International Tinnitus Journal, Vol. 12, No. 2, 172–174 (2006)

Can Cochlear Implants Decrease Tinnitus?

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Abstract: Suppression of tinnitus by electrical stimulation via a cochlear implant has been studied in recent years. Some individuals who undergo cochlear implant surgery report total or partial relief of the symptoms even in the contralateral ear. The mechanisms involved in this suppression are not clear. The results obtained in our study demonstrated an improvement of 71% in 29 implant cases, confirming data found in the literature. Our aim was to study tinnitus in individuals before surgery and after cochlear implant activation and to observe improvement in the perception of tinnitus, comparing these results with data in the literature. We conducted a retrospective study of 29 postlingual adults who had profound sensorineural hearing loss and underwent cochlear implant surgery at the cochlear implant sector of the Otorhinolaryngology, Head and Neck Surgery Department, University of Campinas, São Paulo, Brazil, between May 2003 and June 2005. The device employed in this procedure was the Nucleus 24K multichannel device (Cochlear Ltd, Lane Cove, Australia). After the internal component was activated, patients completed a questionnaire. Before surgery, 21 of the 29 patients (72%) who later underwent cochlear implant surgery presented with tinnitus, which was bilateral in 14 cases (67%). After the cochlear implant was activated, seven patients (33%) presented with total suppression, and eight patients (39%) reported partial relief. In the 14 cases with bilateral symptoms, tinnitus was totally suppressed or decreased in both ears in 12 cases (86%). Individuals who underwent multichannel cochlear implant surgery presented with reduced tinnitus even in the contralateral ear.

Key Words: cochlear implant; profound sensorineural hearing loss; tinnitus

Tinnitus may be defined as a conscious perception of a buzzing, hissing, or ringing sound in the absence of environmental noise. It is a common symptom, with heterogeneic etiologies, perception, and discomfort, that affects 15% of Americans [1]. Tinnitus is classically attributed to cochlear cell lesions. Jastreboff's 1990 neurophysiological model [2] emphasized the importance of the interaction of the central auditory system, the limbic system, and the sympathetic autonomic system. According to this model, peripheral lesions produce an electrical signal that, added to an inefficient control of the encephalic stem system and to emotional and behavioral reactions, leads to an unpleasant buzzing sensation.

Recent studies have demonstrated the occurrence of neuronal plasticity and cortical reorganization related to perception of sound after cochlear damage. The disproportional increase in the number of neurons sensitive to the remaining frequencies of hearing or greater spontaneous activity in reorganized areas may explain the buzzing sensation.

Many patients with sensorineural hearing loss present with tinnitus, especially those with an indication for cochlear implantation. Although several therapies have been recommended for the treatment of tinnitus, none of them has been totally effective. Several studies suggest that electrical promontory stimulation is effective in suppressing tinnitus [3–6]. Reduced tinnitus has been reported after cochlear implant surgery [7,8], including in the contralateral ear [9]. According to a bib-

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This research was presented at the Fourth Brazilian Triological Meeting, São Paulo, Brazil, November 10–14, 2005.

liographical review by Quaranta et al. [10], 66–86% of cochlear implant users complained of tinnitus before implantation of the device. After the implant, approximately 86% presented with partial or total improvement, with exacerbation seen in only 9%.

Just one study in the Brazilian national literature reported tinnitus improvement in four of five patients who underwent monochannel cochlear implant surgery [11]. The purpose of our research was to study tinnitus before surgery and after activation of the cochlear implant, to observe the suppression of tinnitus perception and to correlate these results with data in the literature.

PATIENTS AND METHODS

We conducted a retrospective study involving 29 adults who had postlingual sensorineural hearing impairment and underwent surgery for Nucleus 24K multichannel (Cochlear Ltd.) cochlear implant at the cochlear implant sector of the Otorhinolaryngology, Head and Neck Surgery Department, University of Campinas (UNICAMP), São Paulo, Brazil, from May 2003 to June 2005. After the internal component was activated, the patients completed a questionnaire.

RESULTS

We conducted our study of 29 postlingual adults who were suffering from sensorineural hearing loss and underwent cochlear implant surgery (age range, 25–75 years; mean, 49 years; 17 females [59%] and 12 males [41%]). The mean time of hearing loss before surgery was 15.3 years (range, 0.6–44 years).

Before surgery, 21 individuals (72%) presented with tinnitus, which was bilateral in 14 patients (67%). After the cochlear implant was activated, tinnitus completely disappeared in seven patients (33%) and partially decreased in eight (39%). Tinnitus remained unaltered in three patients (14%) and worsened in three (14%). One individual reported the onset of tinnitus after the device began functioning (Fig. 1).

Twelve (86%) of the 14 individuals who presented with bilateral tinnitus reported either complete disappearance or decrease in both ears and, in 2 patients (14%), the tinnitus worsened, even in the contralateral ear (Fig. 2).

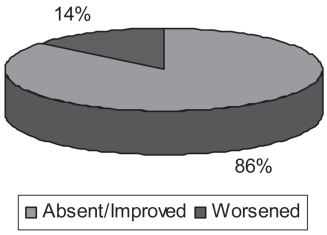

Figure 2. Evolution of tinnitus after cochlear implant activation in patients with bilateral complaints.

Seven (47%) of the 15 patients who continued with tinnitus were aware of the buzz only when the device was disconnected; 5 patients (33%) perceived tinnitus even when the implant was activated; and 3 patients (20%) continued under both conditions (Fig. 3).

DISCUSSION

In our study, the incidence of tinnitus in individuals with profound bilateral sensorineural hearing loss was 72%, compatible with the data in the literature [10,12]. Tinnitus decrease or suppression after cochlear implantation in 71% of cases was also compatible with the results obtained by similar studies [10,12,13], regardless of the type of internal component.

The literature contains no consensus regarding the cochlear implant mechanism of tinnitus suppression. The masking effect most probably works like environmental noise that induces vibration of the basilar membrane at the damaged site, suppresses abnormal activity of the cilia cells in the internal ear, and produces a buzzing noise. A similar effect could be produced by a hearing prosthesis that would improve hearing and suppress tinnitus [9].

The literature demonstrates that multichannel devices have proven to be more effective than the monochannel implants in reducing tinnitus. It is suggested that the

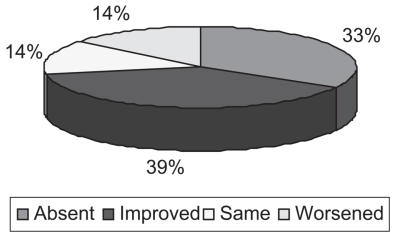

Figure 1. Evolution of tinnitus after cochlear implant activation.

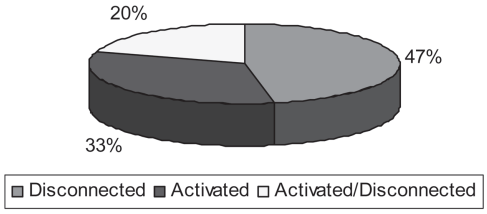

Figure 3. Perception of tinnitus after cochlear implant.

greater the external sound received by the cochlear implant, the smaller the tinnitus perception [10].

Reports have cited the possibility of tinnitus worsening or being exacerbated after cochlear implant surgery [10] but, according to Ruckenstein et al. [14], this procedure does not present a significant risk for poorer outcomes. In our study, we observed tinnitus to worsen in only three patients. In two of the three cases, tinnitus was slightly worsened, and in only one case the patient referred to an annoying effect.

Our results in relation to tinnitus suppression and partial suppression were similar to those found in the literature [9,13–18]. Electrical stimulation of the implant is transmitted to the cochlear and superior olivary nuclei, causing direct inhibition of the inner-ear cilia cells through the efferent pathways. Activation of the efferent system would explain the suppressive effect of the cochlear implant on tinnitus [9].

Unilateral sound therapy was thought to be ineffective in the treatment of tinnitus. However, asymmetrical stimulation produced by the cochlear implant has proved to be beneficial even in the contralateral ear [9,12,16–18]. The plastic alterations in the cortical areas may have a physiological explanation [19]. According to Salvi et al. [20], spontaneous action of the damaged areas of the hearing system is responsible for some cases of tinnitus. Reorganization of these areas, which occurs after cochlear implant, may reduce this activity and, as a result, diminish tinnitus. Owing to decussation in the central hearing system, decrease of tinnitus is also expected in the contralateral ear after cochlear implantation [10]. In our study, 12 patients also presented with tinnitus improvement in the contralateral ear. However, two patients reported that tinnitus had worsened in the contralateral ear after surgery.

Postsurgical onset of tinnitus occurred in one of our patients when the implant was activated. A probable explanation is that program adjustment had not occurred owing to the short period of activation.

The postsurgical cochlear implant benefits obtained by patients with tinnitus raise the following question: Is cochlear implant surgery justifiable for the treatment of tinnitus? Similarly, the influence of tinnitus in relation to choice of ear for cochlear implantation is also a complex subject. Some indications suggest that cochlear implantation in the ear in which tinnitus is more severe has a chance of greater suppression [15].

CONCLUSION

The results of this study demonstrated that cochlear implants had a positive effect on tinnitus and could also induce its partial or total suppression in the contralateral ear.

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