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Tinnitus, cochlear implants and how they affect patients

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Abstract

The relationship between tinnitus and cochlear implantation is an important issue that needs to be established because it may affect implant use. In this study 99 patients over 15 years of age completed pre- and post-cochlear implantation questionnaires, and underwent performance testing. The findings show that after implantation, there was marked suppression of tinnitus in both implanted and contralateral ears whilst the implant was off, and this was further enhanced when the implant was switched on. These effects are probably a combination of local and central factors. Presence of tinnitus, before or after implantation, had no detrimental effects on performance.

In conclusion, providing all other factors permit, this study recommends implanting the ear with the worst tinnitus.

Key words: Cochlear implants; Quality of life; Tinnitus

Introduction

Eighty-five per cent of patients undergoing cochlear implantation have experienced tinnitus pre-operatively that significantly affects their quality of life (Souliere *et al.*, 1992). The relationship between tinnitus and cochlear implantation is an important issue that needs to be established because it may affect implant use. It has been shown that single and multi-channel cochlear implants can suppress tinnitus in the ipsilateral ear (House, 1984; Hazell *et al.*, 1989; Souliere *et al.*, 1992; Ito and Sakakihara, 1994) and the contralateral ear (Souliere *et al.*, 1992; Ito and Sakakihara, 1994). However, specific questions have never been answered regarding how tinnitus characteristics (intensity or pitch) are affected by cochlear implantation. In addition there is a lack of data to illustrate how the presence of tinnitus post-implantation may affect performance.

This study reports the results of five years of cochlear implantation at the Midland Cochlear Implant Programme (MCIP) with particular emphasis on post-implantation performance.

Methods and population

All patients over the age of 15 years, with post-lingual deafness, undergoing Nucleus 22-channel implantation at the MCIP between 1991 and 1996, were included in this prospective study.

All prospective cochlear implant candidates, at the time of initial assessment by the Cochlear Implant Team, were asked to complete a pre-questionnaire that, in addition to obtaining basic biographical data, was also used to obtain information regarding the patients experience of tinnitus. At nine months post-implantation they also completed an implant use questionnaire, part of which examined the effects of the implant on the patient's tinnitus. Both questionnaires formed part of the Department of Health funded National Programme which was evaluated in 1994 by the Medical Research Council Institute of Hearing Research (Summerfield and Marshall, 1995). At nine months post-implantation all implantees underwent performance tests involving recognition of common environmental sounds and speech discrimination was tested with Bamford-Kowal-Bench (BKB) sentences. These were administered as described in the MRC main report (Summerfield and Marshall, 1995).

All answers were collated and the results analysed using the Chi Square statistical analysis technique. The difference was considered to be statistically significant at a p-value <0.05.

Results

Ninety-nine patients were included in the study (41 males and 58 females), with an age range of 19 to 83 years (mean 48.5; SD 2.18).

Prior to implantation, 80 candidates suffered from tinnitus, 64 bilaterally and 16 unilaterally (Figure 1). After implantation with the implant switched off the number of tinnitus sufferers was reduced to 61, 40 bilaterally and 21 unilaterally. On implant use (switched-on) only 37 implantees experienced tinnitus, 24 bilaterally and 13 unilaterally. Hence 62

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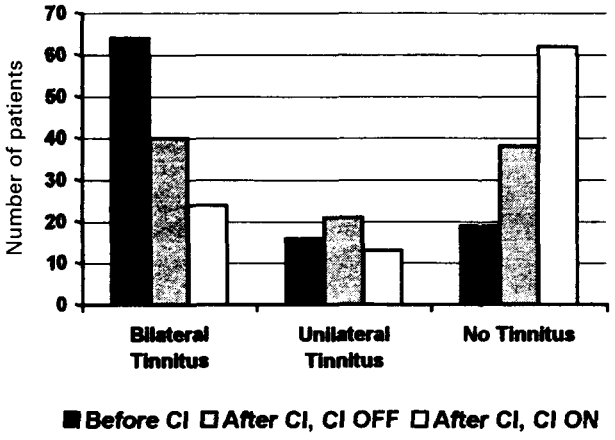

FIG. 1
Number of patients with or without tinnitus and association to cochlear implants (CI)

implantees were tinnitus-free with implant use. The difference between the numbers of patients tinnitus-free in the three groups was statistically significant ($p<0.001$). Seventy-four ears that received cochlear implants had pre-existing tinnitus (Figure 2). After implantation only 45 implanted ears still experienced tinnitus with the device switched-off, and this was reduced to 24 when the implants were switched-on. When comparing the number of implanted ears tinnitus-free pre-implantation with those post-implantation (switched-off), the results were statistically significant ($p<0.001$). Similarly, on comparing the number of implanted ears tinnitus-free post-implantation with the implant switched off and on the difference was statistically significant ($p<0.001$). Seventy contralateral ears (ears that were not implanted) had tinnitus prior to surgery (Figure 2), which was reduced to 56 post-implantation (switched-off), and the difference was statistically significant ($p<0.01$). With the implants in use, the number with tinnitus was further reduced to 33 ($p<0.001$).

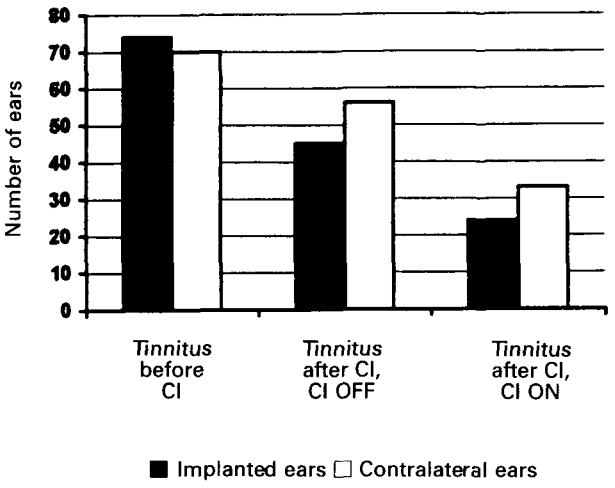

FIG. 2
Individual ears with tinnitus and their relationship to cochlear implants (CI).

TABLE I
THE EFFECTS OF IMPLANT USE ON TINNITUS CHARACTERISTICS

	Implanted ears (45)	Other ears (56)
Intensity		
Total suppression	21	23
Quieter	12	10
Same	8	9
Worse	4	14
Pitch		
Lower	14	10
Same	6	11
Higher	4	12

Using the implant affected both the intensity and pitch of residual tinnitus (Table I). It was noted that implantees who experienced an increase in the intensity of tinnitus also experienced an increase in tinnitus pitch.

The performance of cochlear implantees was assessed using recognition of words in BKB sentences (Figure 3) and recognition of common environmental sounds (Figure 4). Tinnitus-free implants were compared to those with unilateral and bilateral tinnitus, and the results showed no difference between the three groups.

Discussion

In this series the overall incidence of tinnitus was 80 per cent, similar to previous studies (Souliere *et al.*, 1992), the majority of which was bilateral. Thirty-eight per cent of implantees experienced total tinnitus suppression after cochlear implantation with the implant switched off. This observation might be explained by the detrimental effects of endolymph leakage, or the damage inflicted on the basilar membrane and hair cells as a result of electrode insertion (Gstoettner *et al.*, 1997). A further group of implantees (24 per cent) experienced total tinnitus suppression whilst the implants were in use. Distraction may play a part in this, like maskers, as may the reduction in auditory or social isolation post-cochlear implantation.

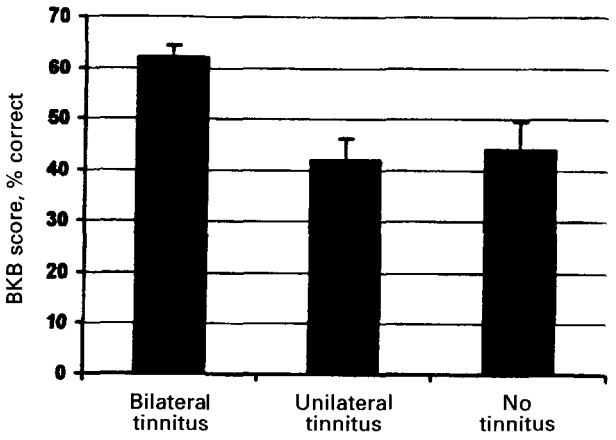

FIG. 3
Accuracy of identification (% correct) of words in sentences from the BKB test at the nine-months post-operative stage. Mean performance for patients with bilateral tinnitus (n = 40), with unilateral tinnitus (n = 21) and with no tinnitus (n = 39).

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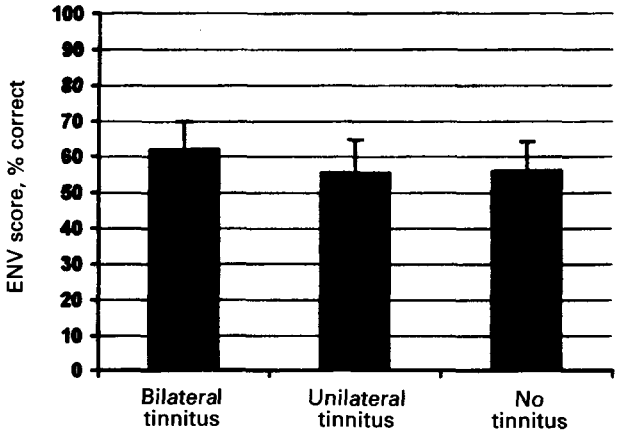

FIG. 4

Accuracy of identification of environmental sounds (% correct) at the nine months post-operative stage. Mean performance for patients with bilateral tinnitus (n = 40), with unilateral tinnitus (n = 21) and with no tinnitus (n = 39).

Sixteen per cent of implantees experienced contralateral tinnitus suppression with the implant switched off, and this was more than doubled when the implants were in use. Contralateral tinnitus suppression could be attributed to effects at the level of the brainstem (Hazell *et al.*, 1995), leading to control masking via the inferior colliculus (Gerken, 1996). This is further supported by studies where electrical stimulation of the brainstem in profoundly deaf individuals showed significant tinnitus suppression (Hatton *et al.*, 1960; Soussi and Otto, 1994).

Considering that 50 per cent of implanted ears experience total tinnitus suppression, with implant use, it seems reasonable to select the ear suffering with the worse tinnitus for implantation if other factors are equal.

Although cochlear implantation did not suppress all cases of tinnitus, the performance of implantees with residual tinnitus was not affected. Speech discrimination testing showed a mean score of 62 per cent correct in implantees with bilateral tinnitus, compared to a mean score of 44 per cent correct in the tinnitus-free implantees. Similarly, environmental sound testing showed a mean score of 62 per cent correct in implantees with bilateral tinnitus, compared to a mean score of 56 per cent correct in the tinnitus-free implantees. These findings support the belief that implants benefit in several ways besides improving hearing.

Conclusions

Cochlear implants have a positive effect on tinnitus, not simply by inducing total suppression, but also by affecting its' characteristics, such as pitch and intensity, and thereby making tinnitus more tolerable for the majority of implantees. Interestingly, implants seem to have both a passive and active effect on tinnitus (switched on or off). It is also apparent that tinnitus does not have any detrimental effects on performance of implantees.

The findings in this study recommends the use of the ear with worse tinnitus for implant insertion, as there is a significant chance for total tinnitus suppression.

Cochlear implants are unlikely to be used primarily to manage tinnitus due to their severe adverse effects on hearing. However, in patients with severe deafness and intractable tinnitus, implantation may be worth considering.

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