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Pathophysiology, Diagnosis and Treatment of Tinnitus - a literature review

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ABSTRACT

Introduction and purpose

Primary tinnitus involves the perception of various types of sounds, usually without the presence of an external or internal stimulus (we then speak of primary tinnitus). Secondary tinnitus is rare, but should be ruled out at the beginning of the diagnostic process, as it can result from a serious disease. The issue of ear noise is a widespread problem in primary care. The purpose of our article was to summarize information on tinnitus, its risk factors, pathophysiology, diagnosis and treatment.

Materials and methods

To write this article, databases such as PubMed and Google Scholar were searched using the following terms: tinnitus, tinnitus treatment, tinnitus cognitive behavioral therapy.

Description of the state of knowledge

There are many mechanisms that can lead to tinnitus. Since they often coexist with hearing loss, tinnitus is thought to be a response to sensory deprivation. In diagnosis, it is very important to take a thorough medical history to distinguish primary from secondary tinnitus, which determines further management of the patient. Due to the truncated knowledge of the pathophysiology of tinnitus, there are no clear guidelines for the treatment of tinnitus. There are various therapeutic options available, such as cognitive-behavioral therapy, sound therapy, somatosensory therapy, neuromodulation and hypnosis. They improve patients' quality of life, however, reliable data confirming reductions in tinnitus intensity is often lacking.

Conclusions

Tinnitus is a commonly encountered condition. Although significant research has been conducted, our understanding, particularly of its pathophysiology, remains incomplete. This makes it difficult to develop effective treatment.

Keywords

Tinnitus; Hearing Loss; Hearing Aids; Cognitive Behavioral Therapy

1. Introduction

Tinnitus can be categorized as either primary or secondary. Primary tinnitus involves the perception of various types of sounds (ringing, ticking, pulsing and others) without the presence of an external or internal stimulus. Their etiology has not been fully elucidated. In most cases, it is associated with sensorineural hearing loss, but also depression, stress and anxiety. Rare cases include situations in which tinnitus is the result of sound generated by a source near the ear, for example, due to a vascular or neuromuscular condition. We then speak of secondary tinnitus, occurring with a frequency of <1% of all cases. It should be noted that tinnitus is a symptom, not a disease. It is very important to rule out a secondary cause at the beginning of the diagnostic process. [1]

Tinnitus is a widespread issue in primary care. It is estimated that about 25% of European and American citizens have experienced at least one episode in their life, and 10-15% experience chronic tinnitus. [2]

2. Objective of the work

The aim of this study is to summarize information on tinnitus, its risk factors, pathophysiology, diagnosis and treatment.

3. Materials and methods

For this review article, databases such as PubMed and Google Scholar were searched. The following terms were used to search for relevant scientific articles: tinnitus, tinnitus treatment, tinnitus cognitive behavioral therapy. Ultimately, 32 research articles were cited.

4. Description of the state of knowledge

Risk factors

Risk factors for the development of primary tinnitus can be divided into those related to otolaryngology and those not related to otolaryngology. The first group includes, for example: hearing loss, occupational exposure to noise, otitis media, platinum therapy. Factors not related to otolaryngology are primarily older age, head and neck pain syndromes, sleep disorders, depression, and stress. [3,4]

Pathophysiology

The cause of primary tinnitus is not fully known. In fact, there are many different mechanisms that can lead to it. One of them is the mechanism related to hearing loss, especially high-frequency. It is assumed that auditory phantom sensations are a response to sensory deprivation. However, it has been proven that hearing loss resulting only from damage to the cochlea does not explain the essence of the problem. It is because, even after the cochlear nerves are severed, tinnitus persists. Damage to the cochlea may be only the beginning of a cascade leading to neuronal changes in the auditory pathway and abnormal nerve activity is perceived by the auditory cortex as non-existent sounds. Various brain structures are involved in the entire process, including: the primary and secondary auditory cortex, the prefrontal cortex, the limbic cortex as well as sensory fibers of the cranial nerves. This explains why tinnitus is often associated with temporomandibular dysfunction, neck pain, depression, anxiety or stress. [5,6,7]

Diagnostics

Both the diagnosis and treatment of tinnitus vary depending on the country and even the region. Tinnitus may have various causes, and knowledge of its pathophysiology is very limited. This results in a lack of specific diagnostic and treatment schemes. [8]

Medical history

During the medical interview, special attention should be paid to the circumstances surrounding the onset of tinnitus. If tinnitus is accompanied by hearing loss, a comprehensive audiological assessment should be performed and, if necessary, a hearing aid should be used. Dizziness, on the other hand, may indicate coexisting Ménière's disease or damage to the vestibular-cochlear system and require a thorough assessment of vestibular function.

If tinnitus is associated with neck pain or temporomandibular joint pain, a consultation with a physiotherapist or dentist should be ordered. [9]

The rate of progression of symptoms is also important. Sudden hearing loss with the appearance of tinnitus requires rapid diagnosis, because there is a high chance of detecting a reversible cause and achieving full recovery.

The nature of the sound (humming, ringing, pulsating) plays a vital role in diagnosis. Rhythmic pulsation reflects the work of the heart, so it may suggest vascular lesions. It is an indication for cardiovascular examination and imaging studies for vascular tumors.

Furthermore, attention should be paid to whether the noise occurs unilaterally or bilaterally. Unilateral occurrence argues for a mechanical obstruction that can be treated causally, such as ear plugging by earwax. Unilateral tinnitus is also an indication for imaging studies due to the possibility of a concurrent neoplasm, such as Schwanoma of the vestibular and cochlear nerve. For bilateral tinnitus, imaging studies are not routinely performed as long as there are no other alarming symptoms.

Additionally, it is crucial to assess whether the patient has recently taken ototoxic medications, like platinum derivatives or salicylates, as they may contribute to ear noise.[1,10]

In the case of comorbid depression or anxiety, the individual should be referred to a psychiatrist, as these complaints exacerbate tinnitus and significantly reduce the patient's quality of life. [11]

Physical examination

In the physical examination, doctors should focus on the head and neck. It is important to examine the function of the cranial nerves and carefully view the oral cavity. In an ophthalmoscopic examination, physicians are able to diagnose the presence of infection, excess earwax or even a tumor. It is also necessary to auscultate the carotid arteries and the

area around the ear, especially in people with pulsatile tinnitus. A Weber and Rinny's test will be helpful in knowing the type and degree of hearing loss. [12]

Audiological tests

Since tinnitus very often coexists with hearing loss, it is essential to carry out audiological tests. With the help of tonal audiometry, it is possible to check whether the hearing loss is conductive or sensorineural. If the hearing loss is conductive, the tinnitus is most likely secondary and the cause should be sought. However, if the hearing loss is sensorineural, it is difficult to determine whether the tinnitus is secondary or primary. The tympanogram, on the other hand, is used to identify the condition of the middle ear and the auditory trumpet. [13]

Imaging studies

Imaging studies are not routinely performed in all patients with tinnitus.
They are applicable in the diagnostic process when tinnitus raises suspicion of its secondary nature. Symptoms that should be verified by imaging studies are:

- pulsatile tinnitus
- unilateral tinnitus
- asymmetrical hearing loss
- focal neurological symptoms
- accompanying headache or dizziness [14, 15]

Treatment

In the case of secondary tinnitus resulting, for example, from an infection, complete recovery is possible. Most often, however, patients are dealing with primary tinnitus, which is chronic in nature and there are few methods that would allow for their complete cure. This makes counseling and educating patients all the more important. It is vital to reassure them that tinnitus is usually not associated with serious pathology and does not lead to hearing loss. This helps in the fight against stress, which only contributes to worsening the problem.
[16, 5]

Pharmacological treatment

Pharmacological treatment of tinnitus has not been successful so far.
Antiarrhythmic drugs (lidocaine, flecainide, tocainide) have been studied, but at their low doses the effect was unnoticeable, and at high doses there were too many side effects.
Studies on benzodiazepines indicate that they only have an effect while the drugs are taken. After they are discontinued, tinnitus returns and can cause even more suffering. [17, 18]
Antidepressants are often prescribed by doctors because anxiety and depression are common among many individuals suffering from tinnitus. However, it has been found that improvement in these patients is more due to a reduction in psychiatric symptoms than a reduction in tinnitus severity. [19]

Cognitive-behavioral therapy

Cognitive-behavioral therapy is usually based on 6-10 weekly meetings individually or in a small group with a therapist. During the meetings, various topics are discussed including sleep hygiene, stress management, education about tinnitus itself as well as cognitive restructuring. This therapy aims to identify the patient's destructive thoughts and develop ways to deal with them in order to divert attention from the tinnitus. [20]
Studies on the effects of cognitive-behavioral therapy on tinnitus are not fully satisfactory. The improvement in patients is moderate and is mainly associated with improved quality of life. However, it does not significantly affect the reduction in tinnitus volume itself. It is also unknown whether this effect persists in the long term. [21,20]

Hearing aids

Hearing aids are especially recommended for patients who suffer from tinnitus accompanied by unilateral deafness, as this group of patients has seen the greatest improvement. Better hearing distracts from unwanted sounds, which contributes to the patient's comfort of life. It should be noted that the smaller the hearing loss, the less evidence there is that hearing aids bring real improvement. [22, 8]

Sound therapy

Sound therapy involves the generation of background sound (white noise, rain, waterfall) by a device similar to a hearing aid worn behind the ear or by an environmental sound generator. Generators integrated into hearing aids are also available. It is assumed that the sound emitted from the device is less unpleasant for the patient than the original tinnitus, thus masking it and improving the patient's comfort. This type of therapy is currently common, but there is no strong evidence of its effectiveness. [23, 24]

Somatosensory therapy

Somatosensory tinnitus is characterized by being triggered by a physical stimulus such as muscle contraction of the neck, head, limbs or temporomandibular joint. This, in turn, gives us the opportunity to influence the intensity of tinnitus through relaxation treatments. [25] The choice of the appropriate form of therapy must be selected individually according to the patient's needs. It is crucial here to take a thorough history, and to educate the individual on a proper lifestyle that improves the patient's condition and posture. Exercises to enhance muscle strength and stability are recommended. Acupuncture is also used as an adjunctive therapy. [26]

Hypnosis

Hypnosis is one of the alternative forms of treatment. Studies have shown that it is particularly beneficial for patients without accompanying hearing loss. While there is no hard evidence for the effectiveness of hypnosis in the treatment of tinnitus, it should be emphasized that it is a non-invasive form of treatment that often improves patients' well-being. [27, 28]

Neuromodulation

Neuromodulation is a technique that affects the excitability of the cerebral cortex, particularly the auditory cortex, through magnetic or electrical stimulation. Neuromodulation has not yet been applied to the treatment of tinnitus, but recent work on bimodal stimulation has provided promising results that could contribute to the development of a new treatment method. [29, 2]

In neuromodulation, as with other tinnitus treatments, it is important to better understand its pathophysiology. This would make it possible to more accurately link them to the relevant brain networks that would be subjected to modulation. [30]

Surgical methods

Surgical methods are used primarily in secondary tinnitus when the specific cause is known. These include, for example, vestibular neurofibromas or vestibulocochlear nerve conflicts at the level of the brainstem. Stereotactic radiosurgery and microvascular decompression are used for their treatment. Unfortunately, it should be noted that after surgery, hearing loss or even worsening of tinnitus may occur. [31] Surgical procedures that can help resolve tinnitus also include: reconstruction of the ossicular chain, cochlear implantation, injection of steroids into the eardrum (in the case of Meniere's disease or sudden sensorineural hearing loss). [32]

5. Conclusion

Tinnitus is a common problem in primary care. At the beginning of the diagnostic process, a thorough medical history plays a crucial role. Based on this, it is possible to determine whether the tinnitus is primary or secondary to another condition. This, in turn, helps in the selection of further tests. Although more and more is known about the pathophysiology of tinnitus, there is still a lack of reliable information on which to base effective treatment. At present, treatment is not well-organized, and there are no clear guidelines for physicians to follow. Even though there are many therapies used in daily medical practice, they are often not effective enough in eliminating tinnitus. Instead, they tend to focus on improving the patient's quality of life.

Disclosure:

Authors' contribution:

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