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Review Article

A Review Article on Tinnitus: Pathophysiology and Treatment Approaches

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ABSTRACT

Tinnitus is a perception of sound in proximity to the head with the absence of an external source. It is estimated to occur in 15–20% of the world's population, with 1–3% of cases severely affecting quality of life. Severe tinnitus is frequently associated with depression, anxiety and insomnia. Tinnitus has been associated with a variety of risk factors, including prolonged noise exposure, head and neck injury and infection. The most recent pathophysiologic theory of tinnitus suggests that the central nervous system is the source or "generator" of this condition. However, treatment modalities are still aimed at lessening the awareness of tinnitus and its impact on quality of life rather than attaining a definitive cure. Currently, no drug is available that has demonstrated replicable, long-term reduction of tinnitus impact in excess of placebo effects. This review assesses the current developments in the pathophysiology and treatment for tinnitus, which remains a chronic and debilitating condition.

INTRODUCTION

Tinnitus, originating from the Latin word *'tinnire'* ('to ring'), is a perception of sound in proximity to the head with the absence of an external source [1]. Tinnitus is when you experience ringing or other noises in one or both of your ears. The noise you hear when you have tinnitus isn't caused by an external sound, and other people usually can't hear it. Tinnitus is a common problem. It affects about 15% to 20% of people, and is especially common in older adults.

Tinnitus is usually caused by an underlying condition, such as age-related hearing loss, an ear injury or a problem with the circulatory system. For many people, tinnitus improves with treatment of the underlying cause or with other treatments that reduce or mask the noise, making tinnitus less noticeable. (2)

PATHOPHYSIOLOGY

Tinnitus has been associated with a variety of risk factors, including prolonged noise exposure (22%

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of cases), head/neck injury (17% of cases) and infections (10% of cases) [3]. The most recent pathophysiologic theory suggests that the central nervous system is the source or "generator" of tinnitus [4]. Positron emission tomography (PET) scanning and functional magnetic resonance imaging (FMRI) studies indicate that a loss of cochlear input to neurons in the central auditory system (such as occurs in cochlear hair cell damage or a lesion of the vestibulocochlear nerve) can result in abnormal neural activity in the auditory cortex [5]. This activity is linked to the perception of tinnitus. In addition, there is also a loss of suppression of the neural feedback loops which help tune and reinforce auditory memory in the central auditory cortex[5].Disruption of this feedback loop leads to the disinhibition of normal synapses and the creation of uncontrolled alternative neural synapses which lead to the abnormal auditory perception of tinnitus

SYMPTOMS

Tinnitus is most often described as a ringing in the ears, even though no external sound is present. However, tinnitus can also cause other types of phantom noises in your ears, including:

- Buzzing
- Roaring
- Clicking
- Hissing
- Humming

Most people who have tinnitus have subjective tinnitus, or tinnitus that only you can hear. The noises of tinnitus may vary in pitch from a low roar to a high squeal, and you may hear it in one or both ears. In some cases, the sound can be so loud it interferes with your ability to concentrate or hear external sound. Tinnitus may be present all the time, or it may come and go. [2]

CAUSES OF TINNITUS [2]

Tinnitus can be caused by a number of things, including broken or damaged hair cells in the part of the ear that receives sound (cochlea); changes in how blood moves through nearby blood vessels (carotid artery); problems with the joint of the jaw bone and problems with how the brain processes sound.

In many people, tinnitus is caused by one of the following:

- **Hearing loss:** There are tiny, delicate hair cells in your inner ear (cochlea) that move when your ear receives sound waves. This movement triggers electrical signals along the nerve from your ear to your brain (auditory nerve). Your brain interprets these signals as sound.

  If the hairs inside your inner ear are bent or broken — this happens as you age or when you are regularly exposed to loud sounds — they can "leak" random electrical impulses to your brain, causing tinnitus.

- **Ear infection or ear canal blockage:** Your ear canals can become blocked with a buildup of fluid (ear infection), earwax, dirt or other foreign materials. A blockage can change the pressure in your ear, causing tinnitus.

- **Head or neck injuries:** Head or neck trauma can affect the inner ear, hearing nerves or brain function linked to hearing. Such injuries usually cause tinnitus in only one ear.

- **Medications:** A number of medications may cause or worsen tinnitus. Generally, the higher the dose of these medications, the worse tinnitus becomes. Often the unwanted noise disappears when you stop using these drugs.

DIAGNOSIS [2]

Your doctor will typically diagnose you with tinnitus based on your symptoms alone. But in order to treat your symptoms, your doctor will also try to identify whether your tinnitus is caused by another, underlying condition. Sometimes a cause can't be found.

To help identify the cause of your tinnitus, your doctor will likely ask you about your medical history and examine your ears, head and neck.

Common tests include:

- **Hearing (audiological) exam:** During the test, you'll sit in a soundproof room wearing earphones that transmit specific sounds into one ear at a time. You'll indicate when you can hear the sound, and your results will be compared with results considered normal for your age. This can help rule out or identify possible causes of tinnitus.
- **Movement:** Your doctor may ask you to move your eyes, clench your jaw, or move your neck, arms and legs. If your tinnitus changes or worsens, it may help identify an underlying disorder that needs treatment.
- **Imaging tests:** Depending on the suspected cause of your tinnitus, you may need imaging tests such as CT or MRI scans.
- **Lab tests:** Your doctor may draw blood to check for anemia, thyroid problems, heart disease or vitamin deficiencies.

Do your best to describe for your doctor what kind of tinnitus noises you hear. The sounds you hear can help your doctor identify a possible underlying cause.

- **Clicking:** This type of sound suggests that muscle contractions in and around your ear might be the cause of your tinnitus.
- **Pulsing, rushing or humming:** These sounds usually stem from blood vessel (vascular) causes, such as high blood pressure, and you may notice them when you exercise or change positions, such as when you lie down or stand up.
- **Low-pitched ringing:** This type of sound may point to ear canal blockages, Meniere's disease or stiff inner ear bones (otosclerosis).
- **High-pitched ringing:** This is the most commonly heard tinnitus sound. Likely causes include loud noise exposure, hearing loss or medications. Acoustic neuroma can cause continuous, high-pitched ringing in one ear.

TREATMENT [2]

- **Earwax removal:** Removing an earwax blockage can decrease tinnitus symptoms.
- **Treating a blood vessel condition:** Underlying blood vessel conditions may require medication, surgery or another treatment to address the problem.
- **Hearing aids:** If your tinnitus is caused by noise-induced or age-related hearing loss, using hearing aids may help improve your symptoms.
- **Changing your medication:** If a medication you're taking appears to be the cause of tinnitus, your doctor may recommend stopping or reducing the drug, or switching to a different medication.

NOISE SUPPRESION [2]

Many times, tinnitus can't be cured. But there are treatments that can help make your symptoms less noticeable. Your doctor may suggest using an electronic device to suppress the noise.

Devices include:

- **White noise machines.** These devices, which produce a sound similar to static , or environmental sounds such as falling rain or ocean waves, are often an effective treatment for tinnitus. You may want to try a white noise machine with pillow speakers to help you sleep. Fans, humidifiers, dehumidifiers and air conditioners in the bedroom also produce white noise and may help make tinnitus less noticeable at night.

- **Masking devices.** Worn in the ear and similar to hearing aids, these devices produce a continuous, low-level white noise that suppresses tinnitus symptoms.

MEDICATION [2]

Drugs can't cure tinnitus, but in some cases they may help reduce the severity of symptoms or complications. To help relieve your symptoms, your doctor may prescribe medication to treat an underlying condition or to help treat the anxiety and depression that often accompany tinnitus.

POTENCIAL FUTURE TREATMENT [2]

Researchers are investigating whether magnetic or electrical stimulation of the brain can help relieve symptoms of tinnitus. Examples include transcranial magnetic stimulation (TMS) and deep brain stimulation.

MANAGEMENT OF TINNITUS [7, 9]

Primary and secondary prevention: Most cases of tinnitus are caused by SNHL (Sensorineural Hearing Loss). As SNHL cannot be reversed, primary prevention is vital. High-volume music through headphones from portable listening devices, including Smartphone, has a substantial damaging effect on the auditory system. Similar to the perceived effects of smoking, which are distant and intangible, so too are the adverse effects of noise exposure. As noise damage is related to the intensity and duration of exposure, the 80-to-90 rule (volume 80% of maximum, listen for < 90 minutes a day) is recommended to prevent noise damage. Using occlusive headphones can also decrease external noise and lessen the intensity of sound delivered .To prevent noise damage in the workplace, employers must be aware of occupational exposure limits, employ regular audiometry evaluations, and provide appropriate hearing protection.

Dietary factors, including increased glycemic load and hypercholesterolemia, are associated with increased risk of age-related hearing loss. Dietary changes to reduce carbohydrate and cholesterol intake might prevent or delay the onset of SNHL.

CONCLUSION

Tinnitus may originate in any location along the auditory pathway from the cochlear nucleus to the auditory cortex. Some leading theories include injured cochlear hair cells which repetitively stimulate auditory nerve fibers, spontaneous activity in individual auditory nerve fibers, hyperactivity of auditory nuclei in the brain stem or a reduction in the usually suppressive activity of the central auditory cortex on peripheral auditory nerve activity.

Though there have been advances in the understanding of the pathophysiology of this condition, the treatment modalities are still aimed at lessening the awareness of tinnitus and its impact on quality of life rather than attaining a

definitive cure. Currently, no drug is available that has demonstrated replicable, long-term reduction of tinnitus impact in excess of placebo effects. Medical therapy has been limited in efficacy and consistency and more research needs to be conducted into non-medical treatment modalities such as TRT, cognitive behavioral therapy and masking. As a result, tinnitus remains a chronic, often debilitating condition for a significant number of patients. However, the development of molecular, biochemical and imaging techniques are offering increasing insights into the underlying causes of tinnitus and for the development of new potential targets for treatment.

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