Conductive Hearing Loss

Abraham Jacob, MD

Department of Otolaryngology – Head & Neck Surgery
Otology, Neurotology, and Cranial Base Surgery
The Ohio State University

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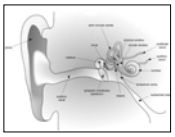
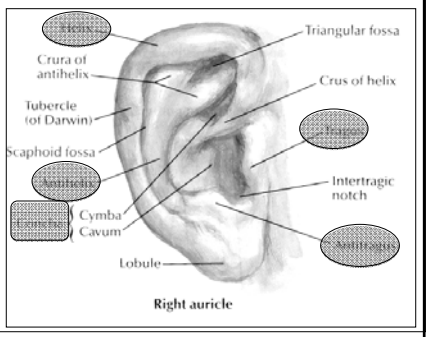
Temporal Bone Anatomy – External Ear

Pinna/Auricle





Objectives

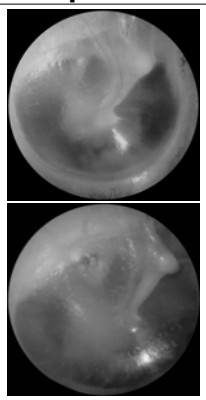
- To understand the basic functional anatomy of the ear
- To describe components of a comprehensive audiogram and define conductive hearing loss by audiometric and physical exam parameters
- To recall the common causes of conductive hearing loss and appreciate their medical/surgical management
- To describe options for aural rehabilitation in patients with conductive hearing loss

Temporal Bone Anatomy – External Ear

The External Auditory Canal

- Body's only skin-lined cul-de-sac
- Keratinizing stratified squamous epithelium
- 2.5 cm long
- 1/3 cartilaginous; 2/3 bony
- The cartilaginous ear canal has hair follicles, sebaceous glands, and ceruminous glands
- The bony ear canal has skin directly overlying periosteum

Temporal Bone Anatomy – External Ear



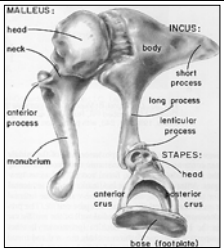
The Tympanic Membrane

- **The tympanic membrane has 3 layers**
  - ✓ **Squamous, fibrous and mucosal layers**
- **Made up of the pars tensa and pars flaccida**
- **Visible light reflexes during otoscopy are the primary and secondary light reflex**

Temporal Bone Anatomy – Middle Ear Space

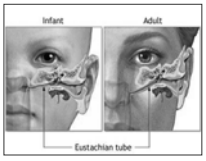
- **Mesotympanum**
- **Epitympanum**
- **Protympanum**
- **Hypotympanum**

Temporal Bone Anatomy – Middle Ear Ossicles



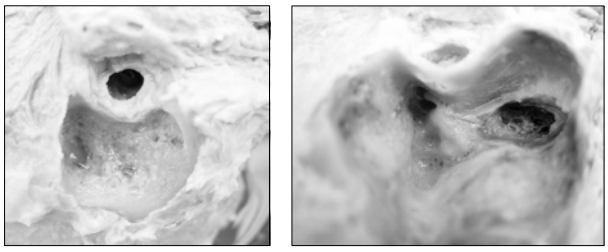
- **Malleus**: umbo, manubrium, head, neck, anterior and lateral processes
- **Incus**: body, short process, long process, and lenticular process
- **Stapes**: head, footplate and two crura

Temporal Bone Anatomy – Eustachian Tube



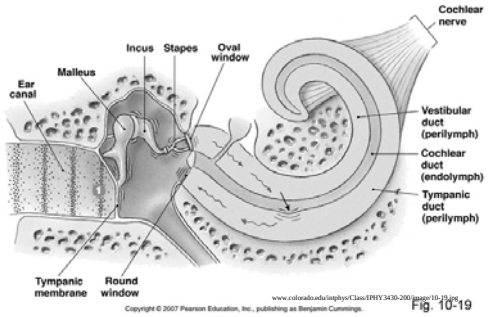
- **Connects protympanum (ME) to nasopharynx (NP)**
- **Medial 2/3 fibrocartilage; lateral 1/3 bony**
- **Equalizes ME pressure with atmospheric pressure**
- **Lined with respiratory epithelium**
  - ✓ **Mucociliary clearance towards the NP**
- **Usually closed to prevent reflux of NP contents into ME**
  - ✓ **Opens during palate movement**
- **13 mm @ birth; 36 mm in adulthood**
- **More horizontal at birth; elongates and descends over time**

Temporal Bone Anatomy – The Mastoid Region

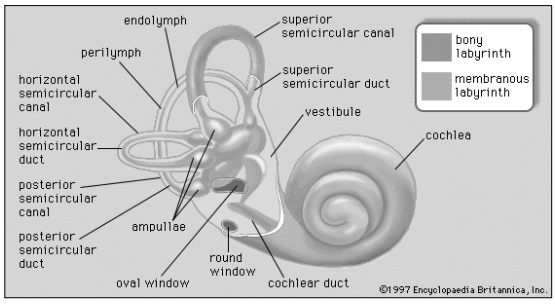


- **The mastoid region of the temporal bone is posterior to the bony ear canal**
- **Surgical landmarks include the tegmen, sinodural angle, sigmoid sinus, horizontal semicircular canal, incus, & the vertical segment of the facial nerve**

Physiology of Hearing



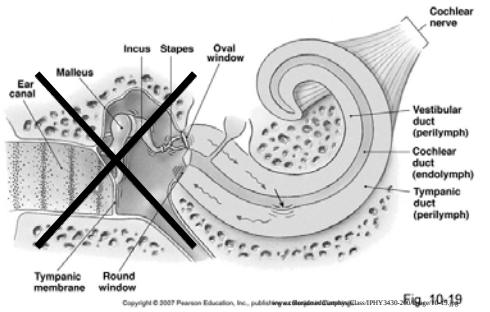
Temporal Bone Anatomy – The Inner Ear



Hearing mechanism: Cochlea

Balance mechanism: Utricle, saccule, and 3 semicircular canals

Conductive Hearing Loss!



Sensorineural Hearing Loss!

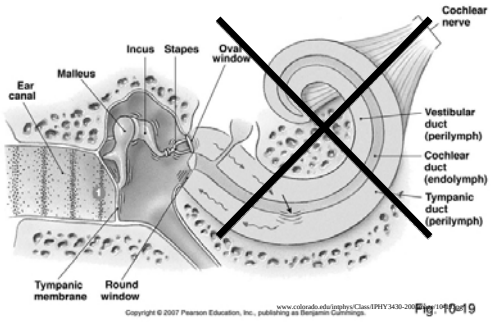


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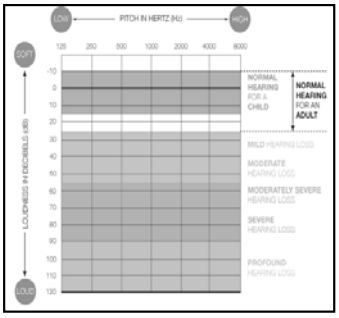
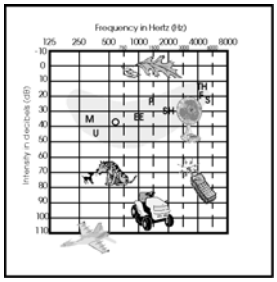
Fig. 10-19

The Normal Audiogram





Mixed Hearing Loss!

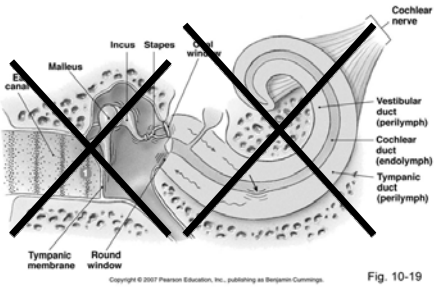


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Fig. 10-19

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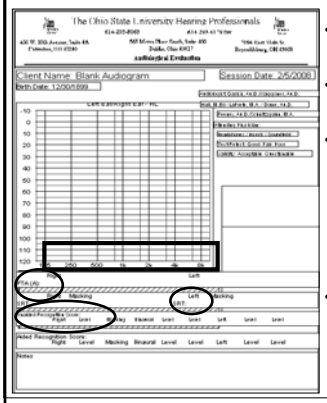
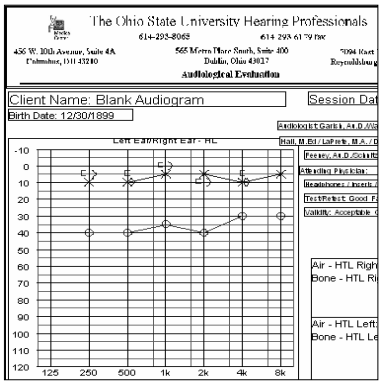
The Normal Audiogram



- **PTA (pure tone average): An average for pure tone thresholds at 500, 1000, and 2000Hz**
- **4-tone PTA: An average for pure tone thresholds at 500, 1000, 2000 and 3000Hz**
- **SRT (speech reception threshold)**
  - **Uses spondee words having equal emphasis on each of 2 syllables**
  - **Threshold should agree within 7 dB of PTA**
  - **Usually lower threshold than PTA (our auditory system is more sensitive to spoken words than to tones**
- **WRS (word recognition score): uses standardized phonemically balanced words representing phonemes in the English language**
  - **Reported as % correct**

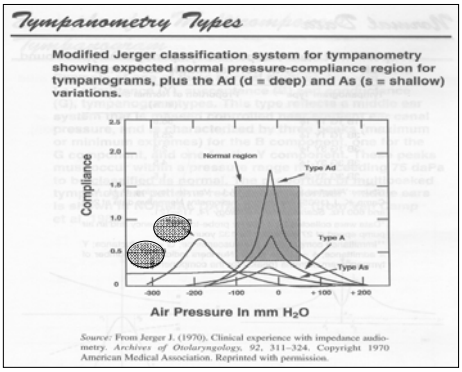
Audiometry – Conductive Hearing Loss



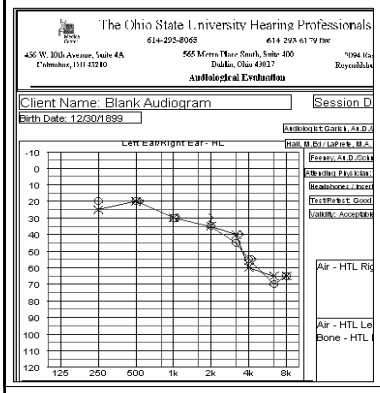
Air Conduction Stimuli (sounds): delivered by over-the-ear or insert earphones

Bone Conduction Stimuli: delivered through a bone conduction vibrator placed on mastoid region

Immittance Testing: Tympanogram



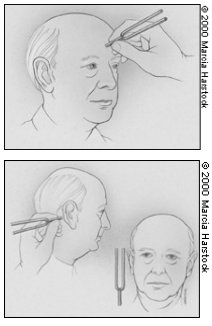
Audiometry – Sensorineural Hearing Loss



Air Conduction Stimuli (sounds): delivered by over-the-ear or insert earphones

Bone Conduction Stimuli: delivered through a bone conduction vibrator placed on mastoid region

Tuning Fork Tests



- **Used to confirm audiogram results (512 Hz tuning fork)**
- **Weber: Lateralizes to the poorer ear with a conductive HL or the better ear with sensorineural hearing loss**
- **Rinne: A positive Rinne indicates that air conduction is greater than bone conduction. A negative Rinne indicates that bone conduction is greater than air conduction**

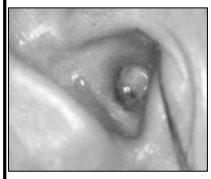
Causes of Conductive Hearing Loss

Foreign Bodies in the Ear Canal

- Objects
  - ✓ Plastic toys or beads; Cotton, paper
  - ✓ Insects
  - ✓ Organic material (popcorn kernels or vegetable material)
  - ✓ Button batteries (caustic!)
  - ✓ Ear wax (cerumen impaction)
- Symptoms: pain, ear drainage, conductive hearing loss
- Treatment: Removal
  - ✓ Risks tympanic membrane injury
  - ✓ Kill live insects rubbing alcohol or mineral oil
  - ✓ Use otologic microscopes with microinstruments and suction
  - ✓ Ear irrigation (do not use if organic foreign body or button battery)
  - ✓ Otic antibiotic drops

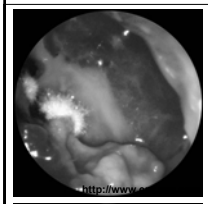
Diseases of the External Auditory Canal

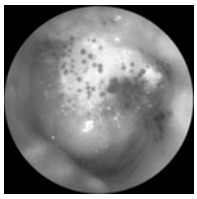
Otitis Externa



- Inflammation of the external auditory canal
  - ✓ acute and chronic types
- Ear canal defenses
  - ✓ Cerumen
    - Acidic
    - Contains lysozyme and immunoglobulins
    - Lipid rich and forms a moisture barrier for underlying skin
  - ✓ Epithelial migration from center of tympanic membrane outward (0.07 mm/day) to meatus
  - ✓ Curvature of the ear canal
- Excessive moisture predisposes OE
  - ✓ elevates can pH
  - ✓ removes ear wax
  - ✓ keratin debris absorbs moisture and creates medium for microbial growth

Otitis Externa

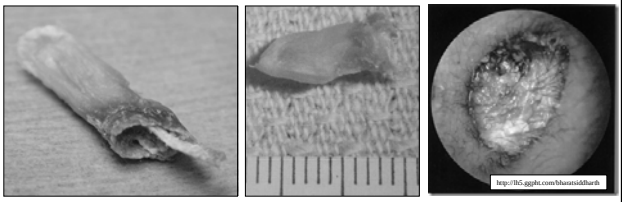




- Majority of OE is bacterial but OE can also be fungal
  - ✓ Staphylococcus aureus and Pseudomomnas aeruginosa – common bacteria
  - ✓ Candida and aspergillus – common fungi
- Presenting symptoms: pruritis to severe pain; ear drainage; conductive hearing loss
  - ✓ Can require narcotics to control the pain
- Treatment
  - ✓ Aural debridement +/- ear wick
  - ✓ Ototopical antibiotic/antifungal drops
  - ✓ Systemic antibiotics for immunocompromised patients
  - ✓ Do not irrigate the ear canal if the status of the ear drum is unknown

Keratosis Obturans

- Disruption of normal epithelial migration in the ear canal
  - Results in a cast of skin debris and wax
  - Can cause remodeling/erosion of underlying bone
- Results in aural fullness, conductive hearing loss, and can otitis externa



Otitis Externa

2% Acetic acid otic solution (VoSol)
With hydrocortisone (VoSol HC Otic)
With aluminum acetate (Otic Domeboro)

Neomycin otic solutions and suspensions
With polymyxin B–hydrocortisone (Cortisporin)
With hydrocortisone-thonzonium (Coly-Mycin S)

Polymyxin B–hydrocortisone (Otobiotic)

Quinolone otic products
Ofloxacin 0.3% solution (Floxin Otic)
Ciprofloxacin 0.3% and hydrocortisone suspension (Cipro HC Otic)

Quinolone ophthalmic solutions
Ofloxacin 0.3% (Ocuflox)
Ciprofloxacin 0.3% (Ciloxan)

Aminoglycoside ophthalmic solutions
Gentamicin sulfate 0.3% (Garamycin)
Tobramycin sulfate 0.3% (Tobrex)

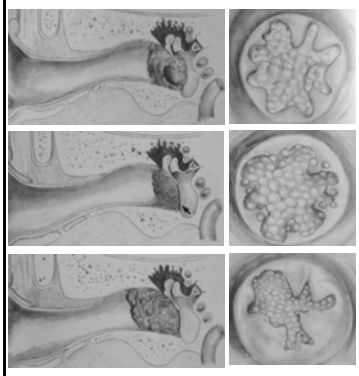
Antifungal

Antibacterial

Keratosis Obturans - Treatment

- Frequent aural debridement
- STRICT dry ear precautions
- Treat underlying infections
  - ➢Ototopical antibiotic/antifungal drops
- Treat underlying skin conditions
  - ➢Eczema
  - ➢Atopic dermatitis
  - ➢Seborrheic dermatitis
  - ➢Psoriasis

Acquired Ear Canal Stenosis

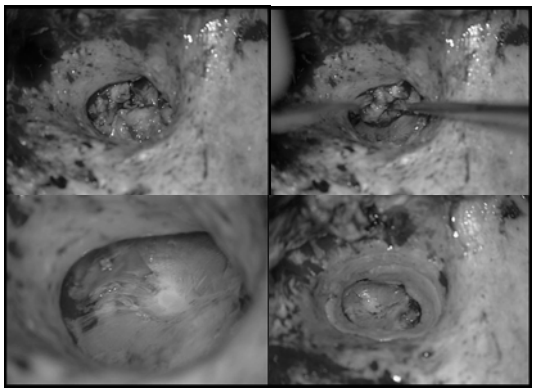


- Formation of a fibrous plug in the ear canal with recurrent ear drainage and progressive conductive hearing loss
- Etiology unknown
  - ? Dermatologic condition
  - ? Fungal infection
  - ? Abnormal wound healing response
- Treatment options
  - Non-intervention
  - Conventional hearing aids
  - Bone anchored hearing aids
  - Surgical excision of scar with canal reconstruction

Congenital Ear Canal Atresia

- Failure in development of the external auditory canal
- Spectrum of severity
  - Complete
  - Stenosis (narrow canal)
- Epidemiology
  - 1:10,000-20,000
  - 3-6:1 Unilateral
  - R > L
  - M > F
- Etiology unknown
- Adjacent regions may be affected
  - Syndromes: Goldenhar, Treacher-Collins, Hemifacial microsomia

Tympanoplasty with canalplasty and split thickness skin grafting



Congenital Atresia Surgery

Congenital Atresia Surgery: Pearls

- Stay anterior (near TMJ) and superior (near tegmen/ middle fossa dura) when drilling open the ear canal
- Avoid entering mastoid air cells
- Careful dissection of atretic plate (without drill) after indentifying incus
- Avoid prosthetics if possible
- Fashion 1.5 cm diameter canal
- Silastic button to prevent lateralization of ear drum reconstruction
- Center meatus by mobilizing the auricle as needed

Atresia Surgery: Complications

- Re-stenosis – 4-12%
- Infection
- Facial nerve injury
- Hearing loss – 12-28%
  - ✓ Scar, lateralization, OCR, OM

Atresia Surgery: Outcomes

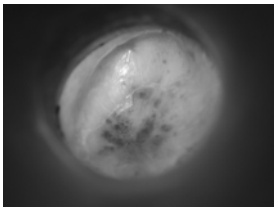
- Goal - restore hearing to an SRT (speech reception threshold) of 15-25 dB.
- Approximately 50% of patients have an SRT less than 25 dB after surgery.
- 1/3 of patients require revision surgery for hearing loss
  - ✓ Approximately 50% obtain an SRT of ≤ 25 dB
  - ✓ Approximately 66% obtain an SRT of ≤ 30 dB

Tympanic Membrane and/or Middle Ear Pathology

The Middle Ear Impedance Matching System

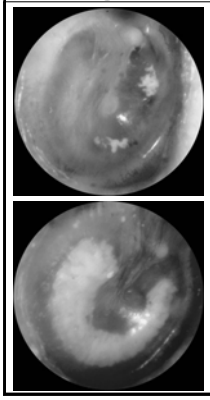
- The impedance of fluid in the cochlea is 30 times that of air
- If sound were applied directly to the oval window (at the stapes footplate), about 97% would be reflected.
- The lever formed by the malleus and incus has a pivot point farther from the tympanic membrane than from the stapes at a ratio of 1.3:1
- The area of the pars tensa is 0.55 cm^2, whereas that of the oval window is only 0.032 cm^2.
- The area difference (16x) and the lever arm (1.3), create a 21-fold (about 13 dB) increase in pressure from tympanic membrane to the oval window membrane (under the stapes footplate).
- With an ear drum and intact ossicular chain, 60% of the signal is transmitted as compared to 3% transmission without a tympanic membrane and ossicles.

Chronic Granular Myringitis



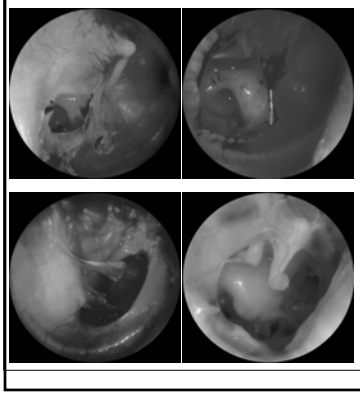
- Inflammation with mucosalization of the ear drum surface
  - Can have progressive involvement of the ear canal
  - Leads to chronic canal wetness and pruritis
- Progressive tympanic membrane thickening impedes vibration
  - Leads to conductive hearing loss
- Treatment: similar to otitis externa; may require surgical excision

Tympanosclerosis



- Hyalinization of the middle layer of the ear drum and/or the middle ear mucosa
  - ✓ Analogous to scarring
- Common in patients with recurrent otitis media and patients with history of tubes
- Stiffens the tympanic membrane, impairing vibration
  - ✓ Can result in mild conductive hearing loss
- Easily distinguished from cholesteatoma when examiner has 3-D view using a binocular otologic microscope
- No treatment required

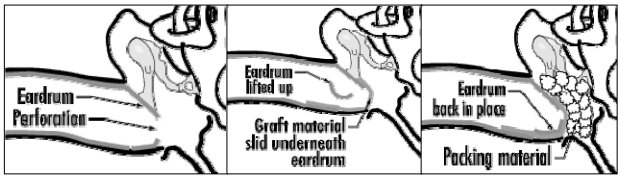
Tympanic Membrane Perforation



- Variable degrees of conductive hearing loss
  - ✓ Typically 20-30 dB
- Large perforation or anterior/marginal perforations are more difficult to repair
- Treatment: Tympanoplasty

Tympanic Membrane Repair

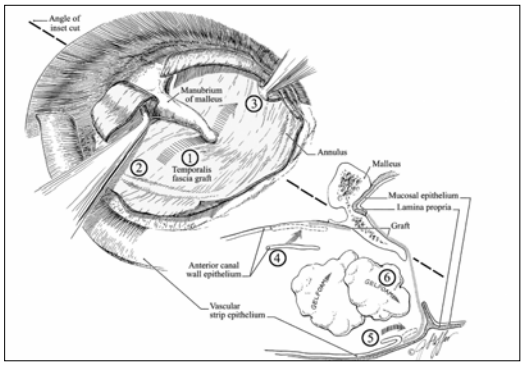
- Paper patch myringoplasty
- Fat myringoplasty
- Underlay tympanoplasty (medial graft technique)



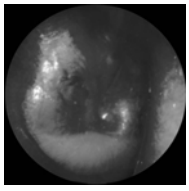
Eustachian Tube Dysfunction (ETD)

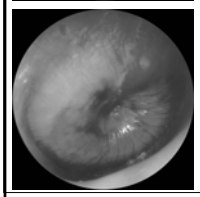
- **ETD is** central **to the development of middle ear pathology**
  - ✓ **Lack of middle ear ventilation**
- **Specific diseases caused by ETD**
  - ✓ **Acute otitis media**
  - ✓ **Recurrent acute otitis media (ROM)**
  - ✓ **Otitis media with effusion**
  - ✓ **Middle ear atelectasis**
  - ✓ **Chronic suppurative otitis media with and without cholesteatoma**
    - **Ossicular erosion or discontinuity**

Underlay Tympanoplasty



Acute Otitis Media (AOM)





- **Between 1993 and 1995, OM was the most common diagnosis at physician visits in the US (> 10,000,000 visits for 1-4 yr olds)**
- **The diagnosis of AOM requires**
  - ✓ **History of acute onset signs and symptoms**
  - ✓ **Presence of middle ear effusion (MEE)**
  - ✓ **Signs and symptoms of middle ear inflammation**
- **The presence of MEE is indicated by**
  - ✓ **A bulging tympanic membrane**
  - ✓ **Limited or absent tympanic membrane mobility**
  - ✓ **Air-fluid level behind the TM**
  - ✓ **Otorrhea (drainage from the ear)**
- **Signs of middle ear inflammation include:**
  - ✓ **Erythema of the tympanic membrane**
  - ✓ **Otalgia (ear pain)**

Recurrent Acute Otitis Media

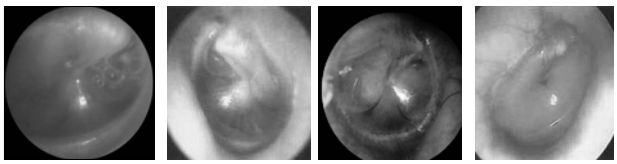
- Multiple bouts of acute otitis media with complete resolution between episodes

Etiology of Acute & Recurrent Acute Otitis Media

• S. pneumoniae	25 -50%
• H. influenzae	20-25%
• M. catarrhalis	10-20%
• S. pyogenes (gr. A)	2-5%
• S. aureus	1%
• Other	6%
• No growth	up to 35%

Otitis Media with Effusion (OME)

- Middle ear filled with serous or mucoid fluid
- No purulence
- Often present after acute otitis media is treated appropriately with antibiotics
- Most middle ear effusions will clear within 3 months



Etiology of OME

- 50% sterile to culture
  - ✓ Molecular techniques find bacterial products
- When culture +, similar to AOM

Risk Factors for Otitis Media

- **Host**
  - Race or ethnic group
  - Age, age at onset
  - Family history, genes
  - Male gender
  - Lower socioeconomic status
  - Low antibody levels
  - Low birth weight or premature
  - Anatomy (Eustachian tube, cleft palate, Down syndrome)
  - Male ☐ female rates for OM, OME
- **Environment**
  - Day care, exposure to children
  - Formula feeding, supine feeding
  - Exposure to smokers
  - Supine sleeping
  - Pacifier use
  - Season, season of birth
  - Nutrition

Antibiotic Treatment: Consensus Recommendations

- 1st line: amoxicillin at 80-90 mg/kg/day (given BID)
- 2nd line: high dose amoxicillin/clav (90 mg/kg)
- 3rd line ceftriaxone
- Encourage tympanocentesis
- Prevnar (PCV7) for all children < 2 and older children at risk

AMERICAN ACADEMY OF PEDIATRICS
AMERICAN ACADEMY OF FAMILY PHYSICIANS
Subcommittee on Management of Acute Otitis Media
CLINICAL PRACTICE GUIDELINE
Diagnosis and Management of Acute Otitis Media

RECOMMENDATION 4: *If the patient fails to respond to the initial management option within 48 to 72 hours, the clinician must reassess the patient to confirm AOM and exclude other causes of illness. If AOM is confirmed in the patient initially managed with observation, the clinician should begin antibacterial therapy. If the patient was initially managed with an antibacterial agent(s), the clinician should change the antibacterial agent(s). (This recommendation is based on observational studies and a preponderance of benefit over risk.)*

Hoberman et al. *Clin Peds*, 2002

Medical Management of Acute Otitis Media

AMERICAN ACADEMY OF PEDIATRICS
AMERICAN ACADEMY OF FAMILY PHYSICIANS
Subcommittee on Management of Acute Otitis Media
CLINICAL PRACTICE GUIDELINE
Diagnosis and Management of Acute Otitis Media

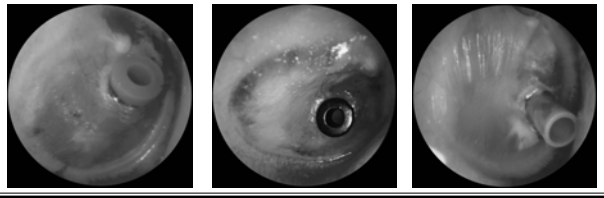
TABLE 4. Criteria for Initial Antibacterial Agent Treatment or Observation in Children With Acute Otitis Media

Age	Certain Diagnosis	Uncertain Diagnosis
<6 mo	Antibacterial therapy	Antibacterial therapy
6 mo–2 y	Antibacterial therapy	Antibacterial therapy if severe illness; observation option* if non-severe illness
≥2 y	Antibacterial therapy if severe illness; observation option* if non-severe illness	Observation option*

This table was modified with permission from the New York State Department of Health and the New York Region Otitis Project Committee.[32,33]
*Observation is an appropriate option only when follow-up can be ensured and antibacterial agents started if symptoms persist or worsen.
Nonsevere illness is mild otalgia and fever <39°C in the past 24 hours. Severe illness is moderate to severe otalgia or fever ≥39°C.
A certain diagnosis of acute otitis media meets all 3 criteria: 1) rapid onset, 2) signs of middle-ear effusion, and 3) signs and symptoms of middle-ear inflammation.

Tympanostomy Tubes

- 4 episodes of AOM in 6 months or 6-7 episodes in 1 year
- In the US, chronic OME > 3mos with hearing loss and/or speech delay is an indication for tympanostomy tube placement
- Suppurative complications of otitis media
- Special populations at increased risk for speech/language delay
- Consider adenoidectomy at 2nd set of tubes, not primary treatment
  - ✓ Except with concurrent nasal disease

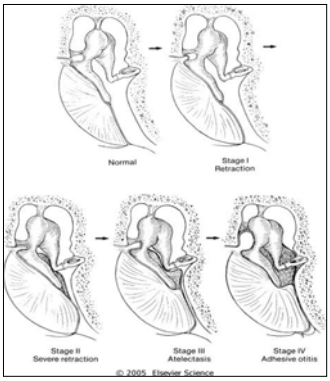


Risk Factors for additional tube insertions

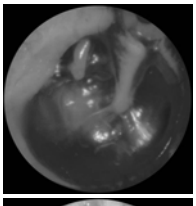
- **Age under 18 months at initial surgery**
  - ✓ **26% reinsertion rate vs. 16%; p<0.05**
- **Craniofacial deformity**
- **Family history of ENT surgery**
- **Concurrent adenoidectomy at 2nd set of tubes reduced need for additional tubes by 3-fold (8% vs 42%), p<0.001**

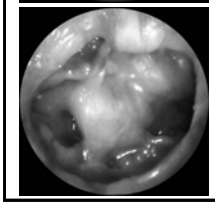
Boston M et al, *Arch OTO-HNS*. 2003

Middle Ear Atelectasis



Middle Ear Atelectasis



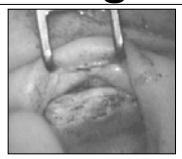
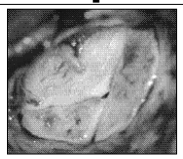


- **Results from eustachian tube dysfunction**
- **Negative pressure (vacuum) in the middle ear**
- **Tympanic membrane becomes flaccid and drapes onto underlying structures**
  - ✓ **Can be mis-diagnosed as a perforation when using hand-held otoscope (with a one-eyed, 2-D view)**
- **Causes variable degrees of conductive hearing loss**

Middle Ear Atelectasis

- **Patient is at risk for** cholesteatoma **due to skin accumulation within retraction pockets**
- **Drum contact with the incus and/or stapes results in progressive** incudostapedial (IS) joint erosion
- **TM is flaccid and non-vibratory – causes variable degrees of conductive hearing loss**
- **Treatment**
  - ✓ **Early ME atelectasis may be treatable with tympanostomy tubes**
  - ✓ **Severe atelectasis requires removal of the flaccid ear drum and replacement using cartilage (cartilage tympanoplasty)**
    - **This adds rigidity to the drum but at the expense of vibratory capacity (as compared with a normal ear drum)**

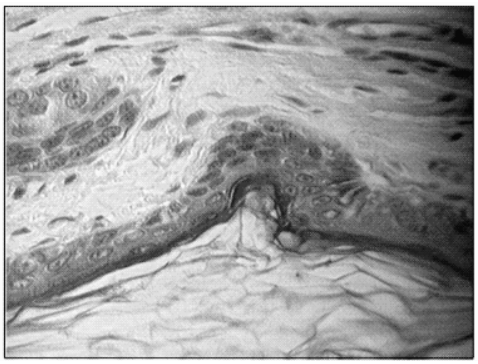
Cartilage Tympanoplasty

- Skin incision on the medial side of tragus - leaving 2 mm of tragal cartilage lateral to cartilage incision
- Can get > 1 cm of flat cartilage
- Can be thinned as needed with a KURZ cartilage-cutting knife
- Can be harvested with or without perichondrium
- Cartilage pallisade technique – precise placement of cartilage to prevent atelectasis and ear drum retraction

Dornhoffer 2003 Murbe D 2002

Cholesteatoma



Cholesteatoma

- Term "cholesteatoma" coined by Johannes Muller in 1838
  - ✓ Misnomer because the cysts don't contain cholesterol
- Cholesteatomas are epidermal inclusion cysts of the ear canal, middle ear and/or mastoid with a squamous epithelial lining
  - ✓ Contain keratin and desquamated epithelium
- Natural history is progressive growth with erosion of surrounding bone due to pressure effects, enzymatic activity, and osteoclast activation

Cholesteatoma

- Annual incidence is unknown
  - ✓ In 1978, there were 4.2 hospital discharges per 100,000 with cholesteatoma

(Ruben RJ: *The disease in society: evaluation of chronic otitis media in general and cholesteatoma in particular.* In Sadé J, editor: *Cholesteatoma and mastoid surgery*, Amsterdam, 1982, Kugler Publishing)

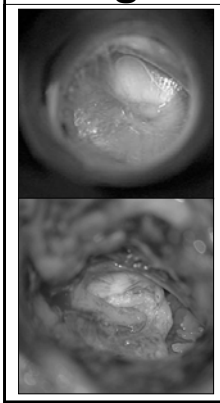
  - ✓ Harker and coworkers estimated the incidence at 6/100,000

(Harker LA: *Cholesteatoma: an incidence study.* In McCabe BF, Sadé J, Abramson M, editors: *Cholesteatoma: first international conference*, Birmingham, Alabama, 1977, Aesculapius Publishing)

  - ✓ Tos and colleagues found 3/100,000 in children and 12.6 per 100,000 in adults

(Tos M: Incidence, etiology and pathogenesis of cholesteatoma in children, *Ann Otol Rhinol Laryngol* 40:110, 1988)

Congenital Cholesteatoma



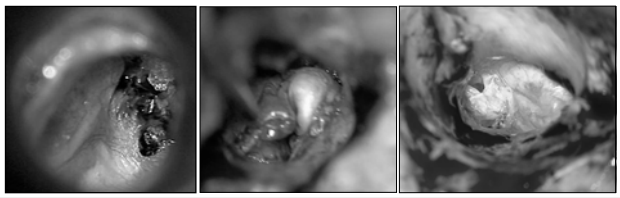
- Rare
- Likely due to epithelial remnants trapped within the temporal bone during fetal development

(Michaels L: An epidermoid formation in the developing middle ear; possible source of cholesteatoma, Otolaryngol 15:169, 1986)

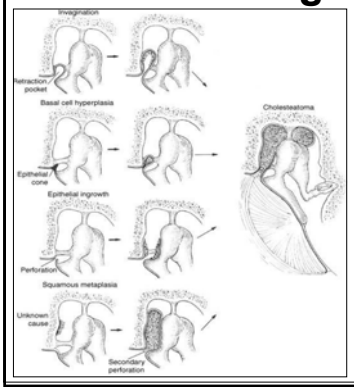
- Diagnosed as a pearly white mass behind an intact tympanic membrane in a child who does not have a history of chronic ear disease
- Often occur in the anterior superior quadrant of the middle ear near the Eustachian tube orifice

Primary Acquired Cholesteatoma

- Secondary to ETD (vacuum in the middle ear)
- Retraction pocket develops within the pars flaccida or the posterior superior tympanic membrane
- Skin debris collects within the retraction pocket, resulting in the formation of a keratin cyst (cholesteatoma)



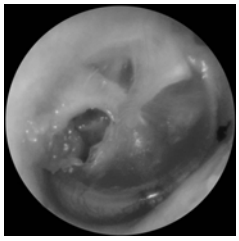
Acquired Cholesteatoma - Pathogenesis

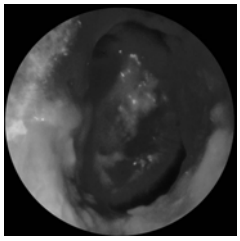


- Skin cysts originating from the tympanic membrane
- Mechanism (theories):
  - ✓ Invagination
  - ✓ Basal cell hyperplasia
  - ✓ Migration (through a perforation)
  - ✓ Squamous metaplasia

Secondary Acquired Cholesteatoma

- Originates from a tympanic membrane perforation
- As the edges of the TM try to heal, the squamous epithelium migrates into the middle ear





Treatment of Cholesteatoma

- Control infection with Ototopical antibiotics +/- oral antibiotics
- Surgical repair of the tympanic membrane
- Repair of the ossicular chain if necessary
- Often requires a mastoidectomy

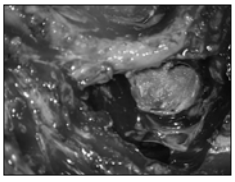
Mastoidectomy

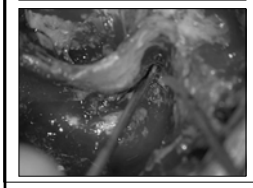
- Intact (bony ear) canal wall mastoidectomy
- Canal wall down mastoidectomy
  - ✓ Radical Mastoidectomy
  - ✓ Modified Radical Mastoidectomy

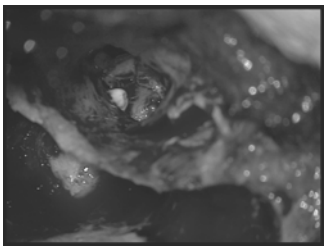
Treatment of Cholesteatoma

- Ototopical antibiotics +/- oral antibiotics to control infection
- Tympanoplasty +/- mastoidectomy
  - ✓ Surgical repair of the TM perforation
  - ✓ Repair of the ossicular chain if necessary
  - ✓ Often requires a mastoidectomy

Intact-Canal-Wall Mastoidectomy

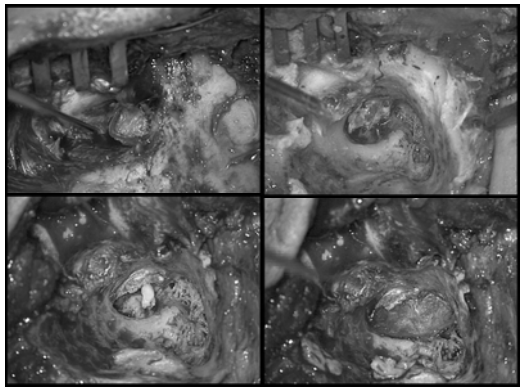






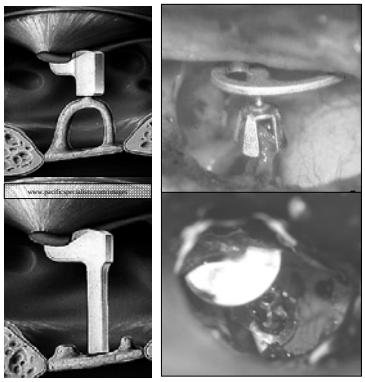
Tympanoplasty with mastoidectomy and hydroxyapatite bone cement ossicular reconstruction

Canal-Wall-Down Mastoidectomy

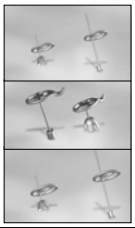


Otosclerosis

Ossicular Chain Reconstruction



- PORP: partial ossicular reconstruction prosthesis
- TORP: total ossicular reconstruction prosthesis

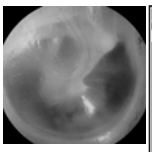


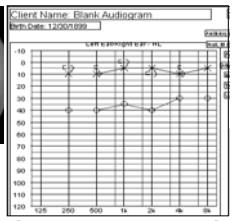
Otosclerosis

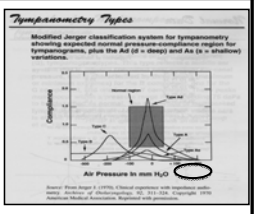
www.otopathology.com/images/otoscl1.jpg

- Unique bone disease affecting the human temporal bone
- Characterized by foci of bone resorption and foci of bone deposition
- Decreased mobility of stapes footplate causes conductive hearing loss
- Incidence
  - ✓ Autopsy studies: 10% of Caucasians
  - ✓ Symptomatic otosclerosis: 0.5-1% of Caucasians
  - ✓ Less common in Blacks and Asians
  - ✓ Genetic component: 60% of patients have an identifiable family member with otosclerosis

Otosclerosis - Diagnosis





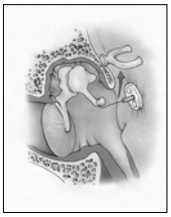


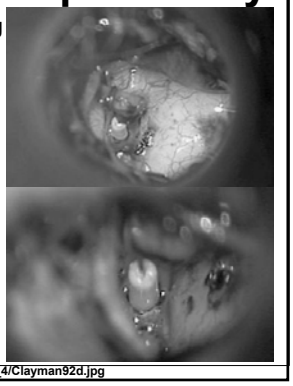
- **Physical exam: normal tympanic membrane with dry middle ear**
- **Audiogram: conductive hearing loss**
- **Tympanogram: normal middle ear pressure but shallow configuration**

Aural Rehabilitation

Otosclerosis – Stapedectomy/Stapedotomy

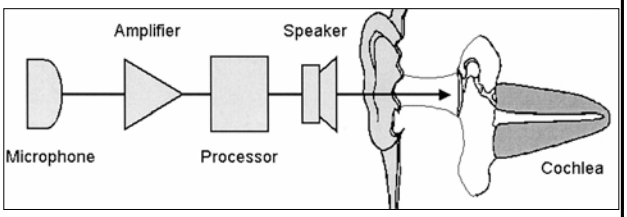
- **> 90% success in eliminating otosclerosis-related conductive hearing loss**
- **0.5-1% chance of profound hearing loss from surgery**





http://163.178.103.176/Fisiologia/neurofisiologia/Objetivo_4/Clayman92d.jpg

Conventional Amplification with Hearing Aids



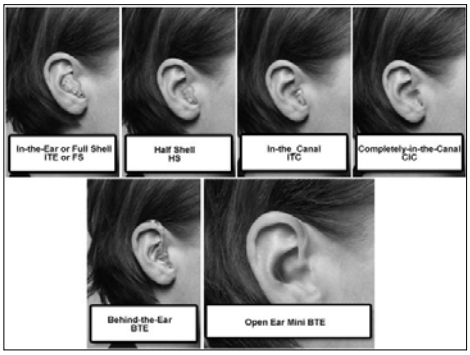
Hearing Aid Basics

- Analog Hearing Aids
  - Basic analog circuitry
  - Single-band amplification with possible high-low pass filtering
  - Limited audiological manipulation
  - User-operated volume control
  - Most beneficial when used in quiet listening environments
- Digital Hearing Aids
  - Fully digital circuitry and sound processing
  - Programmed via computer
  - Multiple frequency bands for discreet frequency manipulation
  - Multiple memory capabilities
  - Advanced digital - speech vs. noise algorithm
- Higher-end analog hearing aids can be "programmable"

Open Fit Hearing Aids

- Primarily used for mid and high frequency amplification
- Appropriate for hearing that is normal/mild hearing loss in the low frequencies.
  - Inappropriate if much gain is needed at 250-500Hz
- Designed to eliminate the occlusion effect

Styles of Hearing Aids

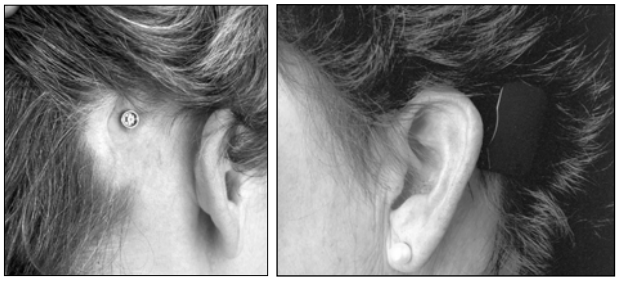


www.hometown-hearing.com/images/about-1.jpg

CROS and BiCROS SYSTEMS

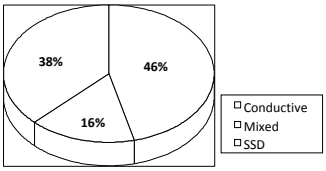
- Used in patients with single sided deafness or poor word recognition ability in one ear
- CROS (contralateral routing of signal) systems have a microphone/FM transmitter worn on the non-hearing side and a receiver worn on the hearing side
  - Used when hearing in the better ear is normal and does not require amplification
  - Everything is heard in one ear
- The BiCROS system has a microphone/FM transmitter worn on the non-hearing side and a hearing aid on the better hearing side that also acts as an FM receiver

The BAHA® System

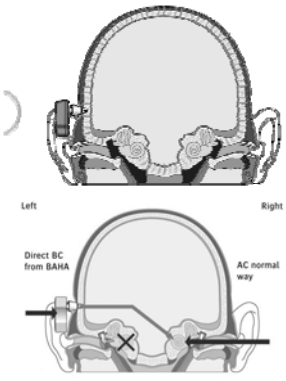


BAHA® The Bone Anchored Hearing Aid

- > 800,000 potential Baha candidates in the United States
  - ✓ Adults and Children >5 years of age
  - ✓ Mixed/Conductive Hearing Loss
  - ✓ Single Sided Deafness (SSD)
- Each year it is estimated that between 25,000 and 30,000 new patients develop hearing loss that are treatable with the Baha system
- We have treated less than 1% of the patients who could benefit



BAHA® Indications



- Conductive/Mixed HL
  - ✓ > 5 years of age
  - ✓ < 45 dB HL BC PTA
  - ✓ ≥ to 60% speech discrimination scores
  - ✓ For bilateral fitting - Symmetric bone conduction thresholds
- Single Sided Deafness
  - ✓ > 5years of age
  - ✓ Normal hearing in contralateral ear defined as 4-frequency AC PTA ≥ 20 dB
  - ✓ Functions by trans-cranial routing of the signal

Concluding Thoughts

- Conductive hearing loss results from impaired transmission of sound through the ear canal, tympanic membrane, and middle ear
- Divergent causes
- Medical/surgical options for treatment
- Numerous modalities for aural rehabilitation
- New technologies on the horizon
- Ask your patients about their hearing during your review of systems!!!