseling to influence a patient's beliefs and reactions; however, TRT employs sound enrichment strategies, usually with a form of broadband masking, intended to decrease the perceived strength of the patient's tinnitus as well as to improve loudness tolerance for those patients with hyperacusis. Based on the neurophysiological model of tinnitus,[61] TRT is practiced and reported on in clinics across the globe. The counseling approach and specific use of sound have evolved somewhat over the years in a way that encourages more clinical flexibility with regard to masker level and the amount of interaction during counseling with the patient.[62]

A few management approaches focus counseling and interaction with patients on an individualized, patient-by-patient basis. Self-efficacy training prioritizes the identification of thoughts and activities that influence a patient's ability to manage chronic health or psychological conditions. Patient outcomes and compliance with medical intervention is improved as patients establish specific levels of confidence in their ability to manage challenging physical or psychological conditions.[63] Self-efficacy training centers on improving patients' level of certainty that they can accomplish specific tasks, for example, diabetics needing to inject themselves with insulin when the initial ability to do so is poor due to a fear of needles. In tinnitus self-efficacy, management of tinnitus is enhanced as a patient's beliefs regarding their ability to control the effects of tinnitus improve. The clinician can target specific life activities, identified through interview

with a self-efficacy scale,[39] and can support through incremental achievements the patient's belief that they can successfully control some of the most bothersome aspects of tinnitus. Items related to tinnitus self-efficacy include, among others, being able to fall asleep despite hearing tinnitus, understanding the difference between hearing loss and tinnitus, using hearing aids to reduce tinnitus handicap, and being able to use masking devices without impairing communication ability. After patients identify activities that they believe are beyond their ability to control, self-efficacy practices represent opportunities to modify thoughts and behaviors, thereby providing patients with the knowledge that control of such situations is within their grasp.

Existential therapy, practiced with a patient-centered approach, also prioritizes understanding the patient's thoughts about tinnitus and learning how the patient came to think in that way about their tinnitus.[64] Specific patient expectations for the therapy are identified and addressed. A great onus is placed on the therapist, who must be flexible and willing to meet the patient not halfway, but where the patient exists and, oftentimes, suffers. Mohr and Hedelund summarized the therapist's work as shifting between two acts: "Entering the client's world, thus being in the position of being-with-the-client, and Exiting the client's world, thus being in the position of being-for-the-client."[40(p.200)] This approach to tinnitus management provides the patient a uniquely high degree of input into the therapeutic process.

SUMMARY

Individualized intervention plans for patients, although difficult to assess in controlled trials, may be employed by clinicians who have a thorough understanding of tinnitus mechanisms and effects, and are comfortable counseling challenging patients. Clinical care for patients with bothersome tinnitus would be more reasonable and likely practiced by more professionals if the process could be boiled down to a cookbook approach that was easy to administer and that produced consistent positive results. Unfortunately, although there are many tinnitus management protocols that are well constructed and that have manuals or guides to support implementation, the differences in tinnitus annoyance patterns across patients limit the effectiveness of any one specific approach. Audiologists should be aware primarily of the value of hearing aids and referrals to other professionals, primarily ear, nose, and throat specialists, when medical management is indicated. Clinical psychologists can help implement CBT programs as these strategies have the greatest evidence base for success in the management of bothersome tinnitus. The lack of a cure should not dissuade audiologists from implementing practical programs to improve the reactions of their patients to tinnitus distress. Patients with tinnitus may be among our most perplexing, and although that fact will not change, it provides the clinician with the potential to provide life-changing benefit.

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