
SOUND THERAPY FOR TINNITUS: MULTIFLEX TINNITUS TECHNOLOGY

The Rationale Behind the Rationale

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The Problem

Tinnitus is the perception of a sound for which there is no external source. Patients may perceive tinnitus as a ringing, buzzing, roaring, hissing, or tonal sound. Recent research indicates that as many as 50 million Americans have experienced tinnitus and that 16 million Americans have reported frequent tinnitus, occurring at least once per day (Shargorodsky, Curhan & Farwell, 2010).

Many of those who experience tinnitus do not report any associated adverse effects; however, individuals with clinically significant tinnitus complain of its negative impact on many aspects of their lives, which may require some form of clinical intervention (Hanley & Davis, 2008; Henry, Zaugg, Myers & Schechter, 2008). Tyler and Baker (1983) reported that tinnitus patients identify tinnitus as the source of problems related to hearing, lifestyle, general health and emotional states. Specifically, participants reported that their tinnitus resulted in problems understanding speech and sleeping, in social situations or relationships, and with headaches, depression and concentration. Other authors have reported similar effects, leaving no doubt that tinnitus can be a considerable problem for many individuals (Hallam, 1987; Jakes, Hallam, Chambers & Hinchcliffe, 1985). Although some authors have suggested that the loudness or pitch of a patient's tinnitus is not correlated to the perceived severity of the tinnitus (Meikle, Vernon & Johnson, 1984), other authors suggest that patients with louder tinnitus may be under more stress (Stouffer & Tyler, 1990).

The perception of tinnitus is thought to be related to changes in the patterns of activity in the central auditory system, which is perceived as sound (Kaltenbach, 2011; Tyler, 2006). Although there is an association between hearing loss and tinnitus, not all individuals with tinnitus have hearing loss (or vice-versa). However, many of the factors that contribute to hearing loss may also contribute to tinnitus. For example, exposure to loud sounds, head trauma, exposure to certain medications or other diseases of the auditory system may cause tinnitus (Crummer & Hassan, 2004). It should be noted that such medically manageable conditions as impacted cerumen, otitis media, temporomandibular joint dysfunction and some cardiovascular conditions are also associated with tinnitus (Lockwood, Salvi & Burkard, 2002).

Management of Tinnitus

Because the physiological mechanisms of tinnitus are not thoroughly understood, approaches for the management or treatment of tinnitus are varied. Various pharmaceuticals have been investigated as potential tinnitus treatments, including anti-depressants, anti-convulsants, muscle relaxants, and anxiolytics, but no drug has been developed specifically for the treatment of tinnitus (Dobie, 1999; Henry et al., 2008). Additionally, supplements such as ginkgo biloba and zinc have been suggested as potential tinnitus treatments; however, evidence to support the use of such supplements is lacking (Noble, 2008). At this time, there is no drug that has been approved by the Food and Drug Administration (FDA) for the treatment of tinnitus. Electrical and

electromagnetic stimulation have been found to be effective in treating tinnitus, and research on these treatment approaches continues (Dauman, 2000; Dornhoffer & Mennemeier, 2010; Noble, 2008; Tyler, 2006).

Sound therapy, or use of any sound for the purposes of tinnitus management, is widely accepted as a management tool for tinnitus. The rationale for the use of sound in the management of tinnitus is to minimize the patient's perception of tinnitus by effectively reducing the signal-to-noise ratio between the tinnitus and ambient or environmental sounds (Folmer & Carroll, 2006; Del Bo & Ambrosetti, 2007). Despite this common rationale, approaches to sound therapy have varying goals, as described by Tyler (2006): "reducing the attention drawn to the tinnitus, reducing the loudness of the tinnitus, substituting a less disruptive noise (background sound) for an unpleasant one (tinnitus), giving the patient some control" (p. 11). Several of the approaches to sound therapy are described in the following paragraphs.

A specific tinnitus management strategy that utilizes sound as one component of its therapeutic approach is Tinnitus Retraining Therapy (TRT). TRT is based on the idea that tinnitus becomes clinically significant because of activity in the limbic and autonomic nervous systems (Jastreboff, 2007). In part, these systems are responsible for generating a response to unpleasant or potentially dangerous situations. The goal of TRT is to reverse the activation of these systems, thus altering the patient's response to his or her tinnitus, a process known as habituation. In TRT, this is accomplished via counseling and use of sound therapy. Counseling is important in reinforcing for the patient that tinnitus is a neutral, rather than negative, stimulus. Sound therapy reduces the contrast between the patient's tinnitus and the background sound. In using sound therapy with TRT, the goal is to present the background sound at a level that still allows the patient to perceive his or her tinnitus, as habituation cannot occur if the patient does not hear the tinnitus (Bartnik & Skarzynski, 2006).

Progressive Audiologic Tinnitus Management (PATM), described by Henry, Zaugg, Myers and Schechter (2008), is a clinical protocol for tinnitus management that integrates use of sound. PATM consists of 5 levels: triage, audiologic evaluation, group education, tinnitus evaluation, and individualized management. This approach allows the clinician and patient to collaborate in the development of a therapeutic plan that is customized for that patient. This plan may include the use of hearing aids, ear-level noise generators, combination (hearing aid and noise generator) devices, table-top sound generators or personal-listening devices. Patients are instructed regarding three types of sounds that can be used to manage tinnitus: soothing sound, background sound, and interesting sound. Soothing sound can be any sound that the patient finds to be relaxing. Background sound reduces the contrast between the patient's tinnitus and the environment. Interesting sound is any sound that shifts the patient's attention away from tinnitus and onto that sound. The patient and the professional work together to determine which types of sounds are most beneficial in the situations in which the patient's tinnitus is bothersome, developing a strategy for the patient to cope with his or her tinnitus.

Masking is another approach to sound therapy. In contrast to TRT, total masking involves use of a sound that completely prevents the patient from hearing his or her tinnitus. The effectiveness of this type of approach has been demonstrated (Hazell et al., 1985). A benefit of total masking is that the patient may experience immediate tinnitus relief; however, patients may find that the sound required for total masking of tinnitus is too loud to tolerate, particularly for extended periods of time (Tyler, 2006). Partial masking involves use of a sound that allows the patient to hear both the masking sound and the tinnitus. Use of sound that partially masks the tinnitus may provide a distraction such that the patient does not focus on the tinnitus as much as if no sound was present (Tyler, 2006).

Counseling is an important component of any tinnitus management program (Henry et al., 2008; Tyler, 2006). As described by Tyler (2006), specific counseling approaches may vary, but share a common goal: changing the way the patient thinks about and responds to his or her tinnitus. This may be accomplished by providing patients with information regarding hearing loss, causes of tinnitus, prevalence of tinnitus, and treatment options for tinnitus. In addition to use of sound therapy, it may be helpful to provide patients with coping strategies (Tyler, 2006).

Multiflex Tinnitus Technology

In developing Multiflex Tinnitus Technology, a central goal was to create a product that was capable of accommodating multiple sound therapy approaches for tinnitus management and the unique preferences of individual patients. Multiflex Tinnitus Technology, integrated in a small receiver-in-canal (RIC) hearing aid (Figure 1), generates an adjustable broadband stimulus. In addition to therapeutic sound, Xino™ Tinnitus offers such advanced features as PureWave Feedback Eliminator, Voice iQ², InVision Directionality and Spectral iQ. The hearing aid can be fit in an

open or occluded configuration, with receivers that can accommodate hearing losses ranging from mild to profound in severity. The hearing aid settings and the Multiflex Tinnitus Technology settings can be configured independently of one another and can accommodate patients with and without hearing loss.

A number of studies have found that a tinnitus management program that integrates a noise stimulus delivered by a wearable device may be effective in treating tinnitus (Folmer & Carroll, 2006; Henry et al., 2006; Schechter & Henry, 2002). The broadband stimulus generated via Multiflex Tinnitus Technology can be adjusted by the professional in the Inspire® fitting software using 16 independent frequency bands. The clinician can tailor the noise stimulus to each patient's needs or preferences, creating a sound therapy stimulus ranging from a broadband to a narrowband noise centered at a specific frequency. Figure 2 displays the Table View for the Multiflex Tinnitus Technology screen in the Inspire fitting software. The controls in this view can be used to adjust individual bands or multiple bands at once. Both binaural and monaural adjustments can be made. Upon performing a Best Fit of the hearing aid, the settings of Multiflex Tinnitus Technology are automatically programmed based on a patient's hearing thresholds. The goal with these Best Fit settings is to set the broadband



Figure 1: Image of the Multiflex Tinnitus Technology RIC hearing aid.

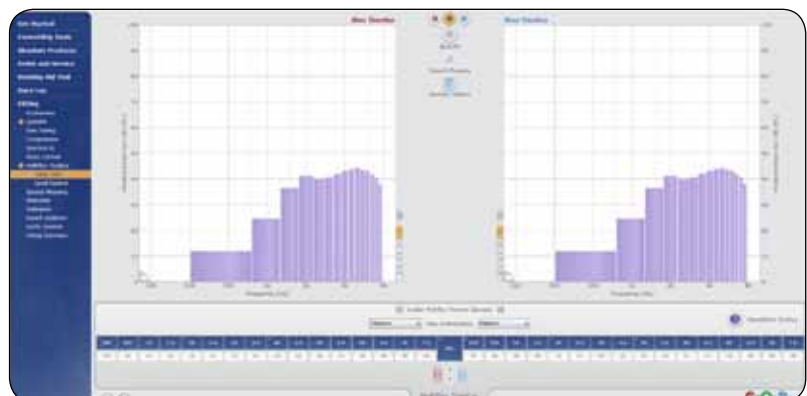


Figure 2: Table View of the Multiflex Tinnitus Technology screen in the Inspire fitting software. The table displays 2cc coupler output values per band in dB SPL. These values are represented by the purple bars on the fitting graphs. Adjustments to individual or multiple bands can be made by selecting the desired frequency region and using the arrow buttons.

stimulus to a level that is audible and comfortable for the patient, simplifying the fitting process. From this starting point, the settings of the noise can be fine-tuned.

Multiflex Tinnitus Technology also features a modulation setting, with the options of Slow, Medium and Fast. This setting controls the rate of periodic changes in the amplitude and the frequency response of the noise over time, resulting in an auditory perception similar to ocean waves or a breeze. Previous research has indicated that a dynamic sound, or a sound that varies over time, may be more effective than bands of noise in reducing tinnitus annoyance (Henry, Rheinsburg & Zaugg, 2004). This modulation setting provides the professional with an additional option for customizing the setting of Multiflex Tinnitus Technology based on the patient's needs and preferences.

Xino Tinnitus with Multiflex Tinnitus Technology features a configurable user control. The user control can be configured by the professional to allow for patient adjustments of hearing aid volume, Multiflex Tinnitus level, or both. Use of a level control for the noise may be beneficial for patients: Vernon and Meikle (2000) suggested that it is important for the patient to have the ability to adjust the level of the sound generator independently of the hearing aid, such that the sound generator's settings are comfortable and no louder than is required to provide relief. Additionally, the user control can adjust the hearing memories. Both hearing aid settings and the Multiflex Tinnitus Technology settings can be configured independently in each of the

four hearing aid memories. Memories may be configured with hearing aid only functionality, hearing aid and Multiflex Tinnitus functionality, or Multiflex Tinnitus functionality only. These various user control options offered with Multiflex Tinnitus Technology give the patient the ability to adjust the tinnitus stimulus as needed for different listening situations.

In 2011, Starkey introduced SoundPoint as a unique feature that allows a patient to fine-tune the frequency response of the hearing aids via an interactive interface within the Inspire fitting software. Multiflex Tinnitus Technology includes SoundPoint Tinnitus, which allows the patient to fine-tune the noise stimulus within a range of possible settings. As the patient explores the space on the screen via a mouse or touchscreen, the overall level and frequency shape of the noise change in real time. Figure 3 displays the SoundPoint interface. The patient can click to select settings that are desirable; these are represented by the pushpins. A patient's favorite setting is represented by a star on the screen. There may be several benefits to involving the patient in the fitting of the sound therapy stimulus. The patient has the opportunity to explore various settings for the noise and select the settings that may be most pleasant or beneficial. Additionally, allowing the patient to adjust the sound therapy stimulus directly may give the patient a sense of control over his or her tinnitus.



Figure 3: SoundPoint Tinnitus interface. The patient moves the mouse around the screen to explore a variety of noise stimulus settings. The pushpins represent patient-selected settings. The star represents the patient's favorite settings.

Conclusion

Multiflex Tinnitus Technology integrated within a discreet, RIC hearing aid offers the necessary adjustability for use in any tinnitus management program that utilizes sound therapy. The Best Fit settings and SoundPoint Tinnitus simplify the fitting process. Additionally, the flexibility in adjusting the spectrum of the noise and in setting the modulation rate allows the professional to tailor the sound therapy for each patient.

For additional information regarding tinnitus and tinnitus treatment, please see the following resources:

- **American Tinnitus Association**
www.ata.org
- **Mayo Clinic**
<http://www.mayoclinic.com/health/tinnitus/DS00365>
- **American Speech-Language-Hearing Association**
<http://www.asha.org/public/hearing/tinnitus/>
- **American Academy of Audiology:
How's your Hearing?**
<http://www.howsyourhearing.org/tinnitus.html>
- **Tinnitus Research Initiative**
<http://www.tinnitusresearch.org/index.php>

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