Tinnitus Distress, Anxiety, Depression, and Hearing Problems among Cochlear Implant Patients with Tinnitus

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Abstract

Background: While several studies have investigated the presence and annoyance of tinnitus in cochlear implant (CI) recipients, few studies have probed the handicap experienced in association with tinnitus in this population.

Purpose: The aim of this study was to use validated self-report measures in a consecutive sample of CI patients who reported tinnitus in order to determine the extent of tinnitus handicap.

Research Design: In a retrospective design, a total of 151 patients (80% response rate) responded to a postal questionnaire, and of these, 111 (74%) reported that they currently experienced tinnitus and were asked to complete the full questionnaire. Sampling was performed at a point of a mean 2.9 years postsurgery (SD = 1.8 years). Three established self-report questionnaires were included measuring tinnitus handicap (Tinnitus Handicap Inventory [THI]), hearing problems (Gothenburg Profile), and finally, a measure of anxiety and depression (Hospital Anxiety and Depression Scale). We analyzed the data by means of Pearson product moment correlations, t-tests, ANOVAs, and chi-square.

Results: Data from the validated questionnaires showed relatively low levels of tinnitus distress, moderate levels of hearing problems, and low scores on the anxiety and depression scales. Using the criteria proposed for the THI (which was completed by 107 patients), 35% (N = 38) had a score indicating “no handicap,” 30% (N = 32) “mild handicap” 18% (N = 19) “moderate handicap”, and 17% (N = 18) “severe handicap.” Thus 37 individuals from the total series of 151 reported moderate to severe tinnitus handicap (24.5%). Tinnitus distress was associated with increased hearing problems, anxiety, and depression.

Conclusion: Tinnitus can be a significant problem following CI, but that the experienced distress is often moderate. However, a quarter of CI recipients do demonstrate moderate/severe tinnitus handicap, and thus are candidates for tinnitus specific therapy. The level of tinnitus handicap is associated with hearing problems and psychological distress.

Key Words: Anxiety, cochlear implant, depression, hearing problems, tinnitus distress

Abbreviations: CI = cochlear implant; GP = Gothenburg Profile; HADS = Hospital Anxiety and Depression Scale; THI = Tinnitus Handicap Inventory

Cochlear implants (CI) are now routinely used to restore functional hearing for children and adults with severe/profound hearing loss in whom hearing aids are of very limited benefit. A secondary benefit from cochlear implants is the possible reduction of tinnitus intensity following implantation (Quaranta et al, 2004; Baguley and Atlas, 2007). The literature suggests that a significant proportion of CI recipients benefit from the implant with regard to their tinnitus (Quaranta et al, 2004; Baguley and Atlas, 2007), though a recent randomized controlled trial found that bilateral implantation appeared to be associated with increased tinnitus annoyance (Summerfield et al, 2006). In another recent paper,
41 patients with bilateral tinnitus were assessed before and after cochlear implantation. Results showed a significant reduction of tinnitus-related distress following the treatment (Quaranta et al, 2008), and another prospective study found similar benefits (Di Nardo et al, 2007). Additionally, a minority of patients do show exacerbation of tinnitus following implant surgery or device activation (Baguley and Atlas, 2007).

The mechanisms by which a cochlear implant can reduce the intensity and the impact of tinnitus are not well understood (Baguley and Atlas, 2007). Improved awareness of external sound may mask the tinnitus or reduce the starkness of the tinnitus. Attentional processes involved in listening through the CI may divert attention away from the tinnitus. The increase in afferent information from the electrically stimulated cochlea to the central auditory pathway may directly inhibit the tinnitus signal. Finally, increased confidence and well-being in a patient with a CI may reduce the emotional burden of the tinnitus. Much further work is needed in this area, but an important distinction should be made between the reduction of tinnitus intensity with a CI (which has been the subject of previous study; see Baguley and Atlas, 2007, for review) and a reduction in the burden associated with the tinnitus, for which terms such as annoyance, distress, and handicap are used. This is the focus of the present study, and we use handicap to describe the self-perceived tinnitus problems associated with tinnitus as measured by the Tinnitus Handicap Inventory (THI) (Newman et al, 1996).

There is a consensus that most people with tinnitus are not greatly troubled by it and that the proportion of individuals with tinnitus who are significantly disturbed by it approximates 10% (Andersson et al, 2005). However, the level of tinnitus handicap in CI recipients with remaining tinnitus or postimplant onset of tinnitus is not yet clear or reported in consecutive samples of CI recipients. For example, in one study the authors found that 35% of their CI sample had troublesome tinnitus, but no standardized questionnaire was used to evaluate the level of tinnitus severity (Mo et al, 2002). Although several studies have investigated the tinnitus status of cochlear implant recipients (Quaranta et al, 2004; Baguley and Atlas, 2007), few studies have used validated instruments. One of the most commonly used instruments for evaluating tinnitus distress is the THI (Newman et al, 1996), for which norms and guidelines for scoring (Newman et al, 1998) have been established. More specifically, Newman et al (1998) scored the THI based on quartiles of the total score, where 0–16 indicates no handicap, 18–36 mild handicap, 38–56 moderate handicap, and 58–100 severe handicap. In this article we will follow that categorization: while another classification into five categories has been suggested (McCombe et al, 2001) this has not been empirically verified.

The present study was designed to delineate the proportion of individuals with CI who have significant distressing tinnitus utilizing validated self-report measures of tinnitus-related handicap and hearing problems in a consecutive sample of unilaterally implanted CI patients who reported tinnitus postimplantation. Associations between tinnitus distress, symptoms of anxiety and depression, hearing problems, and demographic factors including type of implant were also investigated. Due to the retrospective nature of this study, it was not appropriate to attempt to determine change in the perceived intensity of the tinnitus signal.

METHODS

Procedure and Inclusion

Patients were recruited from the Cochlear Implant Unit, Karolinska University Hospital, Sweden. Candidacy criteria for CI required patients eligible for CI to have speech recognition scores below 45% for phonetically balanced word lists, and severe bilateral sensorineural hearing loss. All patients who had received their implants between the years 1999 and 2005 were approached for inclusion. Three implant brands were used, and all three were available during the study period (Med-El, the C40+ and the Pulsar100 system; Nucleus CI24M, CI24K CI24 Contour; and Advanced Bionsics Clarion 1.0 ICS, 1.2 ICS, and HiRes 90K). Decision on what type of implant to use was led by clinicians and based on patient preference and/or clinical characteristics. Tinnitus handicap had not been assessed in any systematic manner in association with the surgery, apart from regular note taking. Files were not used as tinnitus had not been assessed in a similar manner across patients.

Measures

Standard audiological and otological tests were part of the regular CI candidacy procedure. These tests will not be reported here. A selection of self-report measures was included in the study. First, a set of background questions were asked regarding tinnitus history and current characteristics. With regard to the tinnitus experience in relation to the CI 10 screening, questions were asked. The Tinnitus Handicap Inventory (THI) (Newman et al, 1996) was utilized as the main measure of tinnitus distress. The THI consists of 25 items scored 0, 2, or 4 and summed in a total scale (maximum 100 representing maximum possible handicap). A Cronbach's alpha of $\alpha = .93$ was reported in the validation study (Newman et al, 1996). The subscales of the Hospital Anxiety and Depression Scale (HADS) were used to assess depression and anxiety, with each scale calculated as the sum of seven zero-to-three-point items (Zigmond and Snaith, 1983). For tinnitus patients, internal consistencies of $\alpha = .83$ for the HADS anxiety subscale (HADS-A) and $\alpha = .88$ for the HADS depression subscale (HADS-D) have been reported (Andersson et al, 2003). Finally, we included the Gothenburg Profile (GP) (Ringdahl et al, 1998), which was used for the assessment of hearing problems. This
questionnaire contains 20 items with 11 response options for each item (never to always). The GP is divided into four subscales: the first five items measure experienced disability as to hearing speech, and the next five items cover sound localization. The next subscale covers experienced handicap in social settings (items 11–15), and the last scale covers personal reactions to the experienced handicap (items 16–20). Using the current World Health Organization terminology (World Health Organization, 2001) these subscales could be translated into hearing related activity limitation and participation restriction. Ringdahl et al (1998) reported high internal consistencies (=.90) for the two global subscales of hearing disability (items 1–10) and hearing handicap (items 11–20). Separate statistics for the five item subscales were not reported.

Subjects

A total of 189 CI users were sent a questionnaire booklet, in which all questionnaires were included. Depending on the results on the first 10 screening questions, which probed for the presence of tinnitus, patients were asked to proceed and complete the full questionnaire booklet. On the THI, patients were asked to consider their general tinnitus handicap as many of the items do not refer to tinnitus presence but, rather, the emotional reactions. Information on the study was provided, and informed consent was obtained. The institutional review board approved the protocol. The response rate was 157 (83%), but six questionnaires were not completed and hence excluded yielding an actual response rate of 80%. Out of the 151 responders, 40 reported that they did not have tinnitus at any time (26%) and were not asked to complete the rest of the questionnaire booklet. The remaining 107 completed the full questionnaires.

There were 68 female and 43 male responders. Mean age of the patients was 58.4 years (SD = 16.0; range 19–85 years). Mean age at the time of the implantation was 54.4 years (SD = 16.0), and patients were sampled at a follow-up 2.9 (SD = 1.8) years after the implantation. CI had been implanted on either the right ear (N = 60) or the left ear (N = 51). There were no bilateral implants. Three types of implants were implanted. A majority had the Med-El system (N = 58, 52%), followed by Nucleus system (N = 42, 38%), and Advanced Bionics (N = 11, 10%).

A total of 111 patients completed the whole booklet or parts of it. Responses on the first 10 screening questions will not be reported as they mainly covered items dealing with the presence of tinnitus and, apart from the screening, did not provide any meaningful data. Moreover, except for stating the presence of tinnitus, some patients without tinnitus only completed some of the items, yielding missing data. A total of 107 completed the THI, which according to the instructions given to the patients, can be interpreted as an affirmative response to the question if they currently had tinnitus. Hence, based on the criteria of only responding to the THI if tinnitus was present, roughly 71% of the responders reported having tinnitus, as four patients either did not have tinnitus or just failed to complete the full THI.

Statistical Analyses

Results were analyzed by means of Pearson product moment correlations, t-tests, ANOVAs, and chi-square.

RESULTS

Mean Results on Standardized Questionnaires

Results on the standardized measures are presented in Table 1. Mean results showed relatively low levels of tinnitus distress, moderate levels of hearing problems, and low scores on the anxiety and depression subscales of the HADS. Also presented in this table are recently published Swedish comparison data on a tinnitus sample from a trial (Kaldo et al, 2007). Norms for tinnitus patients on the GP are not available.

According to the guidelines presented by Newman et al (1998) for the THI, 36% (N = 38) had a score indicating “no handicap,” 30% (N = 32) “mild handicap,” 18% (N = 19) “moderate handicap,” and 17% (N = 18) “severe handicap.” The percentage of patients scoring above 10 on HADS-A was 13.6%, and the corresponding figure for HADS-D was 5.4%.

Correlations between Measures

All measures were significantly intercorrelated with Pearson r’s ranging between r = .20 and r = .80. The only exception was a nonsignificant association between HADS-A and the GP 6–10 (r = .09). Tinnitus distress was associated with both anxiety, depression, and hearing problems scores (r = .30 to r = .60, all p’s < 0.002). A correlation matrix is presented in Table 2.

Demographic Factors and Implant Brand

There were no gender differences on any of the standardized questionnaires (all p’s > .05), although
there was a trend indicating higher HADS-D scores in males [t(105) = 1.9, p = .056; M = 4.8 for males, M = 3.6 for females]. No significant correlations were found when age, age at implant, and years since implantation were correlated with tinnitus distress as assessed by the THI. Although number of recipients differed between the CI types, we tested differences with ANOVA using THI as dependent variable and implant type as independent variable. The ANOVA was not significant [F(2,104) = 1.9, p = .16].

**DISCUSSION**

Clinically relevant findings emerged in this study, some of which are congruent with previous literature and others that have not been reported. Tinnitus was commonly reported, which is in line with the previous literature on CI recipients (Baguley and Atlas, 2007), in which between 67 and 100% report tinnitus with a mean of 80%. However, as has been discussed above in the introduction to this article, less is known regarding the level of tinnitus distress in the previous studies in the literature. A major finding in the present study was that 17% of patients with tinnitus reported “severe” tinnitus handicap, based on the categorization of the THI (score above 58). This is in line with other tinnitus studies not including CI patients, suggesting that it is possible to experience tinnitus without marked distress (Andersson et al, 2005). However, if we include the persons with moderate tinnitus distress in the definition, the percentage is 24.5 who experience a significant tinnitus problem following CI. With almost 1/4 reporting significant tinnitus, it would be important to study this group further and to develop evidence-based management strategies, which could concern the implant itself (different coding strategies) or other treatment options such as general tinnitus counselling or tinnitus retraining therapy (Jastreboff and Hazell, 1993). No treatment has yet been tested in a randomized controlled trial for this patient group with residual or remaining significant tinnitus following implantation.

While single item questions may provide interesting answers, standardized self-report questionnaires with several items for each construct are more likely to generate robust findings. In this paper we used three validated scales, and we will discuss them each in turn. The THI is a widely used tinnitus distress measure, and the mean THI score obtained in this study (M = 29.8) is broadly congruent with previous tinnitus studies in other patient populations. Baguley and Andersson (2003) found a mean score of 44 on the THI for tinnitus clinic patients and a score of 28 for vestibular schwannoma patients (Baguley and Andersson, 2003), which is a group that usually presents with low degree of tinnitus distress (Andersson et al, 1997).

Results on the HADS anxiety and depression subscales were indicative of low levels of these symptoms, but as one would expect given the known prevalence of anxiety and depression in tinnitus patients, we did find that a small proportion (14%) showed signs of anxiety, and fewer had significant levels of depression symptoms (5%). Again, a different picture emerges if we compare our findings with those in more distressed tinnitus patients, who often show higher levels of these symptoms (Zoger et al, 2001). Previous studies on CI recipients have not clearly reported levels of anxiety and depression. Again, this may have management implications as evidence-based management approaches for tinnitus are largely lacking with the possible exception of cognitive-behavioral therapy, which focuses on the psychological distress associated with tinnitus (Martinez Devesa et al, 2007). To our knowledge this approach has not been tested for CI patients with significant tinnitus and/or anxiety and depression. Given the low percentage of persons reporting significant anxiety and depression, it is also questionable if selective serotonin reuptake inhibitors (SSRIs) are suitable for the tinnitus population (Baldo et al, 2006).

The findings we report on hearing problems are less easy to compare with the previous literature when it comes to the mean scores obtained. However, we have access to the raw data from the Ringdahl et al validation study (1998), which was derived from a general audiological patient population reflected in different levels of hearing loss. Comparing these data with ours on CI recipients confirms the expected finding that CI recipients have significant hearing problems, also in comparison with regular audiology clinic patients. That CI does not fully remove activity limitations and participation restriction (formerly known as disability and handicap) has been found previously, but there is room for more research into management strategies for this group.

As it is well known from the literature that tinnitus distress as assessed by self-report instruments often correlates with measures of anxiety and depression (Tyler et al, 2006), we correlated the self-report scales with each other. With one exception all correlations were statistically significant, and the pattern that emerged suggests that tinnitus in CI patients is associated with symptoms of anxiety and depression as well as reports of hearing problems. This finding is congruent with the

**Table 2. Intercorrelations between the THI, HADS, and GP (N = 107)**

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*Note: THI = Tinnitus Handicap Inventory; HADS-A = Hospital Anxiety and Depression Scale - anxiety subscale; HADS-D = Hospital Anxiety and Depression Scale - depression subscale; GP = Gothenburg Profile.
*p < .05; ** p < .01.*
tinnitus literature at large, in which self-report measures of tinnitus, psychological distress, and hearing problems tend to be correlated (Andersson et al, 2005). The clinical implications of this finding might not be obvious but imply that psychological aspects should be measured in the clinic as they tend to be correlated with tinnitus distress. In particular, identifying cases for which further psychological and/or psychiatric management could be called for can be important. As a screening measure for psychological distress cannot be too long or obtrusive in audiological settings, we recommend the HADS as it is a low impact and brief measure, while still being informative (Andersson et al, 2003).

There are some limitations of the present study that should be considered. First, we used a cross-sectional sample (rather than a prospective design), which thus limits the ability to draw causal inferences. Second, we were not able to use the data obtained regarding screening questions relating to onset of tinnitus in relation to surgery as too few patients completed these questions satisfactorily (N = 79). Another methodological issue concerns that the single item questions were constructed for this study and were used to establish the presence of tinnitus. It is possible that a structured interview might be a better choice to obtain reliable data. We would recommend a more careful differentiation of the effects of CI on tinnitus by means of first investigating the effects of the surgical procedure, then the role of electrical stimulation, and finally its more obvious effect of providing sound enrichment, and possibly masking and residual inhibition. Moreover, the longitudinal aspects of these processes need to be outlined. It is important to study both inhibition and exacerbation of tinnitus in relation to CI use.

In conclusion, in this report of a consecutive series of CI recipients, we found a generally low level of tinnitus distress. However, a quarter of the series demonstrated moderate/severe tinnitus distress and could therefore be regarded as candidates for tinnitus specific therapy. As the level of tinnitus distress was clearly associated with hearing problems and psychological distress, these aspects should be considered when planning rehabilitation and informed consent for CI.

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REFERENCES


