**Decoding the Secrets of Tinnitus: The Ringing Ear**

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**Introduction:**

The term "tinnitus" originates from the Latin word "tinnire," which translates to 'to ring.' In the English language, it is described as the sensation of 'ringing in the ears.' “Tinnitus (also pronounced as “TIN-a-tus”or “Tin-EYE-tus”) is the medical term for the sensation of hearing sound in your ears or head when no external sound is present”. (ASHA; 2011)

**Technical terms:**

* *Tinnitus aurium* – from the Latin meaning “jingling ear”
* *Acousma* – from the Greek meaning “a thing heard”
* *Tinnitus cerebri* – (Latin: cerebrum or brain) head noises
* *Arterial tinnitus* – produced by disturbances in blood flow in arteries passing through middle ear
* *Paracusia imaginaria* – imaginated sound
* *Leudet’s tinnitus* – spasmodic clicking sound from muscles that control ET opening.

**Pioneers in the field of tinnitus:**

* American father of tinnitus – Jack Vernon
* British father of tinnitus – Ross R.A. Coles
* Father of neurophysiological model of tinnitus – Pawel J. Jastreboff.

Numerous individuals, after being in a quiet environment or exposing themselves to loud music, describe perceiving sounds in their ears or head. These sounds are commonly known as tinnitus. The nature of tinnitus, its underlying causes, and its impact on individuals' lives vary significantly. Tinnitus can arise from the auditory system itself or from para-auditory structures, potentially providing insights into pathological conditions. Its presence can adversely affect the well-being of individuals and their families, leading to social and psychological challenges (Davis & El Rafaie, 2000).

Somatosound, also referred to as somatic or somatosensory tinnitus, is the perception of sound without any external auditory stimulation. It originates solely from activity within the central nervous system, without any associated mechanical or vibratory activity within the cochlea. In simpler terms, somatosound represents the perception of sound originating from non-auditory structures within the body.

The connection between somatosound and tinnitus lies in the way our brain processes sensory information. The auditory system and the somatosensory system are closely connected, sharing neural pathways in the brain. This means that signals from non-auditory structures, such as muscles, blood vessels, or nerves, can influence how sound is perceived in the auditory system. According to Jastreboff in 1995, somatosound is defined as the perception of sound arising solely from activity within the central nervous system, unrelated to any mechanical or vibratory activity within the cochlea and not caused by external stimulation. However, if there is a vibratory component within the cochlea associated with the perception of sound, it is referred to as somatosound, as described by Jastreboff & Jastreboff in 2003.

Including somatosound in the definition of tinnitus is considered misleading for two reasons:

1. Somatosound represents real sounds transmitted through the normal cochlear process and can be masked in a frequency-specific manner.

2. Somatosound can be localized to a specific location and may be amenable to medical or surgical treatment.

The perception of tinnitus is believed to result from abnormal neuronal activity at a subcortical level in the auditory pathway, with the cortex playing a mostly passive role. Abnormal synchronization of auditory nerve activity and imbalanced activity of Type I and Type II afferent fibers in the auditory system have been associated with tinnitus perception. Additionally, tinnitus involves pattern recognition memory and connections with other systems, particularly the limbic and autonomic systems.

This model suggests that tinnitus is not solely linked to a specific anatomical site but rather involves multiple centers throughout the nervous system.

**Incidence and Prevalence:**

A study conducted on adults aged 48 to 92 years found that tinnitus had a prevalence of 8.2% at baseline and an incidence of 5.7% during a 5-year follow-up (Nondahl, Cruickshanks, Wiley, Klein, Klein, Tweed, 2002). According to the American Tinnitus Association (2009), 50 million Americans experience tinnitus, with 12 million seeking medical attention. One million individuals have a severe form of the disorder that significantly interferes with their quality of life.

**Classification of Tinnitus**

Tinnitus can be classified based on different criteria:

1. Classification based on site:

- Conductive tinnitus: Occurs as a result of vibrations within the middle ear.

- Sensorineural tinnitus: Arises from problems affecting the inner and outer hair cells, auditory nerves, and other sensory structures.

- Central tinnitus: Develops due to abnormal processing within the central auditory pathways.

2. Classification based on duration:

- Short-duration tinnitus: Connected to issues in the middle ear.

- Long-duration tinnitus: Tied to conditions such as Meniere's disease, acoustic neuroma, palatal myoclonus, glomus jugular, patent cochlear duct, and ototoxicity.

3. Classification based on symptoms:

Objective tinnitus: This type of tinnitus produces sounds that can be heard by a physician, and it may manifest as specific noises like blowing, respiration, pulsating, or popping. Conditions associated with objective tinnitus include patent Eustachian tube, cardiac vascularities (pulsating and synchronized with the heartbeat), vascular tumors in the middle ear, and middle ear muscle contractions. Objective tinnitus is relatively uncommon compared to subjective tinnitus.

Subjective tinnitus: The most prevalent form of tinnitus observed in patients, where only the affected individual hears the sound, making it undetectable by a physician.

It is the most commonly experienced issue where only the patient perceives the tinnitus sound.

*Conditions associated with Subjective tinnitus*

* Otological disorders:

The most prevalent cause across all age groups (90%) is subjective tinnitus, and it often accompanies sensorineural hearing loss. Heller ME and Bergman MT in their work published in Annals of Otology in 1953 have associated tinnitus with the following conditions:

- Otosclerosis, Meniere's Disease, Lerimoyez's syndrome

- Pressure or neuritis of the auditory apparatus; brain tumor, eighth nerve tumor, aneurysm.

- Otitis media: acute, chronic, suppurative, and non-suppurative.

- Otitis interna: acute, chronic.

- Normal hearing with a discrete frequency defect.

- Nasopharyngeal diseases: Eustachian tube salpingitis, sinusitis, pharyngitis, mucosal hypertrophy, hyperplasia, tumor, infection of lymphoid tissue.

- Dental Pathology: Malocclusion, malfunction of the temporomandibular joint, impaction, infection.

- Myositis; cervical, pharyngeal, tympanic.

- Intoxication - drugs: quinine, alcohol, salicylates, caffeine, tobacco, antileutic agent, streptomycin, thyroid gland extract.

- Intoxication syndromes: gastrointestinal, facial infection.

- Allergy.

- Cardiovascular pathology: blood dyscrasias, anemias, hypotension, vascular anomalies, arteriosclerosis, cardiac disease.

- Metabolic dysfunction: thyroidism, water balance disturbance.

- Trauma, acoustic, acute or chronic.

- Systemic fatigue.

- Momentary tinnitus, spontaneous idiopathic.

- Impacted cerumen.

- Cervical constriction.

- Psychosis.

- Otic herpes.

- Bell's palsy.

- Foreign body trauma to the ear.

- Head injury, concussion, post-concussion syndrome.

- Myringitis, hemorrhage, tympanum, or myringitis.

* Cardio vascular problems:

A common occurrence among the older population group. Approximately 37% of tinnitus patients have reported cardiovascular issues. The causes may involve:

- High blood pressure.

- Anemia (where tinnitus is secondary to an increased heart rate and cardiovascular output, resulting in low-pitched sounds).

- Extensive arteriosclerosis (low-pitched pulsating sound) - characterized by turbulence noise.

- Changes in venous blood flow (resulting in a low-frequency soft hum).

* Metabolic disease:

- Tinnitus can be caused by diabetes and thyroid disorders.

- Hyperthyroidism, which involves increased cardiac output, can lead to rushing or pulsatile tinnitus.

- Abnormal cholesterol levels and hyperlipidemia are also potential causes.

- Although rare, vitamin deficiency can be associated with tinnitus.

* Neurological Disease

- Tinnitus may result from head trauma, with an incidence of about 10%.

- Conditions such as skull fracture or severe closed head injury can lead to tinnitus.

- While rare, tinnitus can also be associated with meningitis and multiple sclerosis.

* Pharmacological factors:

Tinnitus can potentially be caused by various types of medications. Ototoxic drugs like aminoglycosides, aspirin, caffeine, and nicotine are known to induce tinnitus. Additionally, tinnitus can be associated with:

- Anti-inflammatory drugs.

- Antibiotics.

- Sedatives and antidepressants.

4. Classification based on severity:

- Mild tinnitus is typically perceived only in quiet surroundings or before bedtime. It is generally not highly bothersome, and the patient can easily divert their attention from the tinnitus by focusing on other stimuli.

- Moderate tinnitus is more pronounced and persists consistently. The patient is aware of the tinnitus when attempting to concentrate or trying to sleep.

- Severe tinnitus can incapacitate individuals to the point where they find it challenging to focus on anything other than the tinnitus itself.

5. Classification based on Pathology:

- Typical tinnitus is encountered by the majority of individuals with normal hearing, lasting for less than 5 minutes, and occurring less than once a week.

- Abnormal tinnitus, on the other hand, lasts for more than 5 minutes and happens more than once a week, often experienced by people with hearing loss.

6. Classification based on Site :

* Peripheral
* Central

7. Classification based on etiology

* Noise induced
* Meniere’s disease
* Ototoxcitiy
* Presbycusis
* Unknown etiology

8. Classification based on Duration:

* Temporary tinnitus: Short term tinnitus, probably due to temporary dysfunction of the auditory system, such as after noise in a club or drug exposure.
* Permanent tinnitus: It may be either constant or intermittent (when tinnitus returns after a period of disappearance).

The suggested definitions regarding tinnitus duration indicate that tinnitus episodes can vary widely, ranging from very brief occurrences (such as temporary tinnitus after exposure to loud noise or a high dose of aspirin) to continuous experiences. The common criterion often used is five minutes of perceiving sound to be classified as tinnitus. However, this duration is arbitrary and lacks clear theoretical or clinical significance. Regardless of the proposed theory of tinnitus, the time factor is not relevant to the mechanisms of tinnitus generation. Duration is just one of numerous parameters that contribute to distress related to tinnitus.

**Effect of Tinnitus:**

**Table 1: Psychological Effects of tinnitus: (Rubunistern & Erlandsson, 1991)**

|  |  |  |
| --- | --- | --- |
| Emotional distress (Tyler & Baker, 1983) | Interpersonal Complaints | Somatic distress symptoms |
| Irritation, annoyance, concentration and sleep difficulties, depression and despair | Lack of understanding, negative impact of relationships (relatives, friends & colleagues) | Head ache, neck pain, pain / tension in jaw, muscles, dizziness, hypersensitivity to sounds. |

**Table 2: Three dimensions of tinnitus complaint behaviour:**

|  |  |  |
| --- | --- | --- |
| Emotional | Audiological | Intrusiveness |
| Depression, anger, irritability, anxiety | Perceptual difficulties, (hearing problems in demanding social situations | Continuous focusing of tinnitus, concentration difficulties insomnia |

**Causes of Tinnitus:**

***TINNITUS***

INFURIATING

TRANSIENT

FUNCTIONAL

ORGANIC

CENTRAL

PERIPHERAL

SYSTEMIC

TEMPORAL LOBE EPILEPSY

CEREBROVASCULAR DISEASE

INTRACRANIAL VASCULAR TUMORS

**MIGRAINE**

ANEAMIA

STRYCHNINE POISONING

HYPER/HYPOTENSION

IN THE EAR

OUTSIDE THE EAR

ET DYSFUNCTION

PALATALMYOCLONUS

IMPACTED WISDOM TOOTH

INNER EAR

MENIERE DISEASE

HAIR CELL DAMAGE

OTOTOXICITY

ACOUSTIC NEUROMA

NOISE TRAUMA

EXTERNAL EAR

WAX

FOREIGN BODY

MIDDLE EAR

OTOSCLEROSIS

FLUID IN MIDDLE EAR

GLOMUS TUMOR

**Figure 1: Tree diagram explaining causes of tinnitus**

**Assessment*:***

*Tinnitus assessment protocol. (Goldstein & Shulman 1991, & Hall et al. 2001).*

1. Pitch matching
2. Loudness matching
3. Masking

*Pitch matching and loudness matching:*

*Pitch matching protocols:*

Several protocols are available to estimate tinnitus pitch.

* *Method & Limits: (Small, 1973):*

The patient might be asked whether the tinnitus has a higher or lower pitch than that of a pure tone. The average of a series of pairs of ascending / descending trials is considered the pitch match frequency.

E.g. 2 tones taken f1 and f2, when f1 < f2 – then ask which is closer in pitch. If e.g. patient judges tinnitus with f2 then next two tones are f2 + higher tone, f3 – can be used in most clinical audiometers.

* *Method of adjustment:*

Here the patient manipulates the frequency of a tone until its pitch is about equal to the most important pitch of the tinnitus.

* *Adaptive methods:*

Under computer control asked whether tone pitch is higher or lower than tinnitus. Penner & Bilger (1992) found low variability with a ‘double staircase’ adaptive procedure compared to method of adjustment.

Note: In all pitch matching techniques, it is important to have the loudness of the pure tone closely resemble the loudness of the tinnitus across all frequencies being assessed. Many patients can accurately choose the loudness and pitch of a pure tone that closely matches their tinnitus. However, when pitch matches are repeated, there can often be discrepancies of an octave or more between the matches, as noted by Henry et al. in 2004 and Tyler & Conrad-Irmes in 1983.

*Procedure:*

For pitch and loudness matching procedure (A. Henry & Zaugg, 2005). Identify ‘Tinnitus ear’ & ‘Stimulus ear’ also identify the ear with the loudest or most prominent tinnitus. Present stimulus to the other ear. Binaural deplacusis would be suspected if thresholds are asymmetrical and reported distortion so concern should be taken.

*Ensure the patient understands ‘loudness’ & pitch*

Patients often confuse pitch and loudness when matching tones is their tinnitus (Vernon & Fenwick, 1984). Explain: In terms of piano Keys, man versus women voice for pitch, volume on radio for loudness.

General testing strategy for tinnitus matching using an audiometer: 1st objective is to determine the frequency of a pure tone that patients perceive closest to the pitch of their tinnitus. These procedures start with a frequency of a pure tone below the perceived tinnitus pitch so they will easily differ the pitch.

About 90% of patients will select a frequency of 2 kHz or higher as a pitch match (Meikle et al. 2004). So 1 kHz is a good starting frequency. This frequency is also called ‘mid pitched tone’ to provide a reference.

Tones with different frequencies are presented in octave intervals to gradually approach and identify the octave frequency that is closest to the perceived tinnitus pitch.

The pitch matched tone is then compared with tones an octave higher and an octave lower, to ensure that patient has not made the common mistake of octave confusion (Evered & Lawrenson, 1981, Graham & Newby, 1962; Vernon & Miekle, 1988).

The second objective of tinnitus matching with determines the level of the pitch matched tone that matches the patients perceived tinnitus loudness.

* After pitch match, the threshold of the perceived matched tone is obtained to closest 1 dB. The tone is then raised in 1 dB steps to determine the loudness match (SL or HL) at pitch match frequency. Present all matching tones at levels close to the patients perceived tinnitus loudness.
* These levels will generally 10-20 dB SL at frequencies when hearing is in normal limits and 5-10 dB SL (or level) where hearing thresholds are significantly elevated.

*Start testing:*

Present 1 kHz tone at 10-20 dB SL and ask the patient is the tinnitus louder or softer than tone. Adjust the level accordingly before proceeding with pitch matching. Then ask is the tinnitus high pitched or lower pitched than the tone.

*Identify the tinnitus pitch match:*

Repeat the above procedure at adjacent octave frequencies, maintaining output levels that approximate tinnitus loudness. When octave frequencies is identified as a ‘close match’ to the tinnitus, continue testing to adjacent inter octave frequencies.

*Test for ‘octave confusion’ to confirm final pitch match:*

After a pitch match is identified using the procedure described above, octave-confusion testing is performed. The pitch matched tone should be presented in alternation with a tone an octave above, then an octave below. This match using this procedure is the final, octave confirmed pitch match.

E.g. 8 kHz is the response then present one octave above (16,000 Hz) and one octave below (4 kHz). Compare 8 kHz vs. 16 kHz tone also Compare 4 kHz vs. 8 kHz tone Presented alternatively. If subject says 16 kHz-octave confusion test is positive. If he says ‘no’, ‘it is 8 kHz’ only octave and octave Confusion test is negative

*Obtain loudness match at pitch match frequency:*

The loudness match will be measured to the closest 1 dB (or the smallest step size in audiometer). The loudness match should be reported in dB SL. Start 5 dB below threshold, increase in 1 dB steps until the patient hears the tone.

*Determine whether the tinnitus sounds more like a tone or more like noise*

* The tinnitus matched tone at same loudness is compared with NBN at same frequency and same loudness (alternatively) ‘which of these sounds most like your tinnitus’.
* If tone selected no further testing
* If NBN selected – next task is to determine whether tinnitus sounds like NBN (or) BBN
* When the patient selects the test match – a hearing threshold and tinnitus loudness should be obtained.

*Plot the tinnitus match on the audiogram*

* Usually plotted for counseling purpose
* If match is tone – a single point plotted at that frequency and dB HL
* If NBN – a short horizontal line is made at the dB
* If BBN – a horizontal line is made correspondingly

**Management of Tinnitus:**

* Main aim is to improve habituation to the tinnitus rather than “cure” tinnitus.
* Most people don’t seek treatment.
* Multitude of potential treatments.
* Problems with scientific evidence

Basic advice to patient:

* Reassurance
* Avoid aggravating factors eg. noise, NSAIDs
* Decreased intake of stimulants eg. caffeine and nicotine
* Relaxation
* Avoiding silence
* White noise eg. Detuned radio
* Hearing aid:

Many tinnitus management techniques advocate the use of sound as a therapeutic tool; hearing aids have been used both for masking (Hazell et al1985; von Wedel et al1998; Vernon & Meikle, 2000) and habituation based tinnitus therapies such as tinnitus retraining therapy (Jastreboff & Hazell1993; Formby & Keaser 2007). Providing sound therapy through hearing aids may reduce tinnitus in several ways (Kochkin & Tyler, 2008). Amplified sounds may increase the level of neuronal activity, which reduces the contrast between tinnitus and background neuronal activity; the amplification of speech and ambient sound to a comfortable level may reduce tinnitus audibility and awareness, by interfering with the central processing of tinnitus thus reducing the attention paid to it (Parra & Pearlmutter, 2007). High proportion of hearing professionals (88%) see hearing aids as their primary tinnitus treatment strategy (Kochkin & Tyler, 2008) but very few patients (24%) see hearing aids as an option they would self select (Aazh et al, 2009).

* Cochlear implant:

Patient having severe o profound hearing loss with tinnitus can go for cochlear implant. Suppression of tinnitus by electrical stimulation via a cochlear implant has been studied in recent years. Some individuals who undergo cochlear implant surgery report total or partial relief of the symptoms even in the contralateral ear. The mechanisms involved in this suppression are not clear (Yonehara, Mezzalira, Porto, Bianchini, Calonga, Curi, Stoler, 2006). If a cochlear implant is successful and allows the patient to hear some external sounds, this usually reduces the perception of tinnitus, especially on the implanted side.  Cochlear implant cannot be considered a treatment option for tinnitus because a cochlear implant is done only if the individual with hearing loss is having no benefit with a hearing aid, and it is a very costly affair, especially in developing countries like India where most of the population

is below poverty line. This benefits only an individual with hearing loss, so covers only a part of the population who complains of tinnitus.

* Tinnitus masking devices

The use of an externally produced sound to severity of tinnitus can offer relief for few individuals. Tinnitus maskers generate noise bands, preferably with user-adjustable frequency emphasis, to permit the user to select the optimum noiseband for achieving ‘‘coverage’’ or masking of the tinnitus at the lowest possible sound level. With masking, the purpose is not to cover up, or “mask,” the patient’s tinnitus. The purpose is to use sound to achieve a sense of relief from the stress or tension caused by tinnitus (Hobson, Chisholm, El Refaie, 2010). Environmental sound generators are electronic devices that resemble a radio. They produce quiet, soothing sounds that are often heard in nature, such as a babbling brook, wind rustling the leaves of a tree or waves lapping on a shore. Sound generators are particularly useful when placed by your bedside because they can distract you from your tinnitus when you are falling asleep. Many environmental sound generators have timers so that they can turn themselves off after you have fallen asleep. An ear-level sound generator is a small device that resembles a hearing aid. It may be recommended if you have normal hearing or mild hearing loss. For more severe hearing loss, some hearing aids have built-in sound generators. These are known as combination instruments. The effectiveness of this treatment is also present only when the device is on, though some devices produce residual inhibition where the individual might not perceive the tinnitus even after the sound generator is turned off.

* Tinnitus Retraining Therapy

Tinnitus Retraining Therapy (TRT) is based on the neurophysiological model of tinnitus developed in the late 1980s by Pawel Jastreboff and Jonathan Hazell. The neurophysiological model of tinnitus suggests that it is the limbic system – the part of the brain responsible for our emotions – that gives importance and meaning to tinnitus sounds. According to this model, we perceive tinnitus sounds to be a threat or a danger and this provokes an emotional response. Our awareness of tinnitus is heightened and so we perceive it to be louder or more persistent. TRT combines [counseling](https://www.actiononhearingloss.org.uk/your-hearing/tinnitus/how-can-i-manage-my-tinnitus/what-therapies-are-available/what-is-tinnitus-retraining-therapy/tinnitus-retraining-therapy-counselling.aspx) and low-level sound therapy. It doesn’t work directly on your tinnitus, but on your awareness and understanding of it.  In time, as your awareness of the sounds is reduced, you’ll only notice your tinnitus when you focus on it. This is known as ‘habituation’ and is the ultimate goal of TRT.

* Sound stimulation therapy during sleep

This is a new strategy for treating subjective tinnitus so that it provides treatment during sleep without interfering with the patient’s daytime activities (Pedemonte et al., 2010). The stimulus is a sound that was fixed at the same tinnitus intensity and then applied through an iPod or any device which is compatible to the stimulus. They proposed that the sound stimulation with the same characteristics in frequency and intensity as the tinnitus is a way of reinstalling the normal balance in the central level processing of information. It was based on the acknowledgement that the auditory system also works during sleep, processing the incoming information.

* Neuromonics Tinnitus Treatment

This treatment was originally developed in Australia. The treatment addresses the audiological, psychological and neurological aspects of tinnitus disturbance. It delivers a *spectrally modified* acoustic signal. This means that the music is digitally adjusted to compress some low frequencies and expand some high frequencies, while still maintaining the music's artistic integrity. The relaxing music is metered to mimic a resting heart rate. The signal is customized for each ear based on hearing levels from 250 Hz through 12,500 Hz. Since the device is customized based on each person's hearing and tinnitus profile, it compensates for hearing differences between the ears and ensures a high degree of neural stimulation from the music (Meltzer, 2007). Neuromonics Tinnitus Treatment is a combination of acoustic stimulation with a structured program of counseling and support by a clinician who has been trained specifically in tinnitus rehabilitation (Davis, Wilde, Steed, et al., 2008). Neuromonics treatment follows the procedure of TRT but in a more structured way taking into account the differences in hearing between two ears, this provides chances of a better improvement in the individual with tinnitus.

* Ultra high frequency vibration therapy

Ultraquiet, is a high-frequency bone conduction therapy that aims to reduce long term tinnitus severity by delivering amplitude modulated musical type tones in the range of 10-20 kHz. This based on the assumption that high-frequency masking should provide effective relief in persons with severe problematic tinnitus (Goldstein, Lenhardt & Shulman, 2005). High frequency stimulation aims at slowing down and reversing the process of cortical reprogramming, possibly even leading to the restoration of a normal frequency map.

* Pharmacological Treatment

Antidepressants likely to have a role in the management of tinnitus concomitant with major depression or depressed symptoms and can help in ameliorating comorbities in severe or chronic cases of tinnitus. The sedating tricyclic medications have been reported to be useful in patients with insomnia. GABA receptor-binding medications, like benzodiazepines appear to be reasonable candidates for tinnitus therapy. Prostaglandins and other vasodilators have been studied clinically and were reported to have mixed results (Patterson and Balough, 2006).

* Cognitive behavioral Therapy

Cognitive behavior therapy (CBT) uses techniques such as cognitive restructuring and relaxation to change the way patients think about and respond to tinnitus. CBT can help to relieve your negative associations to tinnitus, can reduce stress and annoyance caused by tinnitus and can redirect your attention from the tinnitus sound. This therapy is effective help the individuals with tinnitus who have effect on their emotional and psychological well being. Many of the individuals are reported to have sleep disturbances and suicidal tendency. Individuals with tinnitus may experience difficulties with attention and anxiety, but those who are most distressed by tinnitus may be psychologically vulnerable (Langguth, Kleinjung, Landgrebe, 2011).  Interventions such as cognitive behavioral therapy may effectively increase quality of life by increasing the patient’s ability to deal with chronic tinnitus by restructuring thought patterns and habituating those patterns when the patient is reacting to tinnitus (Martinez-Devesa, Perera, Theodoulou, 2010). Henry and Wilson (2001) reviewed the studies that have been conducted to evaluate the efficacy of cognitive–behavioral therapy for tinnitus distress. They concluded that these studies offer ‘‘considerable support’’ for using this form of treatment. CBT cannot be used as the only technique to reduce the tinnitus as it does not reduce the loudness of the tinnitus. This technique is more effective when used along with other techniques like sound therapies by reducing the disturbances caused by the presence of tinnitus in their personal and social life.

* Biofeedback Therapy

Biofeedback was advocated for tinnitus treatment in the 1970s (Grosson, 1976). Biofeedback technique aim to teach the patient to control or habituate to the perceived ringing and the subsequent distress. Tinnitus is stressful, and stress can worsen tinnitus. Biofeedback is a relaxation technique that helps control stress by changing bodily responses. Electrodes attached to the skin feed information about physiological processes such as pulse, skin temperature, and muscle tension into a computer, which displays the output on a monitor. Patients learn how to alter these processes and reduce the body’s stress response by changing their thoughts and feelings. Listening to the audio signal is thought to reduce the perceived ringing and muscle tension.

* Relaxation Therapy

Relaxation therapies also offer strategies to focus the patient’s attention away from the sound, aiming to psychologically improve their symptoms (Ireland, Wilson, Tonkin, et al., 1985). This technique helps in improving the quality of life of the patient. Relaxation therapy as mentioned above cannot be used solely; it should be used along with the techniques which help in reducing tinnitus severity. These techniques help to relive the other effects of tinnitus like stress, insomnia and other psychological disturbances which are induced by tinnitus.

* Neuro-feedback Therapy

Neuro-feedback is a computerized learning strategy that enables people to voluntarily alter their own brain activity. Chronic tinnitus sufferers have different patterns of brain activity compared with those with normal hearing (Weisz et al., 2005). Many individuals with tinnitus have abnormal oscillatory brain activity. This pathological activity can be normalized by neurofeedback techniques (Weisz et al., 2005). This is achieved mainly through enhancement of tau activity (8-12 Hz activity as tau activity). Enhancing Alpha frequencies and cutting down Delta activity using neuro-feedback have shown some success in reducing tinnitus (Crocetti et al., 2011). It has also been reported that the use of neuro-feedback therapy to manipulate cortical networks can be helpful in reducing tinnitus loudness and distress (Schlee et al., 2008).

* Virtual Reality Therapy

This technique acts on the sub-cortical mechanisms of integration, thus allowing the patient to willingly manipulate the tinnitus in a visual and auditory 3-Dimensional (3D) virtual environment to control or “master” tinnitus (Londero et al., 2010). The application is based on the model of visual virtual reality coupled with accurate auditory spatial image, as well as a natural sensorimotor interaction provided through the use of two elements. The overall procedure consists of, in the first place, the creation of an auditory avatar (auditory image of patient’s tinnitus), and secondly, the inclusion of an interactive auditory–visual virtual environment where the different audio components are spatialized according to the navigation and manipulation of the patient. Londero et al. (2010) believed that immersion in virtual reality can contribute to tinnitus treatment by promoting plasticity, through the active manipulation of a 3D auditory object linked to a visual representation. Repeated sessions of such virtual reality immersions are then supposed to contribute to tinnitus treatment by promoting cerebral plasticity (Pandey, 2011). Further, clinical research is necessary to demonstrate the clinical relevance in alleviating tinnitus.

* Acupuncture

Acupuncture is a part of traditional Chinese medicine that is used extensively around the world. A number of studies showvarying degrees of success and failure in treating tinnitus (Andersson& Lyttkens, 1996)

* Transcutaneous “black boxes”

The Therapak, a small black box with flashing lights, has been promoted for the treatment of musculoskeletal aches and pains and suggested in the treatment of tinnitus in the UK. Roland *et al. (1993) have suggested that this device did give* significant help in 45% of patients treated. the device produces a variable low-frequency, pulsed, electromagnetic signal, rich in harmonics. Benefits are not good as examination of the inside of the box by an electronics engineer suggested that there were no components capable of producing any type of electromagnetic radiation able to penetrate the body.

* Laser Therapy

Several studies of laser treatment in patients and studies on temporal bones to examine the possibility of laser-activated repair mechanisms within the cochlea have shown consistently negative results (Partheniadis-Stumpf, Maurer & Mann, 1993; Shiomi et al., 1997; von Wedel et al., 1995). The controlled human study showed no improvement in tinnitus, and evaluation of the light intensity in the temporal bone study showed that the laser light did not penetrate in the intact ear (Mirz et al., 1999a; Walger et al., 1996)

* Hyperbaric oxygen therapy

Hyperbaric oxygen has been used for a long time as an empirical treatment for sudden sensorineural deafness, with the reasoning that increasing cochlear blood flow and concentration of oxygen in the perilymph might induce and facilitate recovery of damaged hair cells (Fattori *et al., 1996; Vavrina & Muller, 1995).* An attempt to evaluate effectiveness of this method to treat Méni`ere’s syndrome showed no difference between patients receiving hyperbaric oxygen and a control group (Fattori *et al., 1996).*

* Various herbal therapies

For years, a variety of herbal mixtures with attractive names implying their effectiveness for tinnitus have been introduced on the market. Lack of studies supporting the claims of high effectiveness did not discourage people from buying. The problem is that these products are actually making tinnitus worse, as patients receive another confirmation that “nothing works for tinnitus” once the temporary placebo effect disappears.

* Reflexology, hypnosis, aromatherapy, craniosacral therapy

These therapy are non-specific treatments (in terms of conventional medicine) that are widely used for the reduction of stress and stress-related conditions such as a headache, anxiety, digestive problems, etc. Having the scalp muscles or the soles of the feet massaged, or pleasant smelling oil applied over the body, may produce significant feelings of relaxation and well-being. The treatments are typically applied by therapists without any specialist knowledge of audiology, or the neurophysiology of tinnitus, making diagnosis of these conditions a haphazard process. Tinnitus patients have sometime reported improvement, particularly in feelings of anxiety, following these therapies.

* Music therapy

Music-based therapies have a long tradition in psychology and medicine (Cabrera & Lee, 2000; Good, 1996; Lipe, 2002; Watkins, 1997) and recently elements were proposed for tinnitus treatment. As with any treatment decreasing general stress levels and inducing relaxation, this therapy could be used as an adjunct to TRT but, on theiwn, would be predicted to have only a temporary effect by altering autonomic activity.

* Pharmacological Therapy

Medications🡪 Vasodilators: Enhance cochlear blood flow but no useful effect.

* Local anesthetics🡪 Reliably attenuate tinnitus for a short time. Intravenous hydrazine attenuates tinnitus for a short time (Duckert and Res, 1983)
* Sedatives and Tranquilizers
  + Can reduce the severe anxiety and panic that often accompany tinnitus.
  + they can relax muscle and decrease anxiety.
  + Benzodiazepines create a physiological dependence (Lango and Johnson 2000).
* Antidepressants🡪 Short to medium term antidepressant therapy may be valuable.
* Anti allergic🡪 Treatment with aspirin suppresses somatosounds resulting from SOAE in cochlea (Penner and Coles 1992).
* Transcutaneous Vagus Nerve Stimulation

Transcutaneous Vagus Nerve Stimulation (tVNS): It is a non-invasive technique that involves stimulating the vagus nerve through the skin. It has been studied as a potential treatment for tinnitus. tVNS may help alleviate tinnitus symptoms by modulating neural activity and influencing the brain's perception of the condition. tVNS will target auricular branch of vagus nerve.

* Massage with Gua sha

While it has been traditionally used in Chinese medicine for promoting blood circulation and relieving muscle tension, its effectiveness in treating tinnitus is mainly anecdotal. No published clinical trials or peer-reviewed studies were found, indicating a lack of robust evidence for Gua sha's role in tinnitus management. It will target the cervical branch of vagus nerve.

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