

Key points

- Tinnitus can be classified as subjective, involving sounds that only the patient can hear, or objective, involving sounds that the patient and others can hear.
- Subjective tinnitus is the most common type, and often an underlying cause cannot be found.
- Objective tinnitus is less common; affected patients need a full otological assessment as a serious underlying cause can often be found requiring specialist referral and treatment.
- Causes of objective tinnitus include an audible arterial bruit originating from a vascular skull base or temporal bone tumour, dural arteriovenous malformation, carotid artery stenosis, and a hyperdynamic circulation experienced in pregnancy, anaemia and thyrotoxicosis and in patients with acute or chronic anxiety.
- In many cases of tinnitus, the natural history is habituation, and repeated sound stimulation of the auditory pathways (either from the tinnitus itself or a masking sound) leads to a decreased sense of perception of the stimulus.

Alleviating the distress of tinnitus

A phantom sound

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Tinnitus is a common otological symptom that is best viewed as a phantom sound. In general, the underlying cause of tinnitus is unknown and there is no known cure for the symptom; however, much can be done to alleviate the distress that it can cause.

WHAT IS TINNITUS?

The history of attempts to define and treat tinnitus dates back to ancient times. The *Ebers Papyrus* included great detail on the treatment for a 'bewitched ear'. Descriptions of tinnitus continued throughout the ages, with examples found in Roman, medieval and renaissance literature. Beethoven, although known for going deaf, was afflicted by tinnitus, and the composer Smetana incorporated the tinnitus he heard into one of his string quartets.

The prevalence of tinnitus in the general community has been estimated in several population studies. In the UK a large study estimated that 20% of the population over the age of 17 years had experienced spontaneous tinnitus lasting more than five minutes, with 8% experiencing a moderate to severe annoyance causing interference with sleep. About 0.5% reported that the tinnitus had severely hampered their quality of life.¹ The findings

were similar in studies in the USA, Sweden, Italy and Australia. The Blue Mountains hearing study, conducted in New South Wales, found that 17% of the population over the age of 25 years had some noticeable tinnitus and that 1.6% of the population over the age of 55 years had distressing tinnitus.² Tinnitus occurs at all ages, including childhood, but it is more prevalent with increasing age.

CLASSIFICATION OF TINNITUS

Tinnitus can be simply classified as:

- subjective – sounds that only the patient can hear, or
- objective – sounds that the patient and others can hear (see the box on page 18).

Subjective tinnitus

Subjective tinnitus (a true phantom sound) is the most common type and often an underlying cause cannot be found. Patients variously

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describe it as a buzzing, crackling, humming, static or cicada type sound. The character of the sound has little significance, but the distress it causes is important to define and manage. Is it just noticeable? Does it disturb the sleep pattern? Does it constantly intrude into thought? These are questions that should be asked in the history.

Objective tinnitus

Objective tinnitus is less common, but affected patients need a full otological assessment as a serious underlying cause can often be found, requiring specialist referral and treatment. The character of objective tinnitus is often described as pulsatile in nature.

If the pulsations are unilateral and timed to the heart beat, it is very likely that the tinnitus is an audible arterial bruit originating from a vascular skull base or temporal bone tumour, dural arteriovenous malformation, carotid artery stenosis or aortic valve lesion.

Venous flow murmurs also have a pulsatile component but are often described as a more continuous 'machinery hum' sound and originate from venous malformation involving the temporal bone.

Bilateral pulsatile tinnitus may be due to a hyperdynamic circulation. This can be experienced in pregnancy, in patients with anaemia or thyrotoxicosis, with exercise or, most commonly, in those with acute or chronic anxiety. Very rarely, benign intracranial hypertension is associated with bilateral pulsatile tinnitus.

More rare forms of objective tinnitus originate from spasm of the middle ear muscles (tensor tympani and stapedius muscles) and are described as bursts of regular clicking noises. Even more rarely, otoacoustic emissions can be heard outside the ear. These are audible sounds produced by the outer hair cells of the cochlear.

HOW IS SUBJECTIVE TINNITUS GENERATED AND PERCEIVED?

There are two popular theories as to how tinnitus is generated and perceived. Both incorporate knowledge of how the ear hears and how the brain perceives (listens) and modifies sound to give the various observed manifestations of tinnitus and its associated



distress. An understanding of these potential mechanisms provides clues on how to explain its existence to patients and how to sensibly manage it.

The first theory is simplistic. It postulates that a small lesion in the cochlear produces a hearing loss (which may not be measurable on an audiogram) that the brain compensates by trying to fill in the gaps. This 'straining to listen' is perceived as tinnitus.

The second theory (Figure 1), which is more useful practically, suggests that a cochlear hair cell lesion initially generates a hearing loss that is registered by the brain as distorted hearing or tinnitus. However, the distress that the patient perceives with the tinnitus is due to the connections of the central auditory pathways with the associated areas in the limbic system. The coupled limbic system response is then responsible for the unpleasant distress symptoms seen in tinnitus sufferers. The initial generator or generators of tinnitus in the cochlear eventually resolve or become insignificant, but the unpleasant central (limbic) components dominate the clinical presentation and drive the experiences of severe tinnitus. These symptoms are similar to those of acute and chronic anxiety and can lead to a vicious cycle perpetuating the perceptions of tinnitus and its unpleasant associations.

A CLASSIFICATION OF PERSISTENT TINNITUS

Subjective (inaudible to an outside observer)

- Generator–perceptor theories
- Distress symptoms important in assessment
- Otological pathology
 - Sensory neural hearing loss (noise exposure, ageing)
 - Chronic otitis media
 - Acoustic neuroma

Objective (audible to an outside observer)

- Pulsatile
 - Unilateral
 - Normal otoscopy:* dural arteriovenous malformation, vascular skull base tumour, carotid and aortic valve lesions
 - Abnormal otoscopy:* middle ear vascular tumours
 - Bilateral
 - Hyperdynamic circulation
 - Anxiety, pregnancy, fever, exercise, thyrotoxicosis, anaemia
 - Benign intracranial hypertension
- Click
 - Middle ear muscle spasm
- Audible otoacoustic emissions

In part, these theories explain why historical treatments, focusing solely on the ear and cochlear (the generators), such as cochlear nerve section, are generally unsuccessful in modifying tinnitus, whereas treatments aimed at the limbic system function (perceptor) are more successful in alleviating distress.

Fortunately, the natural history of tinnitus, once it is perceived, is habituation. This is a neural process by which repeated sound stimulation of the auditory pathways leads to a decreased sense of perception of the stimulus. The repeated stimulation can be either the internally generated signal (tinnitus) or

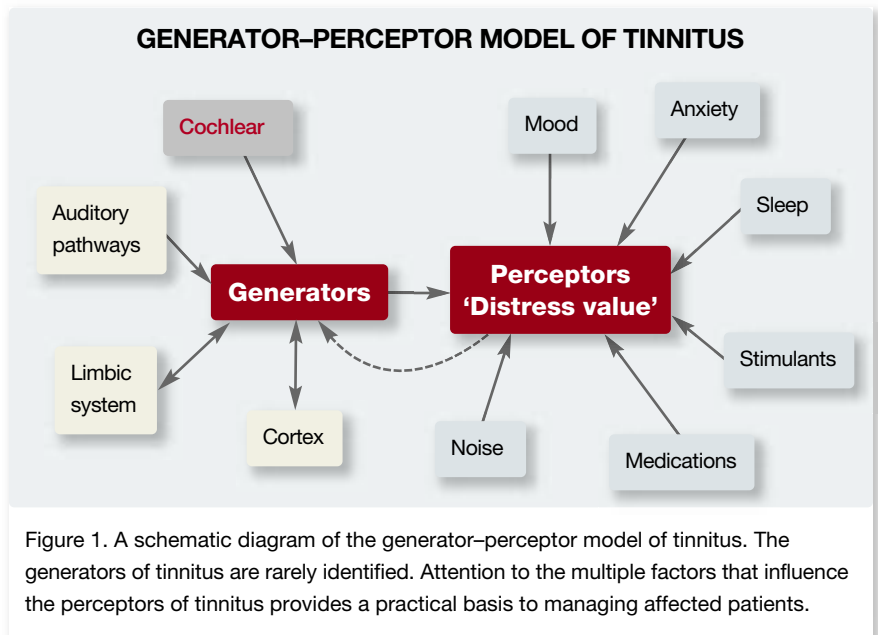


Figure 1. A schematic diagram of the generator–perceptor model of tinnitus. The generators of tinnitus are rarely identified. Attention to the multiple factors that influence the perceptrors of tinnitus provides a practical basis to managing affected patients.

an external sound (masking sound). In simple terms, the listening brain, in time, gets ‘used to the sound’. It usually takes months of exposure to a sensory (auditory) stimulus for this to occur. We have all experienced the process of habituation in our day to day lives – for example, getting used to living next to a noisy road or neighbours.

The generator–perceptor model of tinnitus and its natural history of habituation is a practical way of looking at a complex and poorly understood symptom. Similar models can be applied to other sensory symptoms where their response to medical and surgical treatments is poor. Extreme examples of these perceptive sensory anomalies are phantom limb pain following amputation and phantosmia (unpleasant smell perception without an odour being present).

Low-level tinnitus may well be a normal part of life. An interesting experiment performed in the 1950s and again in 2005 took several hundred subjects without tinnitus and placed them in an anechoic chamber. In the chamber the vast majority of subjects could perceive tinnitus and in some it persisted outside the chamber.³

EXAMINATION

The physical examination of patients with subjective tinnitus is generally normal. Examination usually shows a normal ear canal and drum associated with normal hearing. Signs of psychological distress are often present and related to the associated anxiety and insomnia.

Patients with objective tinnitus require a more probing and thorough examination, as signs of treatable causes of tinnitus may be revealed. Otoscopy may show signs of middle ear (Figure 2) or skull base pathology associated with a hearing loss on tuning fork testing. Skull base tumours such as paragangliomas are often associated with a visible middle ear mass, conductive type hearing loss and, sometimes, lower cranial nerve palsies. Vascular lesions of the skull base and head and neck region causing pulsatile tinnitus may be audible during auscultation of the ear and surrounding anatomy, including the heart (aortic valve lesions) and neck (carotid stenosis).

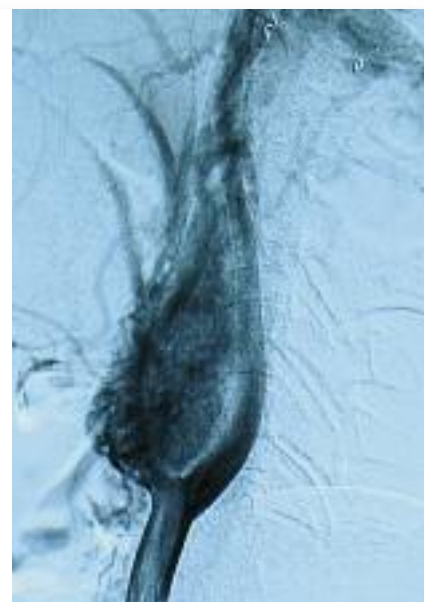
In patients with bilateral pulsatile tinnitus, a general physical examination may reveal a hyperdynamic circulation associated with anaemia, thyrotoxicosis, anxiety or pregnancy.



Figure 2. A vascular middle ear tumour (arrow) in a patient presenting with pulsatile tinnitus. The pulsating tumour can be seen on otoscopy, and the objective tinnitus heard on auscultation through the ear canal with stethoscope tubing.



Figures 3a and b. A carotid body tumour in a patient presenting with unilateral pulsatile tinnitus. Neck lump (a, above) with a palpable trill and audible bruit. The angiogram (b, right) shows the vascular tumour arising from the bifurcation of the carotid artery.



INVESTIGATIONS FOR TINNITUS

There is a wide range of causes underlying tinnitus. Consequently, a common problem for the GP and specialist is how many investigations to order. A simple series of baseline investigations for all sufferers of moderate to severe tinnitus aims to exclude a range of common disorders that



Figure 4. A subcutaneous skull base arteriovenous malformation (arrow) in a patient presenting with unilateral venous hum pulsations heard in the left ear (CT scan). The objective tinnitus could be abolished by digital pressure over the most prominent part of the pulsations.

may underlie the tinnitus and require treatment. An audiogram to document hearing status, and a full blood picture, erythrocyte sedimentation rate and thyroid function tests are reasonable baseline investigations.

If the tinnitus is objective, unilateral (objective or subjective) or associated with a middle ear mass, then imaging investigations are indicated. A CT scan or sometimes an angiogram of the temporal bone, skull base and brain would be useful in defining tumours and vascular malformations in this region (Figures 3 and 4). With unilateral pulsatile tinnitus, carotid artery doppler studies and an echocardiogram will help evaluate the possibility of carotid stenosis and aortic valve lesions. If the hearing thresholds are asymmetrical by more than 10 dB at two adjacent frequencies, an MRI scan looking for an acoustic neuroma (Figure 5) is mandatory.

The yield in discovering pathology, however, is not high. In a recent report, 1070 consecutive MRIs for asymmetrical hearing loss revealed 944 normal results, 56 cases of acoustic neuromas, 27 other cerebellopontine angle tumours, 29 inner ear anomalies, nine brainstem infarcts and one case of multiple sclerosis.⁴

MANAGING TINNITUS

Tinnitus management is generally based on an understanding of the generator-perceptor model described above. A sympathetic description of the nature of tinnitus and how commonly it occurs in the community is a good starting point. Exclusion of sinister underlying causes by examination and simple investigation may be all that is required.

Lowering a patient's anxiety about the tinnitus and possibility of a sinister cause, such as a tumour, generally allows the process of habituation to occur smoothly and the distress value of the tinnitus to be lowered. Advice on adopting a healthier lifestyle, normalising sleep habits, lowering stress and decreasing the intake of caffeine and stimulants in the diet is also very helpful in decreasing the patient's level of arousal and limbic system activity. Avoiding exposure to loud sounds and noise is mandatory.

If the tinnitus is more intrusive it generally disturbs patients' quality of sleep, as tinnitus is perceived more loudly in quiet environments. In such cases some form of sound therapy or masking is required to assist the process of habituation. In its simplest form, this can be delivered by the

ongoing static sound of an untuned radio, pillow speaker or, in summer, a fan placed near the bedside and left on all night. Pleasurable, relaxing 'masking sounds' such as whale song, ocean waves, forest breezes and waterfall sounds can be downloaded as MP3 files and played continuously on a player placed inside the pillow. More sophisticated tinnitus maskers can be custom built and adjusted to mask the specific frequencies affected in individual tinnitus sufferers. However, these devices are often expensive and their benefit is probably no greater than simple cheaper masking devices.

Whatever form of masking is used, it must conform to a few simple guidelines to be effective in aiding the process of habituation. It must be a continuous, low-level sound with minimal fluctuations in its intensity or character, and, importantly, the volume of the masking sound must be at a level where both the masker and tinnitus can be heard simultaneously.

The sound therapy must be applied each night for months, as it may take up to two years for habituation to occur.

Patients with more distressing degrees of tinnitus that are associated with severe sleep disturbance and constant intrusion into day to day thoughts need more intensive management. This may require several sessions for patients to gain relief. Sedatives such as benzodiazepines are often helpful in gaining one or two nights of sleep; however, they should be used with great care and for limited duration (a few nights at most) to prevent dependence from developing. Assessment for signs of depression is important as tinnitus and depression can feed off each other. A low dose of a sedating antidepressant, such as amitriptyline, at night might be helpful and safer than benzodiazepines.

For the most distressed patients, further behavioural treatments are available in the form of tinnitus retraining therapy or cognitive behavioural therapy. These

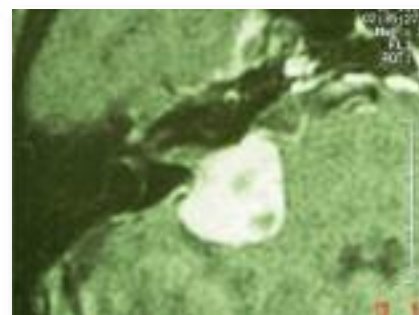


Figure 5. An acoustic neuroma in a patient presenting with unilateral tinnitus (MRI scan). The character of the tinnitus was described as a 'broken speaker distortion of hearing'.

are structured, long-term approaches usually supervised by a team of therapists aimed at reforming the way patients understand and think of their tinnitus. They involve identifying the effect of tinnitus and demystifying its nature. The use of sound therapy to assist habituation and treatment of emotional distress

SUPPORT GROUPS AND USEFUL WEBSITES

Australian Tinnitus association (NSW)

<http://www.tinnitus.asn.au>

Tinnitus Association of Victoria

<http://www.tinnitus.org.au>

Australian Tinnitus Association, WA

29 West Parade, Perth, WA 6000

Phone: (08) 9349 3436 Fax: (08) 9349 3436

Tinnitus Advisory Group Inc. SA

PO Box 683, St Agnes, SA 5079

Phone: (08) 8263 5116

Tasmania Tinnitus Support Group

28 Gormanston Road, Moonah, Tas 7009

Phone: (03) 6228 001

American Tinnitus Association

<http://www.ata.org>

Tinnitus & Hyperacusis Center

Dr Pawal Jastreboff, Emory University,
Atlanta, USA

<http://www.tinnitus-pji.com>

British Tinnitus Association

Sheffield, England

<http://www.tinnitus.org.uk>

is a main aim of the treatment plan. In specialised tinnitus clinics, therapy may continue for up to two years, with success rates of 80% being achieved.

Referral of patients to a local tinnitus support group should be considered as the reassurance that others are experiencing similar symptoms and difficulties is often useful. Information is provided about the nature of tinnitus, association with commonly prescribed medications, simple lifestyle changes and the range of interventions that might help patients. Reputable websites are listed in the box above.

Hearing aids

As many tinnitus sufferers also have a hearing loss, it is reasonable to undergo a trial of a hearing aid to improve their hearing thresholds. This may benefit both the

tinnitus as well as the hearing loss, as the effect of environmental masking sounds with improved hearing may be significant. As tinnitus perception has a strong central component and the higher auditory pathways are bilaterally represented at a cortical level, applying a hearing aid for unilateral hearing loss, or even a hearing loss in an only hearing ear, may have benefits to tinnitus perception on both sides.

Surgery

Rarely, surgery can be considered to improve the perception of tinnitus in cases of middle ear hearing losses such as otosclerosis and chronic suppurative ear disease.

Complementary therapies

Many nonprescription and over-the-counter remedies have been used for years for treating tinnitus. These include *Ginkgo biloba*, zinc supplements, ginseng, valerian, melatonin, St John's wort and *Echinacea*. These preparations, in addition to physical treatments such as acupuncture, massage and chiropractic, have been evaluated with none giving better tinnitus control than placebo treatments.

Fringe therapies

As tinnitus for a small number of patients can be debilitating and resistant to reasonable therapies, a large number of 'miracle cures' have become available. These are often heavily advertised through the internet and are supported by testimonials from satisfied tinnitus sufferers. In fact these treatments rarely live up to their claims of 'curing tinnitus' and are often expensive with a nonreturn policy attached. There is little evidence to recommend their use.

WHEN TO REFER

Referral to an ENT surgeon should be considered for patients with objective tinnitus or tinnitus that has not habituated in response to the simple management interventions mentioned above. If the tinnitus is unilateral, associated with

an asymmetrical hearing loss or objective in nature, further investigation, such as an MRI scan requiring specialist referral, may be needed. Severe tinnitus associated with depression may prompt joint management with a specialist tinnitus clinic offering structured behavioural programs or formal psychiatric assessment.

CONCLUSION

In most cases tinnitus should be viewed as being a symptom that is a temporary hurdle for patients and can be managed satisfactorily. Negative throwaway lines such as 'well you'll just have to live with it' are the cause of much of our patients' anguish and must be discarded. **MT**

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COMPETING INTERESTS. None.

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