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Research Article

The Relationship between Hearing Threshold Loss and Severity of Reactions to Tinnitus

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Abstract

Several studies have suggested that tinnitus severity or distress is worse in patients with more severe hearing loss. We explored the relationship between tinnitus severity measured on two tinnitus questionnaires and hearing thresholds in alarge population of cochlear implant recipients. No significant correlations were found between hearing thresholds and the Tinnitus Handicap Questionnaire and the Tinnitus Primary Functions Questionnaire. We conclude that there is no clear relationship between the reaction to tinnitus and hearing threshold loss.

INTRODUCTION

Tinnitus is a pervasive symptom that affects many people on a daily basis. The great majority (>80%) of those with chronic tinnitus have significant hearing threshold loss, and some of the same causes of hearing loss also cause chronic tinnitus (e.g., excessive noise exposure, ear diseases and head injury). It is generally accepted that tinnitus severity is influenced by stress and depression. However, the relationship of hearing threshold loss to tinnitus severity is unclear [1].

Links in theories of tinnitus to hearing loss

Many theories and models have been proposed to explain the pathophysiological basis of tinnitus [2-4]. The most prevalent theories involvethe hair cells, the auditory nerve, and the central auditory nervous system.

With the loss of hair cells or hair cell function, afferent neurons appear to trigger aberrant auditory sensations at frequencies at or near the focus of the lesion [5]. This ‘‘edge effect’’ theory could explain why tinnitus isfrequently associated with hearing loss, why the frequency of tinnitus is often related to the involved frequencies of the hearing loss, and why tinnitus persists beyond the time expected for normal recovery from noise exposure.

Wherever the coding of tinnitus takes place, it is likely it can be influenced by cochlea activity assuming the cochlea and auditory pathway are relatively intact. Although tinnitus activity is interpreted in the auditory cortex, in many cases it might originate in the cochlea from alterations of the spontaneous activity.

Relationship between Hearing threshold Loss and presence and severity of tinnitus

Studies investigating the relationship of the degree of hearingthreshold loss to tinnitus severity are mixed. Some studies have found no correlation between severity of tinnitus and degree of hearing loss and indicated that hearing loss is an added handicap to tinnitus rather than affecting tinnitus directly.

McKinney et al. [6] found that clinically important hearing threshold loss in tinnitus patients was associated with anxiety and depression as a reaction to hearing loss, which could affect the impact of tinnitus but not tinnitus severity

Baskill and Coles [7] have suggested that the influence of hearing threshold loss on the severity of tinnitus remains uncertain; these authors found that auditory thresholds and bothersome tinnitus were poorly correlated.

Savastano [8] evaluated the relationship between the Tinnitus Handicap Inventory (THI) scores and the presence or absence of hearingthreshold loss in 520 patients with tinnitus. The audiometric results showed that 223 tinnitus patients had “normal “hearing threshold and 297 had hearing deficit. THI results revealed that, in most cases, slight or mild tinnitus handicap was attributed to individuals with hearing threshold loss while normal hearing participants reported moderate and catastrophic handicap. Additionally, Savastano [8] found that more severe hearing loss did not correlate with the severity of bothersome tinnitus.Therefore, it is important to consider patients with normal hearing and tinnitus.

Hallberg and Erlandsson [9] found worse hearing thresholds in patients that reported more concentration difficulties and sleep disorders due to tinnitus, compared to patients with no complaints of tinnitus.These authors found that bothersome tinnitus was notcorrelated to more significant hearingthreshold loss.

Sanchez et al. [10] monitored tinnitus in 36 patients with" normal"audiogram and tinnitus and anew evaluation was done for their tinnitus through questionnaire and anew audiogram. The old and new assessment was compared in all patients Both evaluations were also compared with those who developed hearing loss and those whose hearing remained normal. Results of the study showed that hearing loss occurred in 44.6% subjects, mostly moderate, bilateral and in high frequencies. Tinnitus was referred as constant in 75% of first assessment and changed to intermittent in 53.8% of second assessments, with no other significant differences. Tinnitus remission or improvement occurred in 46.1% of the patients. There was a significant decrease intinnitus discomfort in patients who developed hearing loss.

By comparison, some studies have shown a significant correlation between hearing thresholds and tinnitus severity.

Weisz [11] showed that increased hearing loss at high frequencies (i.e2, 4, 8 kHz) was associated with a lower severity of tinnitus with the (THI).

Axelsson and Ringdahl [12] concluded that tinnitus is more common andmore severe in patients with hearing loss, thus there is correlation between degree of hearing loss and severity of tinnitus.

Coles [13] showed that the severity of tinnitus was correlated with auditory difficulty, finding mild hearing loss in patients with tinnitus that were mildly bothered and severe or profound hearing loss in patients with severely bothersome tinnitus.

In summary, some studies show a correlation of hearing loss to tinnitus severity, while others do not. The evidence is not consistent on this topic.

The aim of this paper was to determine therelationship between the degree of hearing loss and the severity of tinnitus in patients who are candidates for a cochlear implant (CI). We specifically were interested in CI candidates for two reasons; a) there is a wide range of hearing thresholdloss found in this population, and b) tinnitus is commonly reported by CI candidates.

METHODS

This was an analysis of data obtained from 419 CI candidates at the University of Iowa Cochlear Implant Program. Table shows the chronological age and implant age differences for male and female participants. As part of our routine clinical program, we obtained pre-implant thresholds from 250-8000 Hz in both ears using insert earphones. This data was obtained at the evaluation for all CI candidates, typically 1-4 weeks before a patient receives their CI. Additionally, at the evaluation, we administer intake forms to all candidates which contain two tinnitus questionnaires: the Tinnitus Handicap Questionnaire and the Tinnitus Primary Functions Questionnaire. The Tinnitus Handicap Questionnaire (THQ) assesses the physical, emotional, social consequences of tinnitus, and hearing-related changes from tinnitus [14]. The questionnaire consists of 27 items, and previous reports have shown high reliability of .94 using total score that is an average of all 27 items. The questionnaire correlates highly with similar measures of tinnitus handicap, including life satisfaction, depression scales, health status, and hearing ability.

Table: Chronological Age and at receiving CI for study participants.

Age	Gender	Mean (yrs.)	SE Mean (yrs.)	N
Chronological Age	Female	68	1.1	210
	Male	70	1.0	209
Age at receiving CI	Female	65	1.1	210
	Male	68	1.0	209

The Tinnitus Primary Functions Questionnaire (TPFQ) is used to measure the impact of tinnitus on primary or activities of daily living [15]. The 12-item TPFQ has three questions on the following areas that are often impacted by tinnitus, a) emotions, b) hearing, c) sleep, and d) concentration. Based on the total score that is an average of all 12 items, this is a reliable measure (alpha = .89). The questionnaire also correlates highly with similar scales of sleep, depression, trait anxiety, and tinnitus distress measured from the THQ. This was added later in the evaluation process.

We retrieved from our database of CI patients the following data for the purposes of this paper: a) pre-implant thresholds at 500 and 1000 Hz in the better (non-implanted) ear, b) pre-implant thresholds at 500 and 1000 Hz in the worse (implanted) ear, c) pre-implant THQ total score, and d) pre-implant TPFQ total score. Scattergrams were created from this data to compare hearing threshold loss and total score on the two tinnitus severity measures.

Study design

Figures 1and 2 shows the scattergrams of CI candidates relating their better and worse ear hearing thresholds at 500 Hz to the total score on the THQ. First, as we expected, there is a wide range of hearing thresholds observed in this sample of CI candidates, from normal hearing to profound hearing loss. Second, the data indicate no correlation between pre-implant hearing threshold at 500 Hz and tinnitus severity on the THQ. Within any given level of hearing severity, one can observe the range of tinnitus severity. For example, patients with hearing threshold of 20 dB HL at 500 Hz report tinnitus severity from 5 to 95%. This is similarly observed at nearly all threshold levels from 10 to 115 dB HL. Third, there are a considerable number of patients with bothersome tinnitus, reporting THQ scores greater than 50%. For Figure 2, comparing their poorer ear hearing thresholds at 500 Hz and total score on the THQ, a) patients report a range of tinnitus severity that is not correlated to their hearing threshold in the implanted ear, and b) hearing loss is moderate for most patients in the implanted ear.

Figure 3 displays the scattergram of better ear threshold at 1000 Hz and total score on the THQ. No difference in THQ scores at this frequency either, suggesting no correlation at a mid-frequencyof 1000HZ.

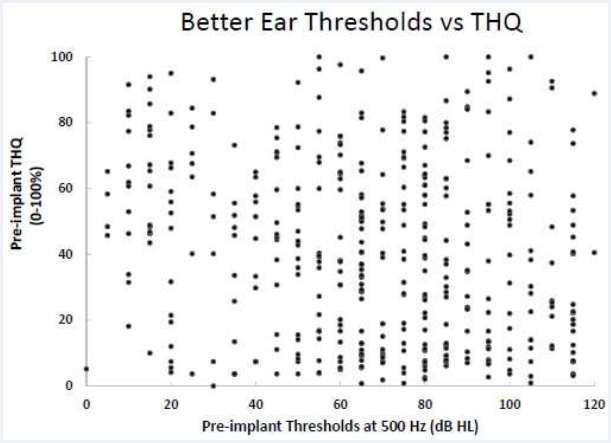

Figure 1 Pre implant hearing thresholds at 500 Hz in better ear versus THQ.

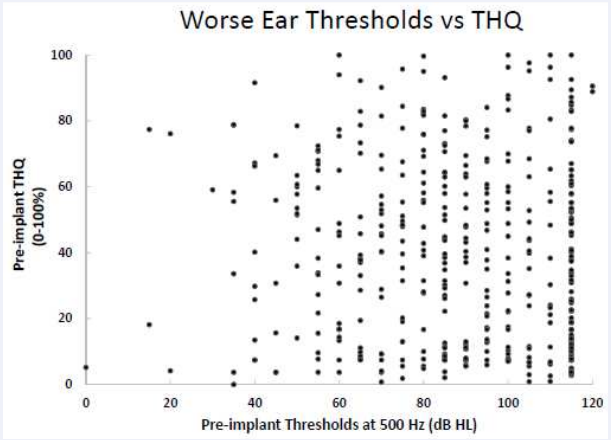

Figure 2 Pre implant hearing thresholds at 500 Hz in worse ear versus THQ.

Figures 4, 5 display the scatter grams of better and worse ear hearing thresholds at 500 Hz and TPFQ total score. There are fewer data points because this questionnaire was administered most recently in our CI clinical program. However, these figures indicate no correlation with pre-implant hearing threshold and impact of tinnitus on activities of daily living from TPFQ total score.

CONCLUSIONS

We observed no relationship between degree of pure-tone threshold loss and severity of tinnitus in our study. There is no clear neural mechanism that has been established as the cause of tinnitus, and there are many subtypes and likely several different neural mechanisms. Although nearly all (perhaps all!) tinnitus sufferers have at least some pure-tone threshold loss, our study indicates thatno relationship exists between the severity of reactions to tinnitus and the pure-tone threshold loss. People's reactions to their tinnitus are influenced by their individual experiences and coping abilities with life's challenging situations.

It is also important to discuss the possibility of tinnitus

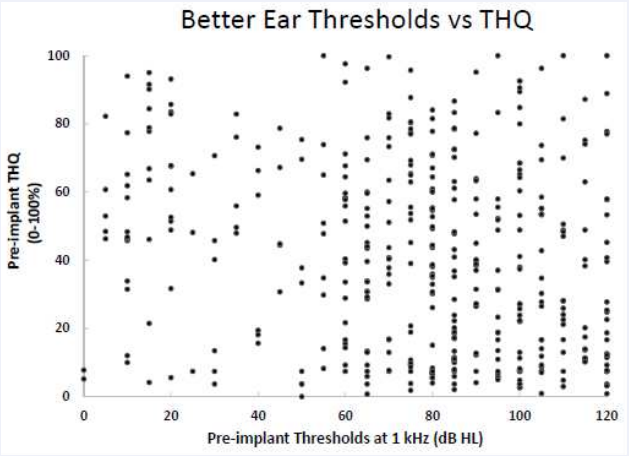

Figure 3 Pre implant hearing thresholds at 500 HZ in better ear versus TPFQ.

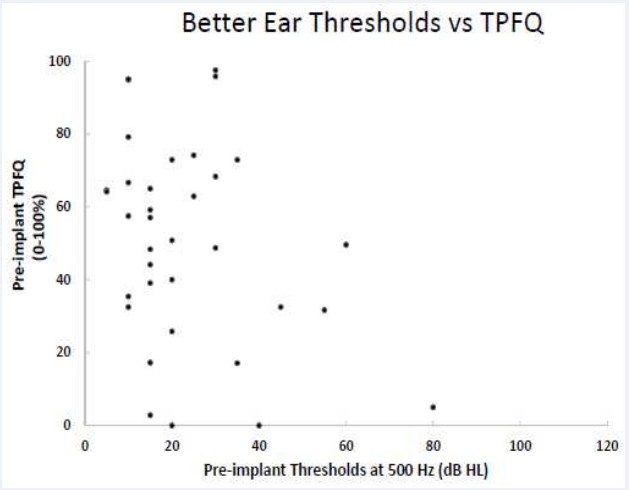

Figure 4 Pre implant hearing thresholds at 500 HZ in better ear versus TPFQ.

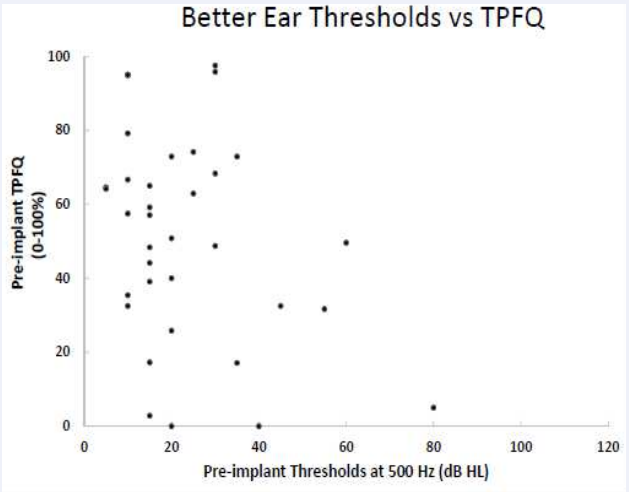

Figure 5 Pre implant hearing thresholds at 500Hz versus TPFQ.

with normal hearing. First, it is important to understand what is meant by normal hearing. Typically, this refers to pure-tone hearing thresholds of 25 dB HL or better from frequencies of 250 to 8000 Hz. This is referred to in this way; because typically people do not benefit from hearing aids unless their pure tone hearing thresholds are worse than this. It must be appreciated that 0 dB HL is an average threshold, and some of us had hearing threshold originally at -15 dB HL.

If our thresholds are now 0 dB HL, that might represent a hearing threshold loss, indicating a loss of cochlear hair cells and subsequently auditory nerve fibers. And of course it has been known for over 50 years that pure tone thresholds do not reflect all of the physiological and psycho acoustical impairments associated with hearing difficulties. Some tinnitus sufferers might have hearing thresholds of 10 dB HL, but this might reflect physiological damage to the auditory system. And, of course, tinnitus can also interfere with hearing speech.

REFERENCES

1. Baskill JL, Coles RRA. Relationship between tinnitus loudness and severity. In J. Hazell (Ed.), Sixth International Tinnitus Seminar, p. 424-428. Cambridge, United Kingdom: The Tinnitus and Hyperacusis Centre, 1999.
2. Baguley DM. Mechanisms of tinnitus. Br Med Bull. 2002; 63: 195–212.
3. Eggermont JJ. Physiological mechanisms and neural models. In R. Tyler (Ed.), Tinnitus handbook (pp. 85–122). San Diego, CA: Singular. 2000.
4. Møller AR. Pathophysiology of tinnitus. Otolaryngologic Clinics of North America. 2000; 36: 249–266.
5. Jastreboff PJ. Phantom auditory perception (tinnitus): Mechanisms of generation and perception. Neurosci Res. 1990; 8: 221–254.
6. McKinney CJ, Hazell JWP, Graham RL. An evaluation of the TRT method. Proceedings of the Sixth International Tinnitus Seminar. 1999. p.9-105; London: The Tinnitus and Hyperacusis Center: Ed Cambridge, 1999.
7. Baskill JL, Coles RRA. Relationship between tinnitus loudness and severity. In J. Hazell (Ed.), Sixth International Tinnitus Seminar, p. 424-428. Cambridge, United Kingdom: The Tinnitus and Hyperacusis Centre, 1999.
8. Savastano M. Tinnitus with and without hearing loss: are its charac¬teristics different? Eur Arch Otorhinolaryngol. 2008; 265: 1295-1300.
9. Hallberg LRM, Erlandsson SI. Tinnitus characteristics in tinnitus complainers and non complainers. Br J Audiol. 1993; 27:19-27.
10. Sanchez TG, Mak MP; Pedalini MEB; Evolução do zumbido e da audição em pacientes com audiometria tonal normal. Arq Int. Otorrinolaringol. 2005; 9: 220-227.
11. Weisz N, Voss S, Berg P, Elbert T. Abnormal auditory mismatch response in tinnitus sefferers with high-frequency hearing loss is associated with subjective distress level. BMC Neurosci. 2004; 5: 8-16.
12. Axelsson A, Ringdahl A. Tinnitus: a study of its prevalence and cha¬racteristics. Br J Audiol. 1989; 23: 53-62.
13. Coles RRA. Epidemiology of tinnitus: prevalence. J Laryngol Otol. 1984; 9: 7-15.
14. Kuk FK, Tyler RS, Russell D, Jordan H. The psychometric properties of a tinnitus handicap questionnaire. Ear and Hearing. 1990; 11: 434 442.
15. Tyler R, Ji H, Perreau A, Witt S, Noble W, Coelho C. Development and validation of the Tinnitus Primary Function Questionnaire. Am J Audiol. 2014; 23: 260–272.

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