Management of tinnitus: discussion paper[1]

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The results of the timely epidemiological study by the Institute of Hearing Research (1981) remind us that over 17% of the population have an experience of tinnitus, at least intermittently, which they find troublesome. About 200 000 people in the United Kingdom have such severe tinnitus that they are unable to work or function socially. At present the majority of these patients seeking help are met with the bland assurance that they should 'go away and live with it'.

It should be remembered that tinnitus, like pain, is a symptom and not a disease and that any attempt to treat it as a disease will have a high proportion of failures. There are many potential generators of sounds in and around the ears, both haemodynamic and electrophysiological, which can result in the sensation of noise or noises in the ears or head, and there are often simple explanations for the presence of tinnitus, such as wax in the ears or middle ear effusions.

Hypothesis for sensorineural tinnitus

It has long been an enigma that three-quarters of the hair cells in the cochlea (the outer hair cells) are almost totally devoid of afferent nerve fibres; instead they receive a rich efferent innervation (the olivocochlear bundle). The inner hair cells, having 90% of the afferent neuronal population at their disposal, would appear to be at a mechanical disadvantage by not having their cilia in contact with the tectorial membrane above them. The work of histologists like Flock *et al.* (1982) has, however, clearly indicated the presence of contractile proteins in the hairs and cuticular plates of the hair cells. Both Wilson (1980) and Kemp (1981) have shown the presence of spontaneous acoustic activity within the cochlea. The original concept of the cochlea acting as a passive receptor of acoustic signals is changing to one of a theory of active resonance in which the outer hair cells, being in continuous vibration, mechanically tune the basilar membrane to respond to different frequencies along its length. Certainly the fine tuning of the cochlea is lost if the outer hair cells are damaged.

A common clinical situation is where a high-frequency sensorineural hearing loss (the result of degenerative hair cell disease associated with age or excessive noise exposure) is associated with a tonal or narrow band tinnitus of a frequency just below that of a maximum area of hair cell loss. If healthy outer hair cells adjacent to an area of inactivity were being encouraged to contribute more mechanical activity to the basilar membrane, this acoustical energy might be heard as tinnitus. The control of outer hair cell activity is partly achieved by neuronal connections between the hair cells, and partly by the intervention of the efferent nerve supply in the olivocochlear bundle. It is not difficult to imagine that automatic gain control mechanisms in the central auditory pathways would tend to reduce spontaneous mechanical activity in the cochlea in the presence of environmental noise. This may explain the apparent increase of tinnitus in a noise-free environment, and also on waking from sleep. There may also be a direct effect on efferent tonal activity as a result of levels of circulating adrenalin, for example, and this may explain the relationship of some types of tinnitus with stress and anxiety states (Hazell 1981*a*).

In the management of sensorineural tinnitus it will be seen that, as with sensorineural deafness, there is a symptomatic solution which can be applied successfully without an intimate knowledge of the exact pathophysiology.

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Methods of treatment

All possible avenues of tinnitus therapy are being explored, including the use of drugs, surgery, electrical stimulation of the ear, psychiatric and psychological techniques, and the use of tinnitus masking instruments.

Drug treatment

The initial experience described by Lewy (1937) that an intravenous injection of lignocaine can reduce or even abolish tinnitus for a short period in some 60% of cases gives rise to false hopes about the use of oral analogues. Tocainide hydrochloride, procainamide and carbamazepine will often produce some effect on tinnitus in high enough doses; unfortunately at these doses the incidence of side effects is unacceptably high. There is a need to study those patients who do respond and see in what ways they can be identified as a sub-group. At present it is best to reserve the use of these drugs for those patients who do not respond to tinnitus masking.

Surgery

Many patients driven near to suicide by their tinnitus come begging for ablative surgery of the ear or section of the auditory nerve. Although some patients can be helped by this technique, there is a growing number who have been made considerably worse. Such surgery renders an ear which may have a trace of residual hearing unmanageable either by tinnitus masking or electrical stimulation.

In passing it is worth mentioning the patulous eustachian tube syndrome. Patients with autophony frequently appear in the tinnitus clinic, and this condition can in our experience be well managed either by the techniques described by O'Connor & Shea (1981) or by the injection of polytef paste to the eustachian cushion (Pulec 1974). Some patients with pulsatile tinnitus have arteriovenous fistulae, the tinnitus being abolished by gentle venous pressure or rotation of the neck. These patients may be managed by jugular venous ties (Arenberg 1977) and occasionally embolic surgery.

Electrical stimulation

Despite the depressing report from Cazals *et al.* (1978) in Bordeaux, it does seem possible that electrical suppression of tinnitus will eventually become the answer for those who do not respond to masking or drug therapy (Hazell *et al.* 1984). An estimated 30% of those in the Los Angeles Cochlear Implant Study (Brackmann 1981) have received some degree of relief from their tinnitus by the introduction of electrodes for the purpose of restoring an element of hearing to an otherwise totally deaf person. Of 4 patients who have recently received cochlear implants for total deafness at University College Hospital, London, 2 are experiencing useful tinnitus suppression.

Psychological techniques

Biofeedback techniques have been used by House (1981) and others, but these need to be applied by suitably trained personnel. A small portable instrument is useful in reducing anxiety and panic states in patients with severe tinnitus, but it does not appear to reduce the tinnitus itself.

Over half the patients seen in the tinnitus clinic suffer from varying degrees of depressive illness, often unrelated to the tinnitus itself, though in the patient's mind the symptoms are inextricably woven together. It is extremely valuable to have the services of a sympathetic colleague in psychiatry who understands both the limitations of our current treatment methods and the reality for the patient of the tinnitus itself. In this connection, self-help groups are enormously beneficial, and over 70 exist around the United Kingdom. They are coordinated by the British Tinnitus Association under the auspices of the Royal National Institute for the Deaf, and the Association now has over 6000 members. They help to disseminate information about tinnitus to other sufferers, as well as to raise funds and kindly interest in tinnitus research.

Tinnitus masking

The effect of environmental noise on tinnitus has been known for a long time (Aristotle 384 BC, Problemata Book 32, para 9). In 1928 Jones & Knudsen published a circuit diagram for a tinnitus masking device but it does not appear to have been used therapeutically. Saltzmann & Ersner (1947) described the use of hearing aids for tinnitus masking. The most important advance occurred in the early 1970s when Vernon in Portland, Oregon, USA, persuaded the American hearing aid industry to produce a wearable ear-level device which would produce a controllable masking sound (Vernon 1977).

The development of the techniques for using these devices has gone hand in hand with the development of the devices themselves, although clearly we still have a long way to go. It is not always easy to persuade a patient who has a noise in his ear that you are going to fit him with an instrument which makes more noise in the ear and that this is going to help him. Each patient has a very individual solution to his or her problem and it may take some time arriving at the solution (Hazell & Wood 1981). A proper assessment is essential and a simplified protocol for tinnitus testing has been published as an appendix to the Ciba Foundation Symposium No. 85.

Detailed frequency analysis of tinnitus can be quite interesting, and several thousand simulations have been performed in our study using an electronic music synthesizer (Hazell 1981*b*). About 10% of patients have really very bizarre sounds in their ears or head; one of our patients has forty different sounds. However, from the point of view of fitting tinnitus maskers, the information that is needed is how the tinnitus responds to different sorts of masking noise. In 1971 Feldmann in Heidelberg published his classic paper which is the starting point for all programmes of tinnitus research and treatment. He identified six audiometric types, each of which has a characteristic masking pattern which is associated with a 'typical' audiogram. One important observation, borne out in practice when fitting tinnitus masking instruments, is that in about 60% of patients wide-band noise is much more effective at masking tinnitus than narrow-band noise or pure tones (Feldmann 1971). Surprisingly, however, narrow bands of noise and pure tones may often be equally good at masking tinnitus.

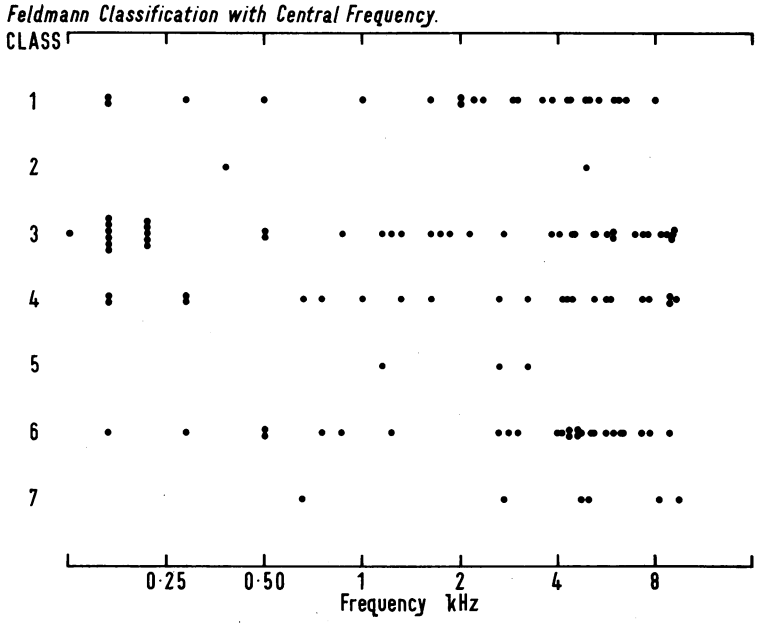

Figure 1. Lack of relationship between masking characteristics of tinnitus and its central frequency. (Data from Hazell 1981*b*)

Our study of 200 tinnitus patients (Hazell 1981*b*) showed that there is no strict correlation between the masking characteristics of the tinnitus (that is the way in which it is masked and by what) and the frequency spectrum of tinnitus (Figure 1). The message from this study and from practical experience in fitting instruments is that the frequency of the tinnitus gives no indication, from a therapeutic point of view, of the most appropriate masking spectrum.

Tinnitus masking instruments and their fitting: The way in which the masker is fitted is of paramount importance (Hazell & Wood 1981). It is generally important to avoid blocking the ear canal in any way, and we usually use an open mould technique. The routine use of a standard occluding ear mould is perhaps the commonest cause of failure.

A great many decisions must often be made over a period of about six months. Binaural tinnitus nearly always needs a binaural fitting, but monaural tinnitus may also require a binaural fitting. Often hearing aids and separate maskers are provided for those with a hearing loss, the masker being needed in place of the hearing aid in the evening and at night when there is an absence of environmental noise. The combinations and permutations of which ear, which instrument, and which type of mould, are many and the best results are often arrived at only after lengthy trial and error.

The most important feature of a tinnitus masking programme is the therapist – either an audiology technician, hearing therapist or audiological scientist – who must take a special interest in the tinnitus patients and give them the confidence to persevere with the treatment that many of them initially regard as bizarre and unlikely to succeed. Informal studies in the USA and the UK reveal that success rates in fitting maskers vary from 10% to 85%, and reflect the differences in experience and techniques of masker fitting and patient counselling.

Patterns of masker use: Many patients wear maskers for only three to four hours in the evening when all is quiet, but a proportion of patients wear their maskers twenty-four hours a day. There is extreme inter- and intra-subject variability. We have patients who have worn maskers continuously over a 7-year period. There is no evidence that these levels of sound are in any way harmful to the ear (unpublished observation).

Residual inhibition occurs in just under half our patients (Hazell & Wood 1981). The tinnitus disappears or is greatly reduced for a period of time after the masker is removed. Even those who do not experience residual inhibition still benefit from the substitution of their internal and relentless tinnitus by an external noise which is often considered to be quite soothing. A small proportion of patients (about 4%) experience very marked residual inhibition after wearing their maskers for only ten to fifteen minutes a day and many have complete relief for the rest of the day. Many patients wear their maskers at night, particularly those who have residual inhibition, and it is often possible to get patients off their hypnotics and back into a pattern of normal restful sleep. In the long term some patients use their maskers rather less, but only a few in this group are prepared to be parted from the instruments. In these patients, as in other milder cases who require only reassurance, a process of adaptation occurs to the tinnitus but this seems to be facilitated by the correct fitting of a masker. Adaptation is often induced after many years of intolerable tinnitus.

Conclusion

The experience of 7 years of running a clinic for tinnitus sufferers suggests that by far the most effective way of controlling idiopathic or sensorineural tinnitus is by the correct fitting of a tinnitus masking instrument or instruments. There are, however, other conditions causing noise in and around the ears which should be identified and treated appropriately. For the majority of those people suffering from tinnitus it would seem that masking techniques are likely to be the best available method of management for some years to come.

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