**AUDIOMETRIC TESTING**

**Why perform audiometric testing?**
- To quantify and localize hearing loss
- To determine the type and degree of hearing impairment by obtaining threshold information for all frequencies important in hearing speech (250-8000 Hz)
- To categorize hearing loss as conductive, sensorineural, or mixed which will aid in the differential diagnosis depending on the patient’s age and clinical history

**Normal Pure Tone Audiogram**
- In this example, air conduction testing was performed in each ear.
- The left (X) ear showed normal air conduction measured at 15 dB at all frequencies.
- The right (>) ear was showed normal air conduction measured at 15 dB at all frequencies.
- Meaning that the softest level that each frequency was audible in each ear was 15 dB.
- 10 dB represents the pure tone average (PTA) in each ear.
- If air conduction is normal, then the entire hearing apparatus including the external, middle and inner ear structures are intact.

**Symbols**
- Each ear is denoted with a different color and different set of symbols.
- Color coding:
  - The right ear is denoted in red
  - The left ear is marked in blue

**Air vs. Bone Conduction**
- **Air conduction**
  - Air oscillator placed on mastoid bone
  - Sound is conducted directly through bone and bypasses the external and middle ear.
  - Tests the bone conduction thresholds.

- **Bone conduction**
  - Bone oscillator placed on mastoid bone
  - Sound is conducted through bone and bypasses the external and middle ear.
  - Tests the sensory receptor component to sound.

**Masking**
- Sound can cross over from one ear to the other during both air and bone conduction testing.
- In air conduction this occurs if there is an air bone gap >40 dB and in bone conduction if there is >10 dB difference.
- To minimize the cross talk, a masking sound is presented to the non-test ear as a distraction.
- Masking consists of a narrow frequency noise which is distinct from the pure tone being presented to the test ear.
- Masking is used to keep the non test ear busy as you know you are testing the ear that you think you are testing.
- Different symbols are used when masking is performed: See key.

**Normal Hearing**
- Normal hearing sensitivity

**Mild Hearing Loss**
- Air conduction is depressed by 20-40 dB

**Moderate Hearing Loss**
- Air conduction is depressed by 40-60 dB

**Severe Hearing Loss**
- Air conduction is depressed by 60-90 dB

**Profound Hearing Loss**
- Air conduction is depressed by >90 dB

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**AUDIOMETRY SYMBOL KEY**
- Ear
- Un-masked
- Masked
- No response

**Right Ear**
- Normal hearing sensitivity

**Left Ear**
- Normal hearing sensitivity

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## EDUCATIONAL OBJECTIVES

- Examine the components of an audiogram
- Understand how the information is used to guide differential diagnosis and subsequent imaging
- Review cases providing radiology-audiometry correlation

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## CONDUCTIVE HEARING LOSS

**Acquired Cholesteatoma**
- Keratinizing squamous epithelium within the middle ear or petrous apex
- The majority are acquired with a prior history of TM perforation
- Most commonly arise from the superior or inferior division of the vestibular nerve
- Unifocal or multifocal punctate or web-like calcific densities in the middle ear cavity

**Postinflammatory ossicular fixation resulting in noncholesteatomatous conductive hearing loss**
- Keratinizing squamous epithelium within the middle ear or petrous apex
- The majority are acquired with a prior history of TM perforation
- The majority are acquired with a prior history of TM perforation
- Most commonly arise from the superior or inferior division of the vestibular nerve

**Meningoid labyrinthitis**
- Meningogenic labyrinthitis is most commonly caused by bacterial pathogens
- Typically bilateral resulting in bilateral SNHL, often affecting the higher frequencies

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## SENSORINEURAL HEARING LOSS

**Vestibular Schwannoma**
- Patients often present with slowly progressive high frequency SNHL
- Most commonly arise from the superior or inferior division of the vestibular nerve
- Although interestingly, patients often do not present with vestibular symptoms

**Meningitis with Labyrinthitis**
- Meningitis with Labyrinthitis is felt to result from the spread of infection via the cochlear aperture and common crus
- Widens the porus acusticus and extends into the internal auditory canal
- Patients often do not present with vestibular symptoms

**Menings with Labyrinthitis**
- Labyrinthitis can be tympanicogenic, meningeogenoric, or parasellar
- Labyrinthitis is a lesion that is often caused by bacterial pathogens
- Meningogenic labyrinthitis is felt to result from the spread of infection via the cochlear aperture and common crus
- Parasellar labyrinthitis can result from a variety of conditions

**Middle Ear Effusion**
- Middle ear effusion
- Middle ear effusion
- Middle ear effusion

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## MIXED HEARING LOSS

**Retrofenestral (Cochlear) Otosclerosis**
- Replacement of normal bone with spongy irregular bone
- 2 types: F在我 eal (retrofenestral) otosclerosis
- 2 types: F在我 eal (retrofenestral) otosclerosis
- 2 types: F在我 eal (retrofenestral) otosclerosis
- Most commonly arise from the superior or inferior division of the vestibular nerve
- Most commonly arise from the superior or inferior division of the vestibular nerve
- Most commonly arise from the superior or inferior division of the vestibular nerve

**Sensorineural Loss**
- Bone conduction is normal
- Air conduction is depressed by >10 dB
- Problem of sound reception and transmission through the ear, tympanic membrane or middle ear

**Semi-circular canal Dehiscence**
- Sound induced vestibular evoked myogenic potential (SIP) testing
- SCDC creates a third window which results in altered movement of perilymph and compression the endolymphatic compartment resulting in dehiscence
- Audiologic findings are variable. However, characteristic audiologic finding of SCDC is an unexplained conductive hearing loss with no true middle ear pathology

**Superior Semi-circular canal Dehiscence**
- Sound induced vestibular evoked myogenic potential (SIP) testing
- SCDC creates a third window which results in altered movement of perilymph and compression the endolymphatic compartment resulting in dehiscence
- Audiologic findings are variable. However, characteristic audiologic finding of SCDC is an unexplained conductive hearing loss with no true middle ear pathology

**Semi-circular canal Dehiscence**
- Sound induced vestibular evoked myogenic potential (SIP) testing
- SCDC creates a third window which results in altered movement of perilymph and compression the endolymphatic compartment resulting in dehiscence
- Audiologic findings are variable. However, characteristic audiologic finding of SCDC is an unexplained conductive hearing loss with no true middle ear pathology

**Semi-circular canal Dehiscence**
- Sound induced vestibular evoked myogenic potential (SIP) testing
- SCDC creates a third window which results in altered movement of perilymph and compression the endolymphatic compartment resulting in dehiscence
- Audiologic findings are variable. However, characteristic audiologic finding of SCDC is an unexplained conductive hearing loss with no true middle ear pathology

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## SENSORY NERVE PATHOLOGY

**SNHL at mid and high frequencies with minimal conductive component at low frequencies**
- Left ear
- Normal hearing sensitivity

**SNHL at mid and high frequencies with minimal conductive component at low frequencies**
- Left ear
- Normal hearing sensitivity

**SNHL at mid and high frequencies with minimal conductive component at low frequencies**
- Left ear
- Normal hearing sensitivity

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**SUMMARY AND DIFFERENTIALS**

### Conductive Loss
- Air conduction is depressed by >40 dB
- Problem of sound reception and transmission through the ear, tympanic membrane or middle ear

### Sensory Nerve Loss
- Bone conduction is normal
- Air conduction is depressed by >10 dB
- Problem of sound reception and transmission through the ear, tympanic membrane or middle ear

### Mixed Loss
- Air and bone conduction are both depressed and there is a gap between air and bone conduction
- Pathology involving external/middle ear and sensory neural apparatus

### SNHL Differential Diagnosis
- Menings with Labyrinthitis
- Labyrinthitis can be tympanicogenic, meningeogenoric, or parasellar
- Labyrinthitis is a lesion that is often caused by bacterial pathogens
- Meningogenic labyrinthitis is felt to result from the spread of infection via the cochlear aperture and common crus
- Parasellar labyrinthitis can result from a variety of conditions

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**References**

3. Decoding the Audiogram: An Illustrative Guide for the Head & Neck Radiologist

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**“Speech Banana”**
SOUNDS NEEDED FOR SPEECH WERE INITIALLY GRAPHED ON AN AUDIOMETER AND A CIRCLE WAS DRAWN AROUND THEM, THE SHAPE LOOKED LIKE A BANANA.

It is important that individuals hear all the sounds within the “speech banana”, as it will affect how well they can understand speech.

Vowels sounds tend to be louder and are usually easier to hear. The consonant sounds like “T”, “K”, and “N” are higher in frequency and sound. The vessels carry the loudness of speech and the consonants carry the meaning of speech.

For patients who have hearing loss, hearing aids provide a boost of volume to make up for the lack of speech sounds audible to the patient, as possible.