

Tinnitus

What is tinnitus?

Tinnitus is defined as the perception of sound when no external sound is present. The common vernacular is "ringing in the ears"; however, the quality of the tinnitus can range from roaring to hissing and chirping to clicking. Tinnitus can pulsate or be constant. It can be a single tone or multiple tones, and its amplitude can vary from background noise to an excruciating experience.

What causes tinnitus?

Tinnitus has a variety of causes. The most common causes include wax in the ear canal, noise trauma or temporomandibular joint (TMJ) dysfunction. It can also be caused by Meniere's disease, endolymphatic hydrops, allergies, destruction of the middle ear bones, infection, nutritional deficiency, cardiovascular disease, thyroid disorders, certain medications, head injury and cervical disorders. Recently, migraine disorders have also been listed as a culprit.

Regardless of the inciting etiology, it has been shown that it is within the brain that the sound resides, persists, evolves and propagates. Tinnitus may begin with damage to the peripheral auditory system (the cochlea and auditory nerve), but its persistence is a function of the attention that it receives (parietal cortex and frontal cortex), the importance that it is given (cingulate cortex, anterior insula) and its maintaining residence in the limbic system (the amygdala, hippocampus and thalamus). Ongoing research is being aggressively pursued to stop this feed-forward cycle in its tracks.

Medications that may exacerbate tinnitus (adapted from Bailey's Otolaryngology - Head and Neck Surgery 4th ed.) include aspirin and aspirin-containing compounds, aminoglycoside antibiotics, nonsteroidal antiinflammatory drugs and heterocycline antidepressants. For a complete list, please visit <http://www.hearinglosshelp.com/articles/pdf/TinnitusDrugList2013.pdf> **Please never stop taking a medication until after discussing it with your prescribing physician.**

Medications that May Worsen Tinnitus

(adapted from Bailey's Otolaryngology - Head and Neck Surgery 4th ed.)

Aspirin and aspirin-containing compounds

Percodan

Darvon

Bufferin

Ecotrin

Aminoglycoside antibiotics

Gentamicin

Kanamycin

Neomycin

Streptomycin

Tobramycin

Amikacin

Nonsteroidal antiinflammatory drugs

Fenoprofen

Ibuprofen

Indomethacin

Ketoprofen

Naproxen
Phenylbutazone
Sulindac
Tolmetin

Heterocycline antidepressants

Amitriptyline
Amoxapine
Desipramine
Doxepin
Imipramine
Maprotiline
Nortriptyline
Protriptyline
Trazodone
Trimipramine

Current therapeutic options

*Please note that the doctor does not endorse or recommend any one tinnitus treatment over another. Consult with the physician regarding which treatment might be best for you.

Alternative Therapy

- Magnesium or B12
- Accupuncture
- Cranio-sacral therapy
- Hyperbaric Oxygen
- Hypnosis

Amplification

- Return of ambient sounds by the use of hearing aids may provide a natural masker for tinnitus

Biofeedback

- Relaxation technique that teaches people to control certain autonomic body functions in order to change the body's reaction to stress and their tinnitus

Cochlear Implants / Electrical Stimulation

- For Deaf or near-Deaf individuals with tinnitus

Cognitive Behavioral Therapy

- Counseling to identify and change negative behaviors and thought patterns associated with their tinnitus. This is oftentimes is most effective when coupled with other tinnitus treatments, including masking or medication.

Medication

- Apart from the supplements listed above, certain medications can diminish the severity of tinnitus in certain patients. These medications include anxiolytics (i.e., Alprazolam,

Clonazepam) and anti-depressants (i.e., selective serotonin reuptake inhibitors or tricyclic antidepressants), amongst others. Please ask your doctor if a medication might be appropriate for you.

Sound Therapy

- Hearing aids
- Masking devices (i.e., ear level, sound machines, etc)

TMJ Treatment

- Tinnitus may be a symptom of dysfunction of the jaw (temporomandibular) joint because many of the nerves and muscles controlling this joint are closely connected with the ear.
- The joint can be addressed with a variety of methods including a soft diet and dental treatments

References

- <http://www.ncbi.nlm.nih.gov/pubmed/23543524>
- <http://www.ncbi.nlm.nih.gov/pubmed/22249877>
- <http://www.ncbi.nlm.nih.gov/pubmed/23598691>
- <http://www.ncbi.nlm.nih.gov/pubmed/23076907>

180 dB	Rocket launch
170 dB	Shotgun blast
157 dB	9mm pistol (sound for shooter)
157 dB	Balloon popping
156 dB	Toy cap gun
150 dB	Jet engine (at take off)
150 dB	Rock music (at peak levels)
140 dB	Deploying car airbag
140 dB	Average firecrackers
130 dB	Stock car races
130 dB	Drum high-hat
125 dB	Electric guitar
120 - 130 dB	Symphonic music
125 dB: Noise at this level causes pain	
117 dB	F-18Fighter jet in flight

114 dB	Abrams tank, internally, 30 mph
110 dB	Flute (at shoulder)
110 dB	Chainsaw
106 dB	Blackhawk helicopter, in cockpit
90-115 dB	Subway train
100-110 dB	MP3 player, CD player
90-110 dB	MRI (magnetic resonance imaging)
90-105 dB	Leafblower
90-100+ dB	Dog bark (outdoors)
90 dB	Average motorcycle
90 dB	Power lawn mower
85 dB: Time for Earplugs Regular, sustained exposure may cause permanent damage to hearing	
84-103 dB	Violin at close range
80 dB	Telephone dial tone
70-80 dB	Electric coffee grinder
72-76 dB	Inside car, windows open, 30 mph
60-85 dB	Vacuum cleaner
60-70 dB	Normal conversation at 3 feet
60 dB	Home washing machine
50 dB	Moderate rainfall
40 dB	Humming refrigerator
30 dB	Soft whisper
20 dB	Ticking wristwatch

Hearing Loss

Physiology / Anatomy of Hearing

There are three parts of the ear that contribute to hearing.

1. Outer ear (Auricle) / external ear (auditory) canal (EAC)

Auricle

Skin, cartilage and soft tissue make up the auricle (pinna). Each layer is quite thin and because of this, it is easily damaged by pressure (hematoma) or cold (frostbite). There are many cranial nerves that contribute to innervation of the auricle, and cross-innervation oftentimes occurs leading to many conditions presenting with ear pain which may not originate from the ear itself.

External Auditory Canal

The external auditory canal (EAC) has two parts - cartilage and bone - and ends in the tympanic membrane (ear drum). The skin lining the cartilage portion has hair, sebaceous glands and ceruminous glands. The stratum corneum is the outer most layer of the epidermis (skin). Cells of the stratum corneum contain a dense network of keratin. Wax is a mixture of keratin and secretions of ceruminous and sebaceous glands. The main organic components of wax are saturated and unsaturated long chain fatty acids, alcohols, squalene and cholesterol.

2. Middle ear / Ossicles

- a. Malleus (hammer)
- b. Incus (anvil)
- c. Stapes (stirrup)

3. Inner ear / Nerve

- a. Cochlea
- b. Semicircular canals
- c. Saccule and Utricle
- d. Superior and Inferior vestibular nerves
- e. Cochlear Nerve

See Video for hearing mechanism

Causes of Hearing Loss

1. External Ear

- a. Congenital Malformations
- b. Foreign Body
- c. Wax / Cerumen Impaction
- d. Exostosis / Surfer's Ear
- e. Trauma
- f. Infection (i.e., otitis externa)
- g. Cysts / Tumors

2. Middle ear

- a. Infection (otitis media)
- b. Blocked Eustachian Tube

- c. Patulous (abnormal patency) Eustachian Tube
 - d. Otic Barotrauma
 - e. Bullous Myringitis
 - f. Mastoiditis
 - g. Congenital Disease of the Middle Ear
 - h. Tumors of the Middle Ear
 - i. Otosclerosis
 - j. Trauma of the Middle Ear (Ossicular Dislocation)
3. Inner Ear and Skull Base
- a. Meniere's Disease
 - b. Ototoxicity (medication-induced)
 - c. Presbycusis (aging)
 - d. Noise Induced Hearing Loss
 - e. Hereditary Neural Deafness
 - f. Autoimmune Inner Ear Disease
 - g. Tumor (Meningioma, Acoustic Neuroma, etc)

Vertigo

Physiology / Anatomy of Balance

Vertigo

Definition

Vertigo is the sense of a movement in a stable environment. The movement can range from rocking to a true spinning sensation.

Causes of Vertigo

1. Benign Positional Paroxysmal Vertigo (BPPV)

Symptoms – A sense of spinning that typically lasts less than a minute, but can be up to a few minutes in duration. It oftentimes occurs when turning over in bed, upon first awakening or turning the head in a car.

Causes - BPPV can be spontaneous or can occur after head trauma. It occurs when the “crystals” (otoconia) that float in the fluid within the semicircular canals are in an abnormal position. This leads to inappropriate stimulation of the vestibular system and a false sense of movement.

Diagnosis – In the Dix-Hallpike Test, the patient's head is turned 45 degrees to the side, and the patient is placed rapidly from a sitting to supine (laying down) position. The patient's eyes are observed and if the test elicits certain specific movement patterns from the eyes (nystagmus) which fatigue within 1 to 2 minutes, the test can be deemed positive. The key in diagnosing this entity is the fatigability of the eye movement.

Treatment – After a positive test is elicited, an Epley Maneuver or Canalith Repositioning Procedure / Treatment (CRT) is performed. This consists of specific sequence of placing the head in specific positions that have been proven to reposition the otoconia in their appropriate anatomic location. The success of this procedure is approximately 85% to 90%.

2. Perilymphatic Fistula / Barotrauma

Symptoms – A sense of spinning that is sometimes initially persistent, but then becomes episodic thereafter and occurs with a change in pressure or loud sound.

Causes – Rapid change in pressure secondary to an ascent or descent while in flight, diving, traumatic injury to the head or other event.

Diagnosis – Diagnosis is mostly based on history. However, it is confirmed through an otoscope examination when the doctor insufflates the ear drum by placing airflow into the external canal moving air across the ear drum. The movement of the ear drum leads to a change in pressure across it. This change in pressure elicits vertigo.

Treatment – Conservative treatment consists of bedrest and stool softeners to allow for the fistula to heal itself. Should the fistula persist, it may be necessary to repair the fistula through a middle ear exploration procedure. More recent research has introduced a new procedure in which autologous blood can be injected into the middle ear space. Should hearing loss also be present, oral steroids may be introduced.

3. Superior semicircular canal dehiscence

Symptoms – A sense spinning or movement / fluttering up and down, hearing loss, autophony (the sense of hearing themselves as an echo), and pulsatile tinnitus.

4. Acoustic Neuroma

5. Migraine Associate vertigo

6. Meniere's Disease

7. Labyrinthitis

8. Vestibular Neuronitis

9. Multiple Sclerosis

10. Mal D'Embarquement

11. Pontine Infarction

Imbalance

Definition

Causes of Imbalance

Balance is the result of a communication between the inner ear (peripheral), the musculoskeletal and peripheral neurologic systems, vision and the brain (central). The dysfunction of any of these entities results in varying degrees of imbalance. It is important to take into account each of these systems in order to properly diagnose and treat the patient. Multiple medications including anti-depressants, muscle relaxants and anxiolytics can affect balance.

Light Headedness

Testing of the Vestibular System

Dix-Hallpike Examination

VNG

Postural Testing

Electrocochleography

VEMP (vestibular evoked myogenic potentials)