Critical Review: Is there evidence to support that hearing aids benefit adults in the reduction of tinnitus perception?

Lam, H.
M.Cl.Sc (AUD.) Candidate
The University of Western Ontario: School of Communication Sciences and Disorders

The aim of this critical review is to examine the literature regarding the effectiveness of hearing aids in the reduction of tinnitus perception. Study designs include: mixed (between and within) measures (pre-post test), between groups and single group pre-post test. Current research suggests the fitting of hearing aids not only benefit a person's hearing loss but helps in the reduction of tinnitus that often accompany the loss. This finding may persuade those individuals not willing to accept a hearing aid to support their hearing loss to be prescribed with a hearing aid to help reduce tinnitus perception.

Introduction

Tinnitus is the conscious awareness of sound perceived in the head or in the ears without an external stimulus. This sound cannot be heard outside the body and affects many people (Trotter & Donaldson, 2008).

Tinnitus is a major factor in reducing the quality of life in its patients. Ferrari, Sanchez, and Pedalini (2007) found that quality of life dropped by as much as 25% in tinnitus related cases by influencing sleep, concentration, emotional balance and social activities.

Hearing loss and tinnitus are two of the most common chronic conditions in the elderly, with a strong relationship between the prevalence of tinnitus and presbycusis. Trotter and Donaldson (2008) found that the best predictor of persistent and spontaneous tinnitus was high frequency loss at 4, 6, and 8 kHz. The overall population is becoming increasingly older due to the baby boomers born between the years of 1946-1964 reaching the ages of 45-63; these boomers are likely to experience presbycusis.

Those that experience presbycusis frequently experience the tinnitus that accompanies it and often have great difficulty finding the help they need; instead they are often told "there is nothing we can do". Due to the subjective nature of tinnitus it is quite difficult to treat it. However with the assistance of informed audiologists, clients with tinnitus may be introduced to several options available that may help reduce the perception of tinnitus.

Strategies available to reduce the perception of tinnitus include: hearing aids, sound generators, tinnitus retraining therapy and simple acoustic therapy. Though the availability of strategies is promising, benefits in the reduction of tinnitus perception is decided individually.

Hearing aids as a strategy to ease the perception of tinnitus was first suggested by Saltzman and Ersner as early as 1947 (Surr, Montgomery & Mueller, 1985). Hearing aids are the only viable option that may be capable of tackling both hearing loss and tinnitus together.

Objectives

The primary purpose of this review is to critically evaluate the existing literature regarding the effectiveness of hearing aids in the reduction of tinnitus.

Methods

Search Strategy

Computerized databases including MEDLINE, SCOPUS and PubMed were searched using the following search strategy: [(hearing aids) OR (amplification) AND (tinnitus)].

The search was limited to articles written in English. No other limits were used. Reference lists in obtained journal articles were also examined to seek out additional relevant sources.

Selection Criteria

Studies selected for inclusion in this critical review were required to investigate the effects of hearing aids in the reduction of tinnitus perception. The reviewed studies also examine the effects of sound generators in the reduction of tinnitus perception as well as various gender and age effects. However this review specifically addresses the effects of hearing aids on tinnitus perception.

Data Collection

A review of the literature yielded four studies: mixed (between and within) measures (pre-post test) (2), between groups measures (1) and a single group pre-post test (1). Each of the studies provided a grade III level of evidence (Dollaghan, 2007).

Results/Discussion

Mixed (Between & Within) Measures (Pre-Post)

Folmer and Carroll (2006) assessed the long-term effectiveness of ear-level devices which include sound generators and hearing aids for tinnitus. One hundred and fifty participants took part in the study, however only the first 50 who purchased digital hearing aids were included. The other 100 participants included 50 who purchased sound generators and 50 who did not purchase either. A detailed questionnaire including: medical, hearing and tinnitus history was to be completed prior to the initial appointment. Questionnaires included the Tinnitus Severity Index, a self-rated loudness tinnitus scale and the Beck Depression Inventory. Their initial appointment included interviews and examinations by an otolaryngologist, neurophysiologist and an audiologist. Those that had an audiologically proven hearing loss were fitted with hearing aids. They returned to the clinic 1-3 times after the initial fitting for additional fine tuning of the hearing aids. A follow-up questionnaire was mailed to the patients 6-48 months following their initial appointment with a 100% response rate. This study found that 70% of the hearing aid users benefited from amplification a moderate amount or more based on their response to the question "Did the hearing aid(s) help your tinnitus?" Compared to the responses obtained prior to hearing aid fitting, the self-rated loudness of tinnitus scale showed significant reduction at $p \leq 0.0005$; there was also a significant reduction (23%) in Tinnitus Severity Index scores, $p \leq 0.0001$; however there was no significant change in the Beck Depression Inventory score. These statistics were calculated and compared using analysis of variance and two-tailed t-tests.

This particular study is useful because it looks at the long-term (6-48 months) effect of ear-level devices on tinnitus. The mean elapsed time from the hearing aid fitting to when the follow-up questionnaire was mailed out was 18 months however it is not known when each patient received their questionnaire. Without this information it is not known which patients experience more benefit, those that have worn the hearing aids for 6 months as opposed to those that have worn it for a longer period of time. The examination provided by the professionals is both positive and negative. It allows for a thorough examination which is beneficial but it may take at least 4 hours to complete and the follow-up appointments lasted at least 2 hours which may have allowed fatigue on the patient's part to possibly skew some data.

Between Groups

Surr, Montgomery and Mueller (1985) conducted a study to assess the effectiveness of hearing aids to reduce the perception of tinnitus among new hearing aid users.

Two hundred new hearing aid users that included active and retired military personnel took part in this study. They were separated into 2 groups; Group 1 consisted of 99% active military personnel and was given a questionnaire on tinnitus after a week of hearing aid use; Group 2 consisted of retired military personnel and was given the tinnitus questionnaire a month or two after fitting. Of the 200 participants, tinnitus was prevalent in 124 of them. Results revealed that 49% experienced some reduction in tinnitus perception.

This study examined the difference of age between the two groups as well as the amount of time between the hearing aid fitting and the completion of the tinnitus questionnaire. They determined that these two variables did not have any influence on the result. However, not providing a pre-post-test requires the participants to rely on their memory of the tinnitus they experienced is a drawback. Another drawback to this study is that there were many missing answers in the questionnaire and at other times there were answers for questions that should have been omitted, i.e. binaural tinnitus participants answering both binaural and monaural tinnitus questions which may have skewed some of the monaural data; no significant results were found between monaural and binaural hearing aid fitting, possibly due to this issue.

Single Group Pre-Post test

Surr, Kolb, Cord and Garrus (1999) conducted a study on 34 hearing impaired men who experienced tinnitus and subsequently fitted with hearing aids based on their audiological test results. The participants were required to complete an unaided form of the Tinnitus Handicap Inventory (THI) during their hearing aid fittings. The aided form of the THI was given to each participant and they were instructed to return the THI in 6 weeks. This study found the difference between the unaided and the aided THI scores to be small, however the results were significant, $p < 0.05$. Amplification did not increase the

reduction of tinnitus perception for those that experience a greater severity of tinnitus.

The THI is a statistically validated and widely recognized subjective questionnaire based on self-reporting by the patient and has been designed specifically for assessment of the impact of tinnitus on the quality of life (Henry, Zaugg, Myers & Schechter, 2008). This assessment tool was developed by Newman et al. (1996) and consists of 25-items that provides the total score and 3-subscale scores evaluating functional, emotional, and catastrophic impact of tinnitus (Bhattacharyya, 2004). The THI has robust test-retest reliability; therefore it has been widely used for documenting the effectiveness of various treatment outcomes of tinnitus (Trotter & Donaldson, 2008).

A limitation to this study is the small sample size of 34 hearing impaired men. This is compounded by the high attrition rate. Only 56% of the aided THI forms were returned thus leaving conclusions to be based on the responses of 19 men.

Mixed (Between & Within) Measures (Pre-Post)

Trotter and Donaldson (2008) presented a 25 year (1980-2004) study which assessed tinnitus perception of patients with hearing loss, both before and after hearing aid fitting.

This study included 2153 patients experiencing tinnitus over the 25 years however only 1440 had audiologically proven hearing loss and thus were fitted with hearing aids either unilaterally (n = 826) or bilaterally (n = 614). Patients seen during 1980-1999 were fit with analog hearing aids while patients seen during 2000-2004 were fit with digital hearing aids.

Tinnitus perception was assessed with a visual analog scale (VAS) before hearing aid fitting and after the patient was satisfied and making optimal use of their hearing aid(s). These results were then compared to determine if a reduction in tinnitus perception was achieved. Differences were grouped as either: greater than 50%, less than 50% or provided no effect.

The VAS is commonly implemented to gauge subjective measures such as tinnitus perception. The loudness or severity of tinnitus is difficult to group into categories such as: mild, moderate and severe, therefore a continuum is used. The VAS is usually comprised of a horizontal line, 10cm in length with descriptors on either end (Wewers & Lowe, 1990). The individual marks on the line that represents their current perception of tinnitus. They return after hearing aid provision and mark the line again to signify their perception of tinnitus. The difference is then used to determine whether or not there was improvement in the perception of tinnitus after hearing aid fitting.

Of the 826 patients who were fit with unilateral hearing aids, 67% of them indicated an overall improvement in their reduction of tinnitus perception while 42% indicated an improvement of greater than 50%. Patients fit with unilateral analog hearing aids (n = 722) during 1980-1999 were found to have an overall improvement of 65% with 39% of the patients indicating an improvement of greater than 50%. Patients who were fit with unilateral digital hearing aids (n = 104) during 2000-2004 were found to have an overall improvement of 82% with 65% of the patients indicating an improvement greater than 50%.

Of the 614 patients who were fit with bilateral hearing aids, 69% of them indicated an overall improvement in their reduction of tinnitus perception while 43% indicated an improvement of greater than 50%. Patients fit with bilateral analog hearing aids (n = 454) were found to have an overall improvement of 60% with 30% of the patients indicating an improvement of greater than 50%. Patients fit with bilateral digital hearing aids (n = 160) found an overall improvement of 96% with 80% of the patients indicating an improvement greater than 50%.

Analysis using the Kendall Tau-B test to compare unilateral fitting of analog and digital hearing aids produced a correlation coefficient of -0.159 with $p < 0.001$ which suggests significantly greater improvement for those fitted with digital hearing aids during 2000-2004. The same analysis completed for bilateral fitting revealed a correlation coefficient of -0.422 with $p < 0.001$ which also suggests significantly greater improvement for digital hearing aid provision.

The hearing aid industry is constantly growing, thus the "25-year experience" is both advantageous and a limitation in itself. The authors are well aware that hearing aid technology and expertise has changed and they are now far more advanced. Fitting protocols have changed and there are now standardized self-rated tinnitus scales such as the THI which would provide more accuracy than the VAS. The authors failed to mention how they were able to group pre- and post hearing aid provision results of tinnitus perception using the VAS. Despite some of these limitations, the large sample size provides evidence to support that hearing aids, in general, do help in the reduction of tinnitus perception for many persons.

Conclusion/Recommendations

After critical evaluation of the 4 studies, reliability and validity were present in each study. There were limitations in each of them, however they were not great enough to question the results. Each of the studies had reached the same conclusion; hearing aids do benefit adults in the reduction of tinnitus perception.

Folmer and Carroll (2006) stated that hearing aids may help reduce the perceived loudness of tinnitus and severity. As cited by Henry, Zaugg & Schechter (2005), Vernon (1992) noted this could be accomplished by the amplification of external sounds or by the instruments internal noise floor thus partially masking the perception of tinnitus.

The psychological well-being or perception of tinnitus of an individual may be affected by stress (Trotter & Donaldson, 2008). Research has shown a significant decrease in self-reported stress in difficult communication environments upon hearing aid provision (Surr et al., 1985). Amplification may help diminish the communicative issues an individual once had prior to hearing aid fitting, therefore hearing aids benefit both the hearing loss and the stress associated with it (Henry et al., 2008).

Although amplification aids in the reduction of tinnitus perception; multiple tinnitus management strategies employed together is more effective than one strategy used in isolation (Folmer & Carroll, 2006). However, only hearing aids provide a solution to both hearing loss and tinnitus which often accompany each other.

Clinical Implications

Audiologists gain a lot of education and experience on hearing and hearing loss, hearing measurement and habilitation of hearing loss (Tyler, Haskell, Gogel & Gehringer, 2008); as a result should be able to provide guidance on tinnitus management when called upon. Hearing aids are a viable option to provide benefit for those that experience both hearing loss and tinnitus.

These studies are invaluable for those that experience both hearing loss and tinnitus. Not everyone is motivated to acquire amplification for their hearing loss, but to know that it may reduce their perception of tinnitus may sway them to consider hearing aids which would benefit their quality of life. Therefore, it is important for audiologists to inform patients of the secondary benefit that hearing aids possess. "There is nothing we can do about the tinnitus" is a phrase that does not need to be repeated by an audiologist again.

Recommendations for Future Research

Hearing aid technology is far more advanced than it was when the studies were conducted. Digital hearing aids were considered by Trotter and Donaldson (2008) and showed a drastic increase in the reduction of tinnitus perception. With features such as, digital noise reduction, directional microphones and compression and expansion characteristics available on modern hearing aids, it would be advantageous to determine if they affect the perception of tinnitus positively.

Henry et al., (2008) suggested that special noise suppression circuitry or digital noise reduction can be a disadvantage to patients with tinnitus. The digital noise reduction may activate and reduce the background noise that is helping reduce the loudness of tinnitus perception.

Hearing aid manufacturers have set expansion levels for their hearing aids to reduce the amount of internal noise created by the hearing aid. This reduction of internal noise may also be a disadvantage to patients with tinnitus. More studies into the effect of compression and expansion characteristics on tinnitus would be valuable.

References

Bhattacharyya, N. (2004). Outcomes research in otology. *Journal of Oto-Rhino-Laryngology and Its Related Specialties*, 66, 214-220.

Dollaghan, C. (2007). The handbook of evidence-based practice in communication disorders. Baltimore: Paul H. Brookes Publishing Co.

Ferrari, G.M., Sanchez, T.G., & Pedalini, M.E. (2007). The efficacy of open molds in controlling tinnitus. *Brazillian Journal of Otorhinolaryngology*, 73, 370-376.

Folmer, R.L. & Carroll, J.R. (2006). Long-term effectiveness of ear-level devices for tinnitus. *Otolaryngology - Head and Neck Surgery*, 134, 132-137.

Henry, J.A., Zaugg, T.L., Myers, P.J., & Schechter, M.A. (2008). The role of audiologic evaluation in progressive audiologic tinnitus management. *Trends in Amplification*, 12, 170-187.

Henry, J.A., Zaugg, T.L., & Schechter, M.A. (2005). Clinical guide for audiologic tinnitus management I: assessment. *American Speech-Language-Hearing Association*, 14, 21-48.

Surr, R.K., Montgomery, A.A., & Mueller, H.G. (1985). Effect of amplification on tinnitus among new hearing aid users. *Ear and Hearing*, 6, 71-75.

Surr, R.K., Kolb, J.A., Cord, M.T., & Garrus, N.P. (1999). Tinnitus handicap inventory (THI) as a hearing aid outcome measure. *Journal of American Academy of Audiology*, 10, 489-495.

Trotter, M.I., & Donaldson, I. (2008). Hearing aids and tinnitus therapy: a 25 year experience. *The Journal of Laryngology & Otology*, 122, 1052-1056.

Tyler, R.S., Haskell, G.B., Gogel, S.A., & Gehringer, A.K. (2008). Establishing a tinnitus clinic in your practice. *American Speech-Language-Hearing Association*, 17, 25-37.

Wewers, M.E., & Lowe, N.K. (1990). A critical review of visual analogue scales in the measurement of clinical phenomena. *Research in Nursing and Health*, 13, 227-236.