Impact of cochlear implantation on the subjective assessment of tinnitus

Review Article

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Abstract

Goals: Tinnitus is a frequent and disabling symptom. It has a prevalence of 85% in patients' candidates to cochlear implant (CI) placement. In sensorineural hearing loss, the cochlear damage involved may be a triggering factor for its appearance. The main goal of this study was to determine the impact of cochlear implant placement on tinnitus complaints.
Material and Methods: Prospective study that included 35 patients with bilateral severe or profound sensorineural hearing loss with complaints of bilateral tinnitus submitted to unilateral cochlear implant placement between January and September of 2022. All patients answered preoperatively and 3 months after CI placement to the Tinnitus Handicap Inventory. The severity of tinnitus was also defined.
Results: the preoperative total mean THI result was 40.2 ± 32.2 points. 3 months after surgery, there was a decrease in the average of the final result (12.06±23.5) and in all its subcategories. The difference in mean was statistically significant between pre and postoperative periods ($p < 0.05$); in 16 of the 35 patients there was a complete resolution of the tinnitus and only one had a worsening.
Conclusions: our study showed an improvement in tinnitus in most patients with unilateral CI placement and a resolution in almost half of them.

Keywords: Cochlear implant; Tinnitus; THI; Adults

Introduction

Tinnitus is defined as the perception of a sound or noise in the absence of an external sound source[1,2]. The word tinnitus is of Latin origin and means ringing. Its prevalence is approximately 15% in the general population and tends to increase after 50 years of age[3]. It may be objective or subjective, with the latter being more common, and has a negative impact on the patients' quality of life because it is associated with an increased prevalence of anxiety, depression, and disturbances in the sleep quality [4,5].

The mechanism of tinnitus generation is still not fully understood but cochlear damage appears to be a triggering factor[6]. Changes in the central auditory pathways, namely in the cochlear nucleus, inferior colliculus, medial geniculate body, and auditory cortex that compensate for the loss of electrical stimulation of the cochlea seem to be one of the mechanisms underlying the onset of tinnitus[7,8]. This theory also explains why, in cochlear disease causing sensorineural hearing loss, tinnitus is a prevalent symptom[9]. Although the association between tinnitus and sensorineural hearing loss is not a direct one, studies have revealed that the prevalence of tinnitus in patients who are candidates for cochlear implantation (CI) reaches 85%[3,10]. This procedure involves the surgical placement of an array of electrodes in the cochlea to stimulate the cells in the organ of Corti to transmit auditory information[5]. It is recommended for patients with bilateral severe-to-profound sensorineural hearing loss who do not benefit from a hearing aid. Despite several studies on the relationship between CI and tinnitus, there is still controversy regarding the role of CI in reducing tinnitus[11].

The objective of the present study was to determine the impact of unilateral CI on the complaint of tinnitus in patients with bilateral severe-to-profound sensorineural hearing loss.

Materials and Methods

This was a prospective study that included 35 patients aged 18 years and over with a history of bilateral severe-to-profound sensorineural hearing loss and complaints of bilateral tinnitus who underwent unilateral CI between January and September 2022. The participants are being followed at the outpatient clinic of Otorhinolaryngology and Head and Neck Surgery of the Centro Hospitalar Universitário de Santo António (CHUdSA). The choice of ear for CI was based on the audiological and anatomical findings. All procedures were performed by the same surgeon using the same surgical technique, via the round window.

All patients who participated in the study answered the Tinnitus Handicap Inventory (THI), validated and translated into Portuguese[12,13] at the preoperative consultation and three months after CI. The THI is composed of 25 questions with three response options: Yes, Sometimes, and No, which correspond to scores of 4, 2, and 0, respectively. The questionnaire is divided into three subgroups: functional (11 questions with a score varying from 0 to 44), emotional (nine questions with a score ranging from 0 to 36), and catastrophic (five questions with a score varying from 0 to 20). Higher scores in the THI indicate a greater impact of the tinnitus on the patient's daily activities. In addition, the tinnitus severity was defined according to the THI score using the scale created by McCombe et al., which classifies the tinnitus severity into slight (0–16), mild (18–36), moderate (38–56), severe (58–76), and catastrophic (78–100)[14].

The status of tinnitus after CI was defined as follows: complete resolution when the THI score was 0; partial resolution when there was an improvement of at least one degree in the severity; and worsening when there was an aggravation of at least one degree in the severity. Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS™) software, version 29. Results with $p < 0.05$ were considered statistically significant. All variables were analyzed using the t-test for paired samples. The Kolmogorov-Smirnov test was used to test the normality of the data.

This study was approved by the Ethics Committee of the CHUdSA.

Results

Table 1 shows the characteristics of the study population regarding age, sex, and side of CI.

Table 1
Characteristics of the study population

Characteristics	n = 35
Age (years)	52,1±13,2
Sex (Female: Male)	20:15
Side (Right: left)	19:16

Table 2 shows the final THI scores for each patient before and after the operation.

The mean total score in the preoperative THI was 40.2±32.2 points, with 17.8±14.5 points in the functional category, 14.6±12.2 points in the emotional category, and 7.9±6.7 points in the catastrophic category. The percentage of patients with slight, mild, moderate, severe, and catastrophic tinnitus was 28.6%, 20%, 20%, 17.1%, and 14.3%, respectively. There was a reduction in the mean final THI score three months after CI (11.54±23.5 points), with a reduction in all three categories (Table 3). The differences in the mean total scores and means of the scores of the categories between before and three months after CI were statistically significant ($p < 0.05$). It is worth noting that 16 of the 35 patients experienced complete resolution of tinnitus, having scored 0 in the postoperative THI, and only one patient had a postoperative score higher than the preoperative one. The percentage of patients with complete and partial resolution of tinnitus was approximately 74% (n=26) (Table 4).

With regard to the severity of tinnitus, the percentage of slight tinnitus increased to 82.9% (n = 29) and that of catastrophic tinnitus decreased to 5.7% (n=2) (Table 5).

Table 2
Results of the pre- and postoperative Tinnitus Handicap Inventory (THI)

n= 35	pre THI score	post THI score
1	6	2
2	8	0
3	10	0
4	100	2
5	92	86
6	100	82
7	20	18
8	2	46
9	74	8
10	36	24
11	34	0
12	12	12
13	6	0
14	78	0
15	70	6
16	8	0
17	32	0
18	68	0
19	54	0
20	6	0
21	10	10
22	80	4
23	44	0
24	38	10
25	8	0
26	72	58
27	54	2
28	68	0
29	10	0
30	78	4
31	6	0
32	72	8
33	6	0
34	38	10
35	32	12

Table 3
Pre- and postoperative THI scores

THI*	Preoperative (total±SD**)	Postoperative (total±SD)	p value***
Functional subgroup	17,8±14,5	6,4±12,3	p=0,01
Emotional subgroup	14,6±12,2	3,6±8,2	p=0,01
Catastrophic subgroup	7,9±6,7	3,2±5,2	p=0,001
Total	40,2 ± 32,2	11,54±23,5	p=0,01

*THI - Tinnitus Handicap Inventory; **SD – Standard Deviation; ***p<0.05 - statistically significant values;

Table 4
Changes in the tinnitus after surgery

	n = 35	(%)
Complete resolution	16	45,7
Partial resolution	10	28,6
No change	8	22,8
Worsening	1	2,9

Table 5
Tinnitus severity pre- and post-operatively

Severity	Preoperatively (%/n)	Postoperatively (%/n)
Slight	28,6/10	82,9/29
Mild	20/7	5,7/2
Moderate	20/7	2,85/1
Severe	17,1/6	2,85/1
Catastrophic	14,3/5	5,7/2

Discussion

Patients with profound and severe sensorineural hearing loss often complain of tinnitus, in addition to having communication problems linked to the disease, and this affects their quality of life. CI is an effective treatment for this type of hearing loss when auditory rehabilitation with a hearing aid is not beneficial, and it has been reported to have a positive impact on the severity of tinnitus[15,16].

In the present study, we examined the impact of CI on the degree of tinnitus in patients with bilateral severe-to-profound sensorineural hearing loss. The impact of CI on tinnitus is controversial and the results of previous studies vary widely[17].

Of the 35 patients with bilateral tinnitus before CI, 16 (45.7%) experienced complete resolution of the disease and 10 (28.6%) had partial resolution. However, these values are lower than those reported in the literature, namely in the studies by Pan et al. and Hsieh et al., in which 61% and 62% of the patients, respectively, experienced complete resolution of tinnitus[18,19]. In 2017, Ahmed et al. demonstrated total suppression of tinnitus in 54% patients, a result that is closer to that obtained herein[10]. Kim et al. obtained similar results, with disease resolution in 45.5% of the patients[20]. No patient in the present study reported de novo tinnitus, unlike in other studies[17].

The mean preoperative THI score was 40.2 ± 32.2, which falls within the moderate category in the scale of tinnitus severity. More than half of the patients exhibited moderate, severe, or catastrophic tinnitus. In addition to the impact of hypoacusis on the quality of life of these patients, it is important not to dismiss the impact of tinnitus, as shown by the findings pf the present study.

The surgical approach appears to influence the impact of CI on tinnitus. Patients who underwent round window insertion had better outcomes with regard to tinnitus than those who underwent cochleostomy, similar to the study of Kloostra et al. that reported resolution of tinnitus in 75% patients who were operated via round window versus 25% patients who underwent cochleostomy[15]. In the present study, the surgical approach was the same for all patients and, therefore, this factor did not affect the results.

Moreover, the duration of tinnitus appears to be strongly associated with the postoperative outcomes. In cases of long lasting tinnitus, the changes at the level of the central auditory pathways are more difficult to reverse. Kloostra et al. showed that patients in whom the tinnitus did not improve after surgery had had tinnitus for a longer duration than those in whom it improved (32.2 years versus 5.2 years)[15,21]. The absence of data on the duration of tinnitus in the present study was thus a limitation of the study.

Conclusion

The results of this study support the hypothesis that in addition to being a therapeutic option for severe-to-profound sensorineural hearing loss, CI is an important tool for alleviating the impact of tinnitus in these patients. In addition, our findings provide evidence for answering the following question: is CI a treatment option for tinnitus suppression?

Conflict of interest

The authors declare no conflict of interest regarding this article.

Data confidentiality

The authors declare that they followed the protocols in use at their working center regarding the publication of patients' data.

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Availability of scientific data

There are no publicly available datasets related to this study.

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