TINNITUS AND THE UNILATERAL DEAD EAR

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Introduction

Since 1976 we have managed over 8000 tinnitus patients in a multidisciplinary protocol. We use an holistic approach with much emphasis on appropriate counselling and rehabilitation, particularly the retraining of attitudes towards tinnitus and the way in which they are evaluated[1,2].

We were struck by the severe distress that often accompanies tinnitus in a dead ear. It was our impression that many of these patients had lost their hearing as a result of failed otosurgery, or as a consequence of otosurgical procedures. We decided to see whether patient attitudes to previous otological management played a part in generating their tinnitus distress.

As part of the process of hearing rehabilitation of this group we used CROS (contralateral routing of signal) and BICROS hearing aids[3] which take sound from a microphone on the deafened side and convey it to the hearing ear via a neck loop or spectacle frame. We were surprised to find that some patients reported significant improvement in the tinnitus in their dead ear while using the device, in addition to help with their hearing.

A few patients remained with intractable tinnitus in an otherwise dead ear and these were tested for electrical tinnitus suppression to assess their suitability for cochlear implantation with a single channel device[4].

Patients and methods

A total of 54 patients with unilateral dead ear and tinnitus were seen in our tinnitus clinic over a seven-year period. They were subjected to very detailed history taking and assessment. In particular we interviewed patients about their previous otological management, attitudes to professionals, and feelings about the causation of their tinnitus. Patients were instructed fully in the mechanism of their tinnitus and counselled about strategies for lessening it's effect. All patients were entered into a trial of CROS hearing aid systems (BICROS where there was also a hearing loss in the "good" ear). They were informed that these devices could restore useful hearing to the deaf side, and that we had also had experience of tinnitus improvement while using them.

Acoustic neuroma exclusion was carried out in all patients who had not already been extensively investigated elsewhere (as most of them had). Care was taken not to alert patients to this risk without conclusive radiological evidence. Patients were assessed at three and six monthly intervals in the tinnitus clinic, but seen on a more regular basis by the audiologists in charge of rehabilitation (LJM and JBS). Patients were assessed by questionnaire after they had been in the trial for not less than one year.

Cochlear implants

We have described elsewhere the development of a round window single channel cochlear implant at University College Hospital London for the purpose of (a) rehabilitation of total

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deafness, and (b) chronic electrieal stimulation of tinnitus in a dead ear[4]. This device consists of a passive receiver buried under the temporalis muscle with an electrode leading through a posterior tympanotomy to the round window or (more recently) a cochleostomy on the promontory. Analogue signals are received by amplitude modulation of a 12 mHz R.F. carrier wave from a transmitter attached above the implanted ear. We determined by acute round window experiments in these and other totally deaf patients with tinnitus that low frequency sinusoid current was most effective in suppressing tinnitus[5]. The unique characteristics of our implant allow the use of this low frequency alternating current for the first time in electrical tinnitus suppression. A total of 10 patients with unilateral deafness and severe intractable tinnitus were entered into the implant protocol. This involves assessment of otological and psychological suitability, and acute round window stimulation with a hard wired electrode via a myringotomy incision[5,6] or a small tympanotomy. The electrode is left in place for up to two days stimulating the ear with the "best suppressor frequency" so that the patient can judge the benefits that might accrue from implantation and continuous electrical stimulation of the affected cochlea.

Results

The mean age was 51 years (sd 21.9) and sex ratio F 46%, M 54%. The etiologies of hearing loss are given in Table 1. Of the 22 cases where tinnitus followed surgery, 10 were stapedectomies, three were mastoideetomies and one acoustic neureetomy. Often patients had little idea what operation had been performed and none could remember being advised about the possible risk of postoperative tinnitus.

Table 1. Etiology of hearing loss

	n	%
Otosurgery	22	40.7
Unknown	11	20.4
Ménière's	9	16.7
Viral cochleitis	7	13.0
Acoustie trauma	2	3.7
Suppurative OM	1	1.8
Otoselerosis	1	1.8
Head iujury	1	1.8

CROS hearing aid systems

The results of fitting CROS hearing aids systems were assessed by questionnaire and the results ehecked with patient hospital records. Seventy-nine percent reported help with hearing on their deaf side, 57% help with direction of sound and 33% help with hearing in a group. Overall help with tinnitus is summarized in Fig 1. Nineteen patients (35%) found their tinnitus less noticeable when wearing the device, but in only two (4%) was it made inaudible. Of the

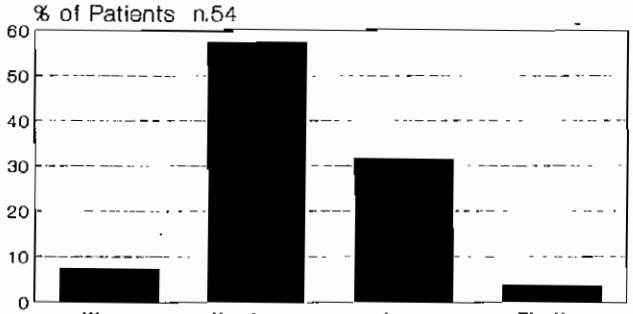

Fig. 1. CROS hearing aids; help with tinnitus.

19 patients all except four obtained help with their hearing. However it was not possible to predict a good tinnitus result from the hearing result and 28 patients were helped with their hearing but not their tinnitus (Table 2). Results were not related to tinnitus severity as scored on an analogue scale. In seven percent tinnitus was quieter for a period after removing the aid. Results were not significantly different if tinnitus was also present in the "good" ear. Diagnosis influenced results in that 47% of the surgical group had improved tinnitus with CROS aiding but none who had suffered viral cochleitis, against 35% of the whole group.

Table 2. Hearing *vs* tinnitus help

	Tinnitus	
	Helped	*Not helped*
Hearing		
helped	7	4
not helped	28	15

Cochlear implants

Ten patients were selected for assessment for cochlear implantation because of intractable tinnitus in a dead ear. Three patients who have received implants have been using them continuously for periods of one, two and three-and-a-half years. Of the remaining seven patients one had no tinnitus suppression on acute testing at any frequency. The others all had tinnitus suppression with balanced sinusoidal current at 50 Hz or below. However, all but one in this group have decided not to have implants at this time, because they feel they are in the process of habituating to their tinnitus as a result of counselling received in the tinnitus programme. In the implanted group the results have been good and implants are used continuously with low frequency sinusoid transmitters set to their best suppression frequency. In this group:

a. tinnitus is suppressed only with the device switched on (no post stimulus inhibition);
b. the stimulating current evokes a sensation of hearing in each case but the sound is much preferred and is much quieter than the tinnitus;
c. the threshold of electrical suppression of tinnitus does not alter with time;
d. the contralateral hearing is unaffected[7];
e. in one case severe instability due to fluctuating vestibular function is also controlled by the implant.

Discussion

A very significant proportion of patients referred for management of tinnitus in a dead ear had failed otosurgery, and for this and other reasons harbour resentment, anger and guilt about the procedures which they believed responsible for their distress. We believe that much distress results from the evaluation and meaning of tinnitus, part of complex central auditory processing. We have discussed this hypothesis at length[8] and agree with the proposals put forward by Jastreboff[9]. The limbic system and prefrontal cortex greatly influence auditory as well as other modalities of perception[10] and therefore strong emotional feelings relating to tinnitus and its etiology are likely to militate against habituation. We found that counselling patients to "forgive" their surgeons did much to reduce the effect of tinnitus on the patient's life. A CROS hearing aid has the effect of providing sensory information about an environmental hemisphere previously thought of by the patient as "dead to sound". Straining to hear on the deaf side may increase gain in mechanisms in the peripheral and central auditory system and thereby increase tinnitus amplitude awareness and intrusiveness. Providing this auditory information, even via the contralateral ear, may reduce this strain and consequently the tinnitus. Where tinnitus in a dead ear remains a serious problem despite these approaches, chronic electrical stimulation with low frequency sinusoids through an implant remains the only way, in our view to influence tinnitus perception, and this it will do in a significant number of cases. We feel cochlear implants have at present a very limited though important part to play in tinnitus management overall, and should always be incorporated into a multidisciplinary and multifactorial approach to tinnitus therapy.

Résumé

Les acouphènes les plus gênants et les plus désespérants sont souvent associés à une perte anditive unilatérale totale et soudaine. La forte réduction des informations auditives venant d'une moitié de l'environnement immédiat a pour conséquence une détection accrue des acouphènes, qui, dans ce cas, sont le seul son ponvant être détecté dans l'oreille sourde. Lorsque la perte auditive et les acouphènes qui en résultent sont la conséquence d'une oto-chirurgie ratée ou d'une blessure à la tête, les patients éprouvent souvent des sentiments de colère et de culpabilité pendant une longue période. Cela peut affecter le processus d'évaluation des acouphènes en facilitant la mise en place d'une attitude négative et en retardant un processus d'accoutumance aux aeouphènes. Le traitement des acouphènes dans l'oreille sourde peut être facilité par:

a. des techniques de conseils appropriés, centrés principalement sur une diminution du sentiment de colère et de culpabilité.
b. l'implantation d'un appareil acoustique CROS pour recouvrer l'audition du côté sourd (amélioration de 33% des acouphènes).
c. dans certains cas sélcctionnés, l'utilisation de stimulation électrique sinusoïdale basses fréquences via une seule implantation cxtra-cochléaire monocanal.

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