Tinnitus

Gordon Shields, MD
Faculty Advisor: Francis B. Quinn, Jr., MD
The University of Texas Medical Branch
Department of Otolaryngology
Grand Rounds Presentation
January 22, 2003
“…only my ears whistle and buzz continuously day and night. I can say I am living a wretched life.”

Ludwig Von Beethoven - 1801
Tinnitus

• Definition
• Classification
• Objective tinnitus – pulsatile
• Subjective tinnitus
• Theories
• Evaluation
• Treatment
Introduction

• Tinnitus - “The perception of sound in the absence of external stimuli.”
• Tinnere – means “ringing” in Latin
• Includes Buzzing, roaring, clicking, pulsatile sounds
Tinnitus

- May be perceived as unilateral or bilateral
- Originating in the ears or around the head
- First or only symptom of a disease process or auditory/psychological annoyance
Tinnitus

- 40 million affected in the United States
- 10 million severely affected
- Most common in 40-70 year-olds
- More common in men than women
Classification

- **Objective tinnitus** – sound produced by paraauditory structures which may be heard by an examiner

- **Subjective tinnitus** – sound is only perceived by the patient (most common)
Tinnitus

- Pulsatile tinnitus – matches pulse or a rushing sound
  - Possible vascular etiology
  - Either objective or subjective
  - Increased or turbulent bloodflow through paraauditory structures
Objective - Pulsatile tinnitus

- Arteriovenous malformations
- Vascular tumors
- Venous hum
- Atherosclerosis
- Ectopic carotid artery
- Persistent stapedial artery
- Dehiscent jugular bulb
- Vascular loops
- Cardiac murmurs
- Pregnancy
- Anemia
- Thyrotoxicosis
- Paget’s disease
- Benign intracranial hypertension
Arteriovenous malformations

- Congenital lesions
- Occipital artery and transverse sinus, internal carotid and vertebral arteries, middle meningeal and greater superficial petrosal arteries
- Mandible
- Brain parenchyma
- Dura
Arteriovenous malformations

• Pulsatile tinnitus
• Headache
• Papilledema
• Discoloration of skin or mucosa
Vascular tumors

• Glomus tympanicum
  – Paraganglioma of middle ear
  – Pulsatile tinnitus which may decrease with ipsilateral carotid artery compression
  – Reddish mass behind tympanic membrane which blanches with positive pressure
  – Conductive hearing loss
Vascular tumors

- Glomus jugulare
  - Paraganglioma of jugular fossa
  - Pulsatile tinnitus
  - Conductive hearing loss if into middle ear
  - Cranial neuropathies
Venous hum

- Benign intracranial hypertension
- Dehiscent jugular bulb
- Transverse sinus partial obstruction
- Increased cardiac output from
  - Pregnancy
  - Thyrotoxicosis
  - Anemia
Benign Intracranial Hypertension

- Young, obese, female patients
- Hearing loss
- Aural fullness
- Dizziness
- Headaches
- Visual disturbance
- Papilledema, pressure >200mm H2O on LP
Benign Intracranial Hypertension

- Sismanis and Smoker 1994
  - 100 patients with pulsatile tinnitus
  - 42 found to have BIH syndrome
  - 16 glomus tumors
  - 15 atherosclerotic carotid artery disease
BIH Syndrome

- Treatment
  - Weight loss
  - Diuretics
  - Subarachnoid-peritoneal shunt
  - Gastric bypass for weight reduction
Muscular Causes of Tinnitus

• Palatal myoclonus
  – Clicking sound
  – Rapid (60-200 beats/min), intermittent
  – Contracture of tensor palantini, levator palatini, levator veli palatini, tensor tympani, salpingopharyngeal, superior constrictors
  – Muscle spasm seen orally or transnasally
  – Rhythmic compliance change on tympanogram
Myoclonus

• Palatal myoclonus associations:
  – Multiple Sclerosis and other degenerative neurological disorders
  – Small vessel disease
  – Tumors

• treatments: muscle relaxants, botulinum toxin injection
Stapedius Muscle Spasm

• Idiopathic stapedial muscle spasm
  – Rough, rumbling, crackling sound
  – Exacerbated by outside sounds
  – Brief and intermittent
  – May be able to see tympanic membrane movement
  – Treatments: avoidance of stimulants, muscle relaxants, sometimes surgical division of tensor tympani and stapedius muscles
Patulous Eustachian Tube

- Eustachian tube remains open abnormally
- Ocean roar sound
- Changes with respiration
- Lying down or head in dependent position provides relief
Patulous Eustachian Tube

- Tympanogram will show changes in compliance with respiration
- Significant weight loss, radiation to the nasopharynx
- Previous treatments: caustics, mucosal irritants, saturated solution of potassium iodide, Teflon or gelfoam injection around torus tubarius
Subjective Tinnitus

- Much more common than objective
- Usually nonpulsatile

- Presbycusis
- Noise exposure
- Meniere’s disease
- Otosclerosis
- Head trauma
- Acoustic neuroma
- Drugs
- Middle ear effusion
- TMJ problems
- Depression
- Hyperlipidemia
- Meningitis
- Syphilis
Conductive hearing loss

- Conductive hearing loss decreases level of background noise
- Normal paraauditory sounds seem amplified
- Cerumen impaction, otosclerosis, middle ear effusion are examples
- Treating the cause of conductive hearing loss may alleviate the tinnitus
Other subjective tinnitus

- Poorly understood mechanisms of tinnitus production
- Abnormal conditions in the cochlea, cochlear nerve, ascending auditory pathways, auditory cortex
- Hyperactive hair cells
- Chemical imbalance
CNS Mechanisms

- Reorganization of central pathways with hearing loss (similar to phantom limb pain)
- Disinhibition of dorsal cochlear nucleus with increase in spontaneous activity of central auditory system
Neurophysiologic Model

- Proposed by Jastreboff
- Result of interaction of subsystems in the nervous system
- Auditory pathways playing a role in development and appearance of tinnitus
- Limbic system responsible for tinnitus annoyance
- Negative reinforcement enhances perception of tinnitus and increases time it is perceived
Role of Depression

• Depression is more prevalent in patients with chronic tinnitus than in those without tinnitus.

• Folmer et al (1999) reported patients with depression rated the severity of their tinnitus higher although loudness scores were the same.

• Which comes first, depression or tinnitus?
Drugs that cause tinnitus

- Antinflammatories
- Antibiotics (aminoglycosides)
- Antidepressants (heterocyclines)
- Aspirin
- Quinine
- Loop diuretics
- Chemotherapeutic agents (cisplatin, vincristine)
Evaluation - History

- Careful history
- Quality
- Pitch
- Loudness
- Constant/intermittent
- Onset
- Alleviating/aggravating factors
Evaluation - History

- Infection
- Trauma
- Noise exposure
- Medication usage
- Medical history
- Hearing loss
- Vertigo
- Pain
- Family history
- Impact on patient
Evaluation – Physical Exam

- Complete head & neck exam
- General physical exam
- Otoscopy (glomus tympanicum, dehiscent jugular bulb)
- Search for audible bruit in pulsatile tinnitus
  - Auscultate over orbit, mastoid process, skull, neck, heart using bell and diaphragm of stethoscope
  - Toynbee tube to auscultate EAC
Evaluation – Physical Exam

- Light exercise to increase pulsatile tinnitus
- Light pressure on the neck (decreases venous hum)
- Valsalva maneuver (decrease venous hum)
- Turning the head (decrease venous hum)
Evaluation - Audiometry

- PTA, speech discrimination scores, tympanometry, acoustic reflexes
- Pitch matching
- Loudness matching
- Masking level
Evaluation - Audiometry

- Vascular or palatomyoclonus induced tinnitus – graph of compliance vs. time
- Patulous Eustachian tube – changes in compliance with respiration
- Asymmetric sensorineural hearing loss or speech discrimination, unilateral tinnitus suggests possible acoustic neuroma - MRI
Laboratory studies

• As indicated by history and physical exam
• Possibilities include:
  – Hematocrit
  – FTA absorption test
  – Blood chemistries
  – Thyroid studies
  – Lipid battery
Imaging

- Pulsatile tinnitus
- Reviewed by Weissman and Hirsch (2000)
- Contrast enhanced CT of temporal bones, skull base, brain, calvaria as first-line study
- Sismanis and Smoker (1994) recommended CT for retrotympanic mass, MRI/MRA if normal otoscopy
• Glomus tympanicum – bone algorithm CT scan best shows extent of mass
• May not be able to see enhancement of small tumor
• Tumor enhances on T1-weighted images with gadolinium or on T2-weighted images
Glomus Tympanicum

Glomus Tympanicum

Imaging

• Glomus jugulare
  – Erosion of osseous jugular fossa
  – Enhance with contrast, may not be able to differentiate jugular vein and tumor
  – Enhance with T1-weighted MRI with gadolinium and on T2-weighted images
  – Characteristic “salt and pepper” appearance on MRI
Glomus jugulare

Glomus jugulare

“salt and pepper appearance”

Imaging

- Arteriovenous malformations – readily apparent on contrasted CT and MRI
- Normal otoscopic exam and pulsatile tinnitus may be dural arteriovenous fistula
  - Often invisible on contrasted CT and MRI/MRA
  - Angiography may be only diagnostic test
Imagining

  - MRI/MRA initially if subjective pulsatile tinnitus
  - Angiography if objective with audible bruit in order to identify dural arteriovenous fistula
Imaging

- Other contrast enhanced CT diagnoses
- Aberrant carotid artery
- Dehiscent carotid artery
- Dehiscent jugular bulb
- Persistent stapedial artery
  - Soft tissue on promontory
  - Enlargement of facial nerve canal
  - Absence of foramen spinosum
Persistent Stapedial Artery

Imaging

• Acoustic Neuroma
  – Unilateral tinnitus, asymmetric sensorineural hearing loss or speech discrimination scores
  – T1-weighted MRI with gadolinium enhancement of CP angle is study of choice
  – Thin section T2-weighted MRI of temporal bones and IACs may be acceptable screening test
Acoustic Neuroma

Acoustic Neuroma

Imaging

• Benign intracranial hypertension
  – MRI
  – Small ventricles
  – Empty sella
BIH – Empty Sella

Treatments

• Multiple treatments
• Avoidance of dietary stimulants: coffee, tea, cola, etc.
• Smoking cessation
• Avoid medications known to cause tinnitus
• Reassurance
• White noise from radio or home masking machine
Treatments - Medicines

• Many medications have been researched for the treatment of tinnitus:
  – Intravenous lidocaine suppresses tinnitus but is impractical to use clinically
  – Tocainide is oral analog which is ineffective
  – Carbamazepine ineffective and may cause bone marrow suppression
Treatments - Medicines

- **Alprazolam (Xanax)**
  - Johnson et al (1993) found 76% of 17 patients had reduction in the loudness of their tinnitus using both a tinnitus synthesizer and VAS (dose 0.5mg-1.5 mg/day)
  - Dependence problem, long-term use is not recommended
Treatments - Medicines

- **Nortriptyline and amitriptyline**
  - May have some benefit
  - Dobie et al reported on 92 patients
  - 67% nortriptlyine benefit, 40% placebo

- **Ginko biloba**
  - Extract at doses of 120-160mg per day
  - Shown to be effective in some trials and not in others
  - Needs further study
Treatments

- Hearing aids – amplification of background noise can decrease tinnitus
- Maskers – produce sound to mask tinnitus
- Tinnitus instrument – combination of hearing aid and masker
Treatments

• Tinnitus Retraining Therapy
  – Based on neurophysiologic model
  – Combination of masking with low level broadband noise for several hours per day and counseling to achieve habituation of the reaction to tinnitus and perception of the tinnitus itself
Treatments

• Electrical stimulation of the cochlea
  – Transcutaneous, round window, promontory stimulation have all been tried
  – Direct current can cause permanent damage
  – Steenersen and Cronin have used transcutaneous stimulation of the auricle and tragus decreasing tinnitus in 53% of 500 patients
Treatments

• Cochlear implants
  – Have shown some promise in relief of tinnitus
  – Ito and Sakakihara (1994) reported that in 26 patients implanted who had tinnitus 77% reported either tinnitus was abolished or suppressed, 8% reported worsening
Treatments

• Surgery

  – Used for treatment of arteriovenous malformations, glomus tumors, otosclerosis, acoustic neuroma

  – Some authors have reported success with cochlear nerve section in patients who have intractable tinnitus and have failed all other treatments, this is not widely accepted
Treatments

- Biofeedback
- Hypnosis
- Magnetic stimulation
- Acupuncture
- Conflicting reports of benefit
Conclusions

• Tinnitus is a common problem with an extensive differential
• Need to identify medical process if involved
• Pulsatile/Nonpulsatile is important distinction
• Will only become more common with aging of our population
• Research into mechanism and treatments is needed to better help our patients