Tinnitus, Use and Evaluation of Sound Therapy, Current Evidence and Area of Future Tinnitus Research

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ABSTRACT

Tinnitus is one of the otologic symptoms seen in persons with ear pathologies. It is defined as an acoustic sensation in the ear without a corresponding external acoustic stimulus. Tinnitus is said to be generated from the higher auditory centres because of reduced feedback from the peripheral or neural component but can be an outcome of irritation at different levels of the auditory system. Several treatment modalities have been tried in the management of tinnitus, either as a single treatment or as part of combination therapy. They range from lifestyle or dietary modification, medications, surgery, to Tinnitus Retraining Therapy (TRT), use of sound generating devices, hearing aids and cochlear implants. Current literature has shown that the prevalence of tinnitus is highly variable and reflects the difference in symptom criteria and patient selection for the various treatment modalities. This variability is also visible in the outcomes of cases where the various treatment modalities have been used. In the presence of an augmented hearing, the brain can focus on the meaningful sound generated externally while suppressing or even aborting the tinnitus. Future tinnitus research needs to apply the highest level of randomization and blinding, in line with the high subjectivity of tinnitus and the possibility of a response with control. The natural sequence of tinnitus is characterized by the conditioning or habituation and possible gradual attenuation of symptom, this implies that there is a limit to which the benefits observed was due to our intervention rather than a natural process of this symptom.

Keywords: Tinnitus; Symptom, Hearing loss.

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INTRODUCTION

Ludwig van Beethoven, the renowned music composer of all times often complained “My ears Whistle and buzz all day and night. I can say I am leading a wretched life.” He suffered from tinnitus as a result of sensorineural hearing loss, which he described as a harsh roaring in his ears. Beethoven died in 1827 but unfortunately, even after several decades of knowledge of tinnitus, there has been minimal advancement in its treatment. Tinnitus is one of the otologic symptoms seen in persons with ear pathologies. “noise in the ear” as it is called in common parlance, can be generated by pathology present at any point along the auditory pathway from the external ear to the brain. Tinnitus is defined as an acoustic sensation in the ear without a corresponding external acoustic stimulus, it is often referred to as ‘phantom noise’. It can be described as buzzing, ringing, whistling, roaring, pulsatile, etc. It is associated with hearing loss in the sense that it usually precedes hearing loss and persists in the presence of an existing hearing loss. It can be subjective or objective. The objective tinnitus also called somato-sounds, is heard by the patient and often by the examiner. It is usually caused by physical causes, like pathologies involving blood vessels or structures near the inner ear. Tinnitus can often be picked up as spontaneous otoacoustic emissions. This objective type makes up about 5% of tinnitus cases. Diverse conditions can cause objective tinnitus, and these include pathologies that can cause pulsatile tinnitus like arteriovascular malformations, vascular tumours, atherosclerosis, ectopic carotid artery, persistent stapedial artery, dehiscient jugular bulb, cardiac murmurs, pregnancy, thyrotoxicosis, Paget’s disease, hypertension, to mention but a few. Muscular causes of objective tinnitus include palatal myoclonus, stapedial muscle spasm, and patulous eustachian tube on the other hand, subjective tinnitus is only heard by the person with tinnitus, and not necessarily generated by physical causes. This makes up 95% of tinnitus cases. Pathologies in which subjective tinnitus can be present include presbyscusis, otosclerosis, noise trauma, Meniere’s disease, acoustic neuroma, middle ear diseases, wax impaction, otitis externa, temporomastoid joint disorders, depression, etc. Subjective tinnitus can also be drug-induced and has been associated with the use of anticancer drugs like cisplatin, antimalarials like quinine, antibiotics like aminoglycosides, anti hypertensives like diuretics, and non-steroidal anti-inflammatory agents like aspirin, diclofenac, and ibuprofen. In most objective tinnitus with underlying pathology, treatment of the primary cause may put an end to the tinnitus, but in cases with subjective tinnitus, the treatment of a suspected underlying pathology may not abort the tinnitus. Tinnitus can be transient and abort spontaneously, however, it is chronic and unlikely to be aborted spontaneously when it has remained for more than three months.

POSSIBLE PATHOPHYSIOLOGY OF TINNITUS

Johannes Muller a prominent psychologist in the 19th century said tinnitus was a result of overstimulation of the auditory nerve associated with brain pathology, weakness or disease of the auditory nerve, while MacNaughton Jones in 1891 reported that tinnitus was an outcome of irritation at different levels of the auditory system. In the same light, tinnitus is said to be generated from the higher auditory centres as a result of reduced feedback from the peripheral or neural component. Thus, reduced firing in the auditory nerve fibres, leads to a feedback mechanism to the brain, which results in an increased spontaneous neuronal activity in higher auditory centres and consequently generating ‘phantom noise’. According to House and Brackman in 1981, tinnitus is generated in the brain, thus cutting the auditory nerve does not eradicate tinnitus This was buttressed by Cope et al in 2011 when they noted that after removal of acoustic schwannoma, tinnitus was perceived in the dead ear in the presence of complete hearing loss. Some authors have reported increased spontaneous activity in the auditory cortex, inferior colliculus, and dorsal and ventral cochlear nucleus in the presence of tinnitus. On the other hand, Liebermann et al, 1984 confirmed a decreased spontaneous firing in the auditory nerve fibres. It has also been reported that the temporal aspect of neural activity which includes the altered rate, temporal discharge pattern, and/or temporal correlation between discharge patterns of different nerve fibres, may also be of importance in the generation of tinnitus.
EVIDENCE ON COCHLEAR IMPLANTS, HEARING AIDS, COMBINATION DEVICES AND SOUND GENERATORS USE IN THE MANAGEMENT OF TINNITUS

The review of the current literature has shown that the prevalence of tinnitus is highly variable and reflects the variability of the various treatment modalities. About 15% of adults in the United Kingdom have protracted impulsive tinnitus without any apparent cause, and at least 8% of these patients have tinnitus affecting their sleep or causing them moderately to severe annoyance, and in 0.5%, their tinnitus severely disturbs their capacity to live a normal life. Therefore, this variability is also visible in the outcomes of cases where the various treatment modalities have been used. For instance, the use of a cochlear implant has appeared promising in the treatment of tinnitus. Ito (1997) reported relief in 77% of the 26 patients who had a cochlear implant for tinnitus and 8% noted worsening of their symptoms.[9] In contrast, Arts et al (2012) in their review work, stated that cochlear implantation suppressed tinnitus in most of the cases and no tinnitus worsening was reported[8] This review by Arts et al did not mention the number of articles reviewed or the number of patients in their review, which may water down the strength of their report. However, they concluded that appropriate patient selection is essential to the outcome of treatment with cochlear implants[8] They believe that positive results are seen in cases where the cochlear implant is done in patients with tinnitus and deafness due to cochlear deafferentation, in the absence of which the use of cochlear implant will have no impact or worsen tinnitus[8] These studies have disregarded the emotional aspect of the effect of tinnitus on these patients, concentrating only on the presence or absence of tinnitus. Also, some of the cases reported had worsening and persistence of tinnitus, which shows that cochlear implant may not be the ideal treatment for tinnitus, despite patient selection. As much as the report from Ito et al and Art et al are primary sources of information from professionals, which gives credence to their findings, it needs to be buttressed with stronger evidence from a systematic review, which will give a holistic assessment of the problem of tinnitus. Van Zon et al in 2015[8], carried out a systematic review of nine studies and looked at speech perception in noise, sound localization, quality of life and tinnitus[10] They concluded that there are no high-level-of-evidence concerning cochlear implantation and one-sided hearing loss. However, they stated that there may be an important benefit of cochlear implant regarding sound localization, and quality of life in patients with tinnitus[10] This study gives stronger evidence and a broader analysis of the role of cochlear implantation in tinnitus treatment.Several studies have looked at the benefit of hearing aid, sound generators, and a combination of both for tinnitus relief. A systematic review was done by Sereda et al (2018)[11] on Sound therapy, looking at the use of amplification devices against sound generators for tinnitus in adults. They looked at eight trials with 590 subjects, and three trials among those considered showed large benefit with hearing aids in terms of health-related quality of life and listening ability. Their review showed the efficacy of hearing aids in improving results in tinnitus patients when compared to placebo and waiting list[7] One of the studies in their review compared severity of tinnitus in...
patients using hearing aids as against those using sound generators and it showed no difference in the efficacy of both forms of treatment based on the severity of tinnitus. Furthermore, three of the trials looked at the severity of tinnitus in patients on hearing aid as compared to combination hearing aids. Combination hearing aids were found to be more effective in one study, whereas hearing aids were more effective in the other 2 studies. However, none of these three studies comparing hearing aids and combination hearing aids measured the outcome of depressive symptoms, anxiety, and health-related quality of life. This evidence is of high value, coming from a systematic review, and thus seem reliable, however, it seems insufficient. From their systematic review, Sereda et al, (2018) made it obvious that there is no evidence supporting the higher effectiveness of sound therapy over placebo or treatment without a sound device. Also, the evidence showing if one form of sound therapy is more effective than the other is insufficient. Therefore, using a combination device, hearing aids, or sound generators result in little or no difference in the severity of tinnitus.

FUTURE RESEARCH IN TINNITUS MANAGEMENT

There is a need for further research to evaluate the effectiveness of sound therapy and to find a more specific and efficient treatment for tinnitus. Such future research needs to apply the highest level of randomization and blinding, in consideration of the high subjectivity of tinnitus and the huge possibility of a response with control. Moreover, currently, no form of treatment for tinnitus is effective in all patients. Besides, cortical activities which give rise to tinnitus has been shown to involve a complex neuronal network. The advent of transcranial high-definition magnetic stimulation, and functional radiological techniques like the functional Magnetic Resonance Imaging (fMRI), and Positron Emission Tomography (PET), have improved the awareness of tinnitus. In line with this, changes in the neuronal activity in the brain may have gained a little more insight with new perception into three-dimensional processing of tinnitus associated activity. As much as this is now slowly being revealed, it is still far from being fully described or understood. Studies have shown that repetitive transcranial magnetic stimulation (rTMS) is non-invasive, and can induce electrical currents in the brain that can reduce the neuronal activity responsible for tinnitus, but there is paucity of data to verify its long-term safety in patients. However, there is a need for further research in this area, to improve on the understanding of tinnitus, because this will be the key to identifying more specific and targeted treatment approaches that will be effective in all patients.

CONCLUSION

There is still a lot to be understood about tinnitus and this affects the provision of treatment modality for it, but obviously, it is not a ‘one cap fits all’ scenario. As much as efficacy has been reported with the use of some of these treatment modalities mentioned above, there are findings where the efficacy was not better than placebo. Since the biological sequence of tinnitus is characterized by the conditioning or habituation and possible gradual attenuation of symptom, it may be that there is a limit to which the benefits seen was due to our intervention rather than a natural process of this symptom. However, we cannot yet proclaim “Eureka” like the famous inventor, as regards the treatment of tinnitus because more effort is needed to identify actual pathogenesis or pathophysiology of tinnitus and inform a more targeted approach to its treatment, with a precise and improved result.

REFERENCES

2. Schaette, R. Tinnitus in men, mice (as well as other rodents) and machines. Hear Res. 2009;311:63-71.