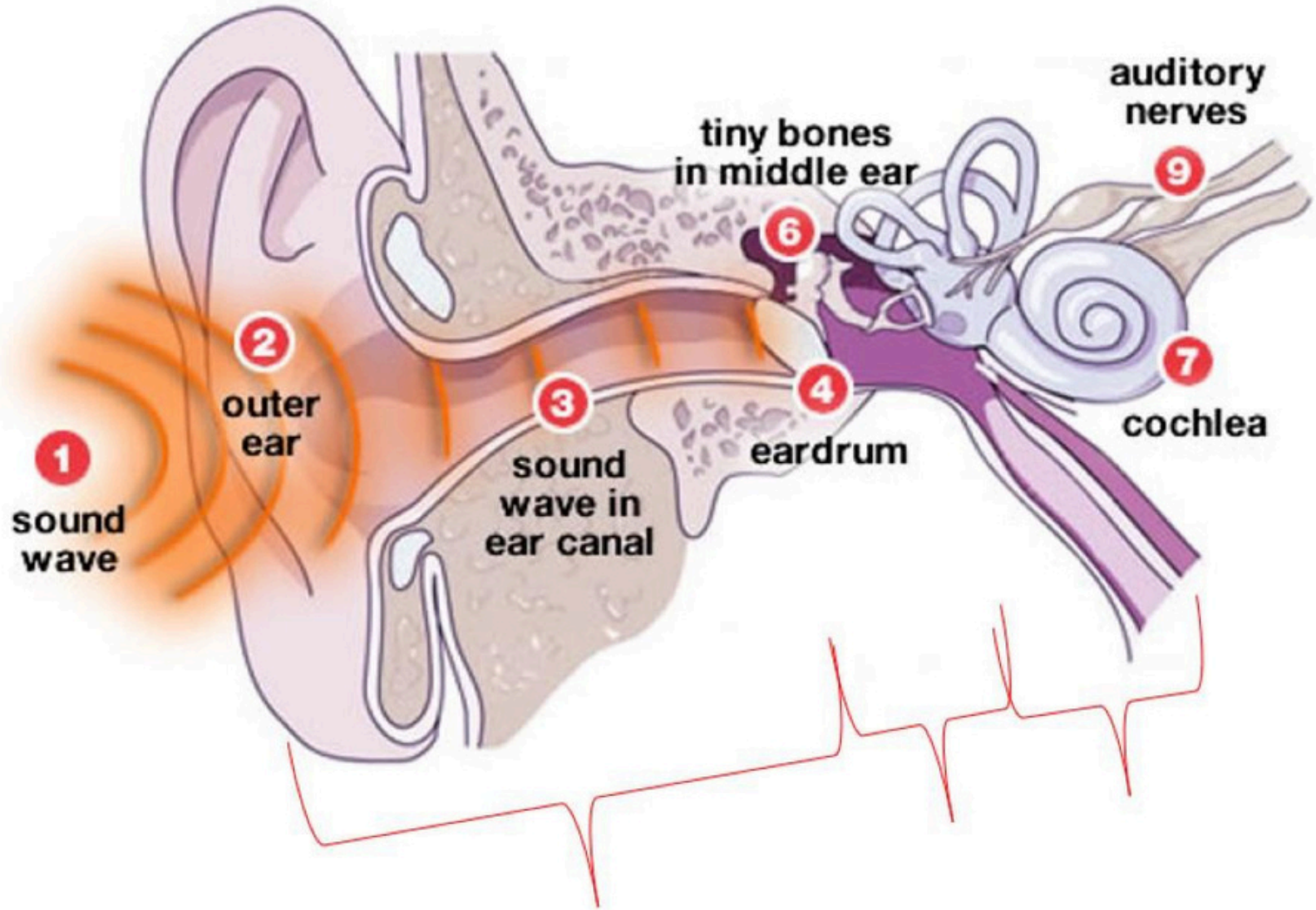
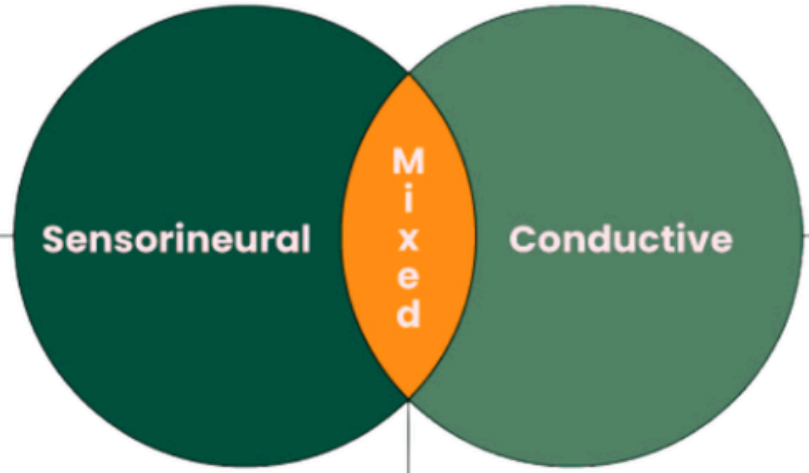
Hearing assessment

Presented by :
Sadeen Mohammad
Raneem Al-Jaafreh
Muath Mahadin

Physiology Of Hearing



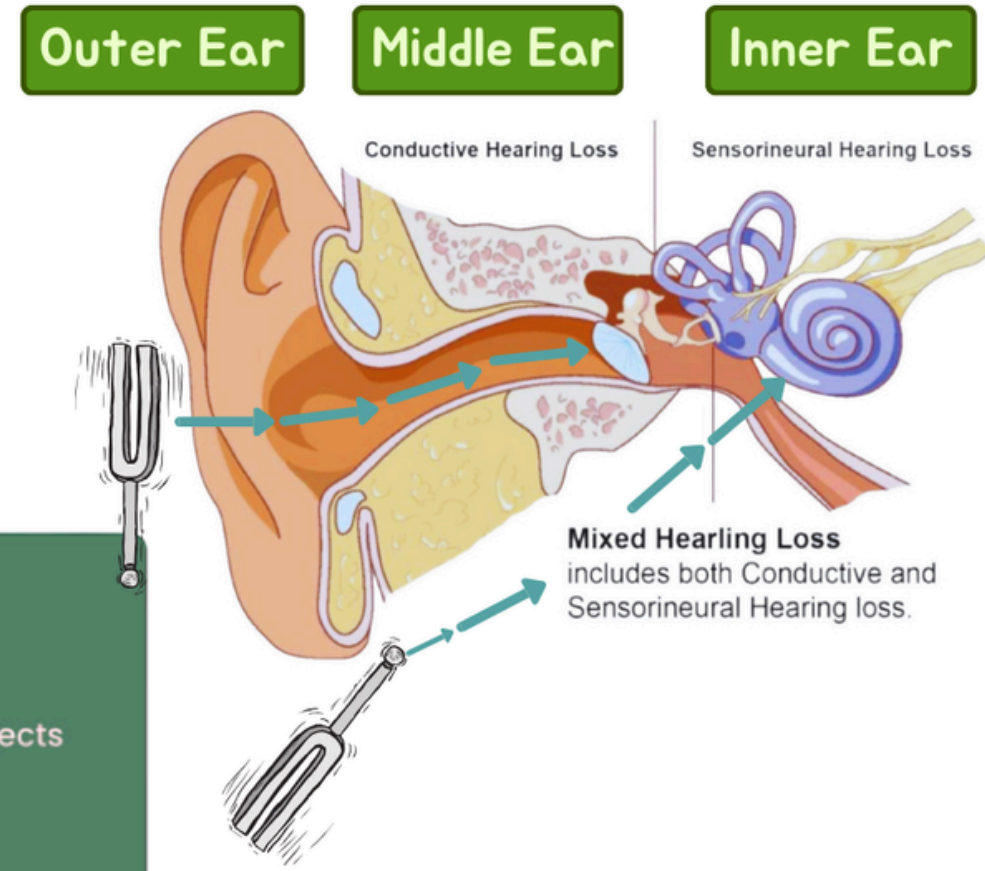
Types of Hearing Loss

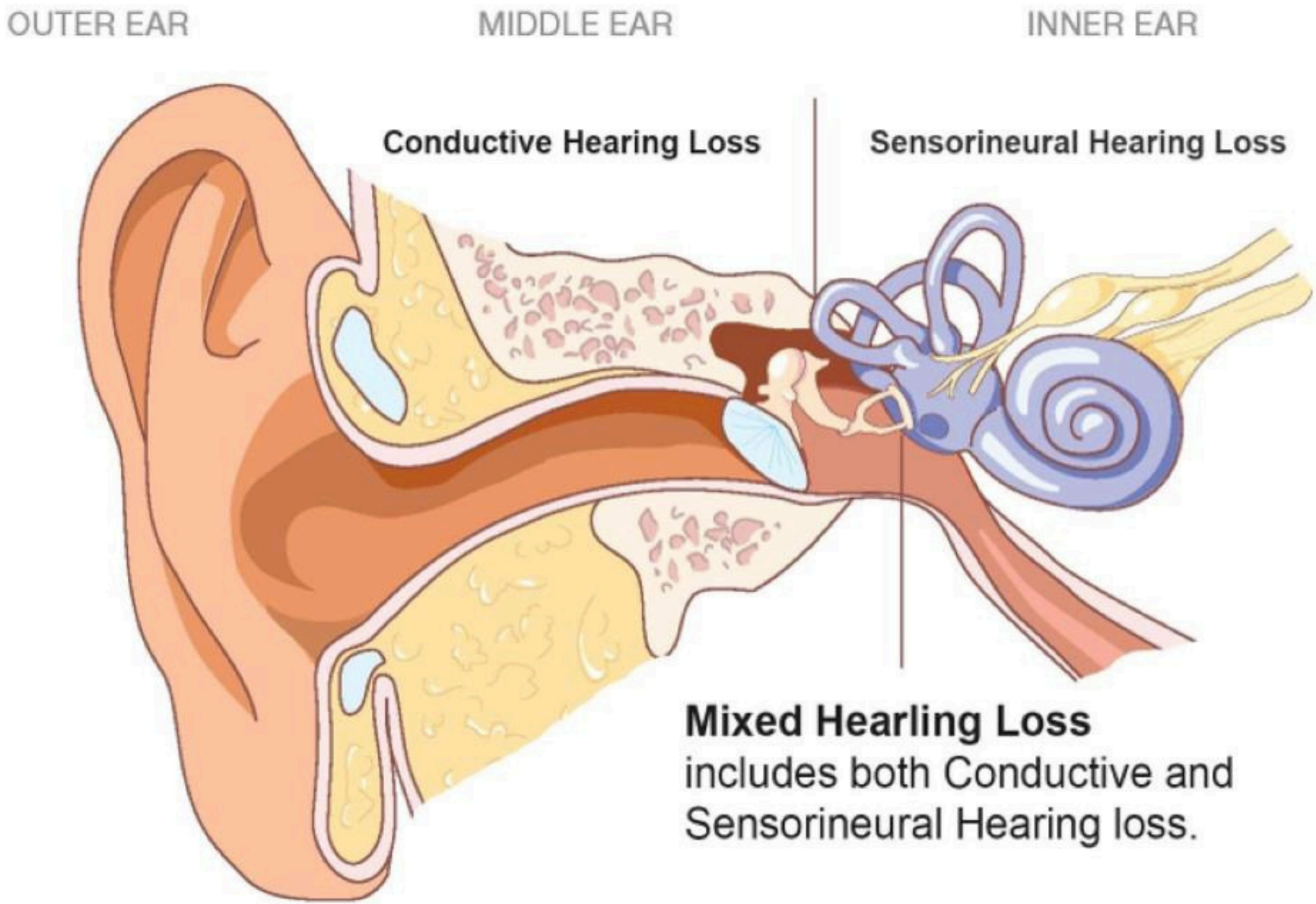


- Aging
- Noise Damage
- Drug Side Effects
- Auditory Tumors
- Blast / Explosion

- Genetic Disorders
- Infections
- Head Trauma

- Fluid
- Foreign Objects
- Allergies
- Ruptured Eardrum
- Impacted Earwax




OUTER EAR
MIDDLE EAR
INNER EAR
Conductive Hearing Loss
Sensorineural Hearing Loss
Mixed Hearling Loss
includes both Conductive and
Sensorineural Hearing loss.

Clinical Assessment Of Hearing

- **Whispered Voice Test**
- **Tuning Fork Tests**
  - Rinne's Test
  - Weber's Test
- **Audiometry**
  - Pure Tone Audiometer
  - Speech audiometer
  - Impedance Audiometer
  - Electric response audiometer

Whispered Voice Test

- Formal Assessment. Ask the patient to repeat words spoken by the examiner at different intensities & distances.
- Examination sequence
  - Stand behind the patient.
  - Start with your mouth about 15 cm from the ear you are testing.
  - Mask hearing in the other ear by rubbing the tragus.
  - Ask the patient to repeat your words. Use a combination of multisyllable numbers and words (1,2,3 or A,B,C). Start with a normal speaking voice to confirm that the patient understands the test. Lower your voice intensity to a clear whisper.
  - Repeat, but this time at arm's length from the patient's ear. People with normal hearing can repeat words whispered at 60 cm.

Interpretation of Results...

Normal

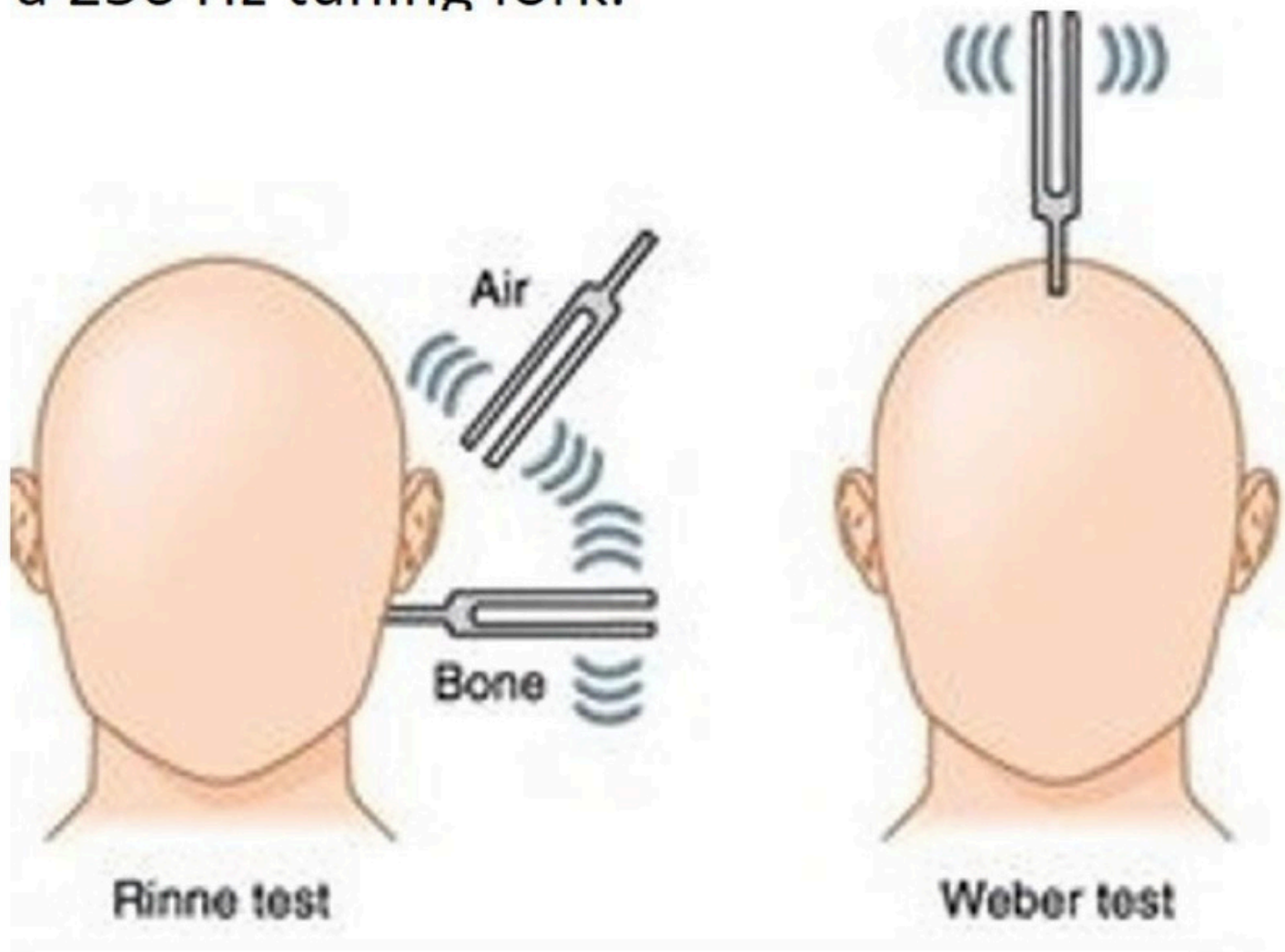
- Patient is able to hear whispered speech accurately.
- Volume is the same in both ears.

Abnormal

- The patient is unable to hear whispered speech.
- The patient hears speech at a higher volume in one ear.
- The patient hears sounds but does not understand words.

Tuning Fork Tests

- using either a 512 Hz or a 256 Hz tuning fork.



	Rinne's	Weber's
normal	positive	centralized
Conductive	Negative	Lateralized to affected ear
sensorineural	positive	Lateralized to the unaffected ear
Profound sensorineural	False Negative	

Rinne’s Test

- Compares the level of air and bone conduction of the same ear.

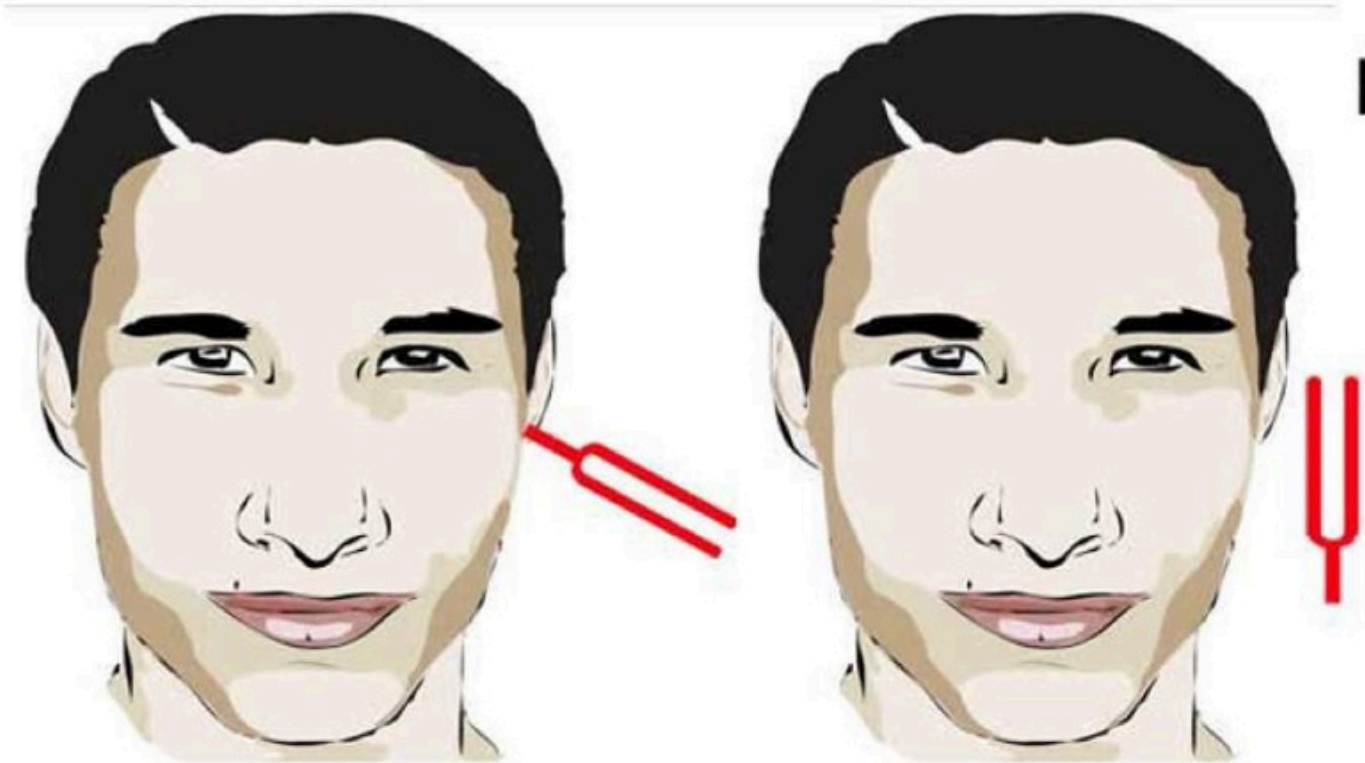
Examination Sequence

- Place the vibrating prongs at the patient's external auditory meatus; ask if he can hear it.
- Now place the still-vibrating base on the mastoid process. Ask: 'Is it louder in front, or behind your ear?'

Alternatively:

- The Rinne’s test is performed by placing a vibrating tuning fork (512 or 256 Hz) initially on the mastoid process until sound is no longer heard, the fork is then immediately placed just outside the ear.

Rinne's Test



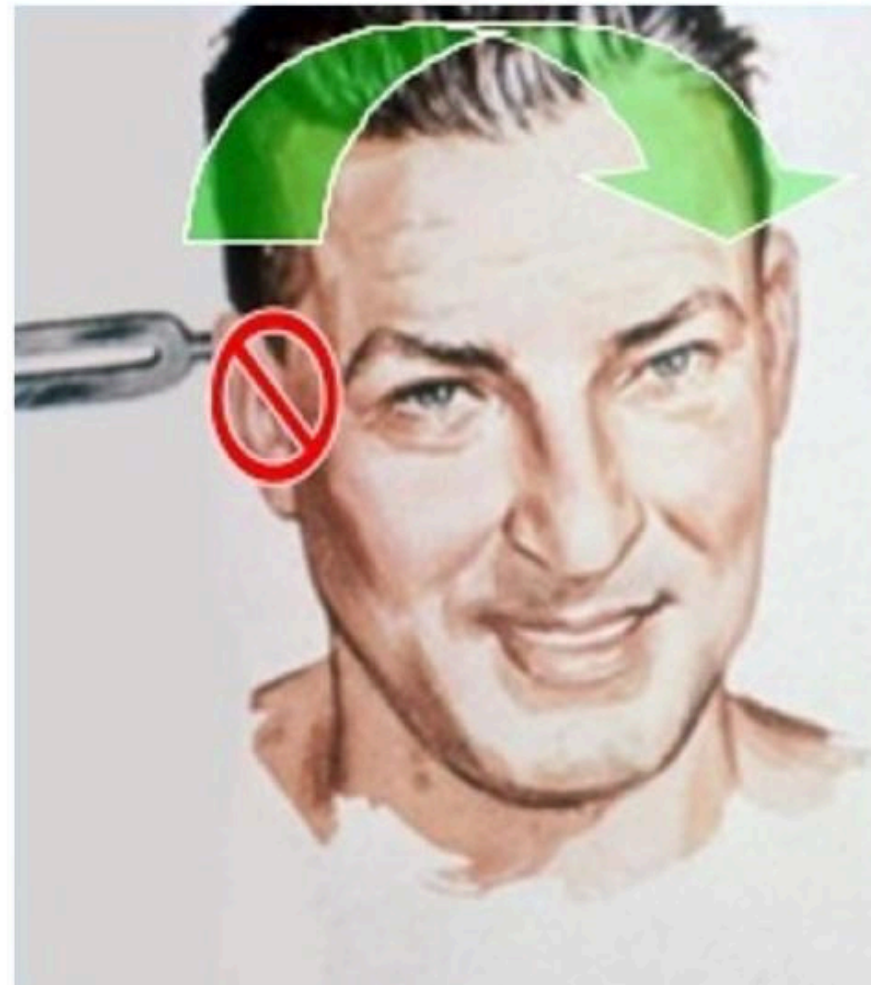
Rinne's Test

With a 512 Hz tuning fork press against the mastoid bone and then hold it 1cm away from the ear.

'Which is louder, behind the ear or in front?'

Additional Note

- If hearing in one ear is extremely poor there may be a false negative Rinne's.
  - The sound will be conducted through the bone to the opposite ear and give a false impression of better BC.



Weber's Test

Examination Sequence:

- Place the base of the vibrating tuning fork in the middle of the patient's forehead.
- Ask: 'Where do you hear the sound?'
- Record which side Weber's test lateralizes to if not central.

Finding	Interpretation
No Lateralization (The sound is heard equally in both ears)	Normal/Healthy Patient
	Bilateral symmetrical Conductive Deafness
	Bilateral symmetrical Sensorineural Deafness
Lateralized to better/healthy ear	Unilateral Sensorineural Deafness
Lateralized to worse/affected ear	Unilateral Conductive Deafness

Quiz Tiiime

- Rinne's Rt(-) Lt(+) Weber's lateralizes to Rt
- Rinne's Rt(+) Lt(+) Weber's lateralizes to Lt
- Rinne's Rt(+) Lt(+) Weber's is centralized
- Rinne's Rt(-) Lt(+) Weber's lateralizes to Lt

Clinical Assessment Of Hearing

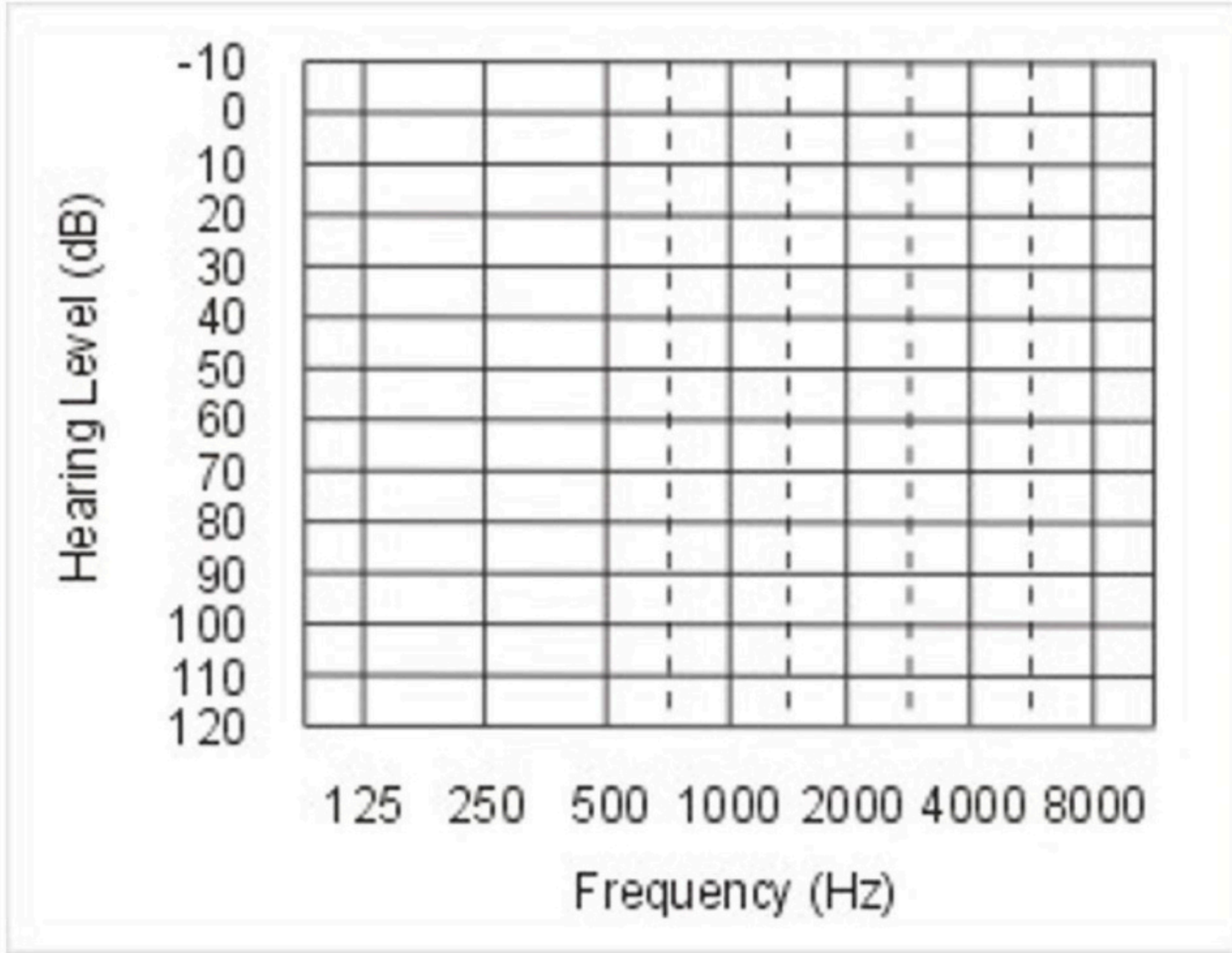
- **Whispered Voice Test**
- **Tuning Fork Tests**
  - Rinne's Test
  - Weber's Test
- **Audiometry**
  - Pure Tone Audiometer
  - Speech audiometer
  - Impedance Audiometer
  - Electric response audiometer

Pure Tone Audiometry

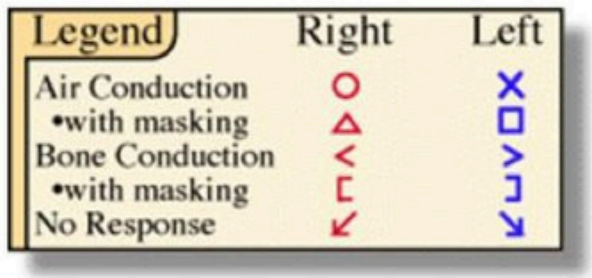
- Electronic device that generates tones for determining hearing thresholds. Displayed on a graphic plot called audiogram.

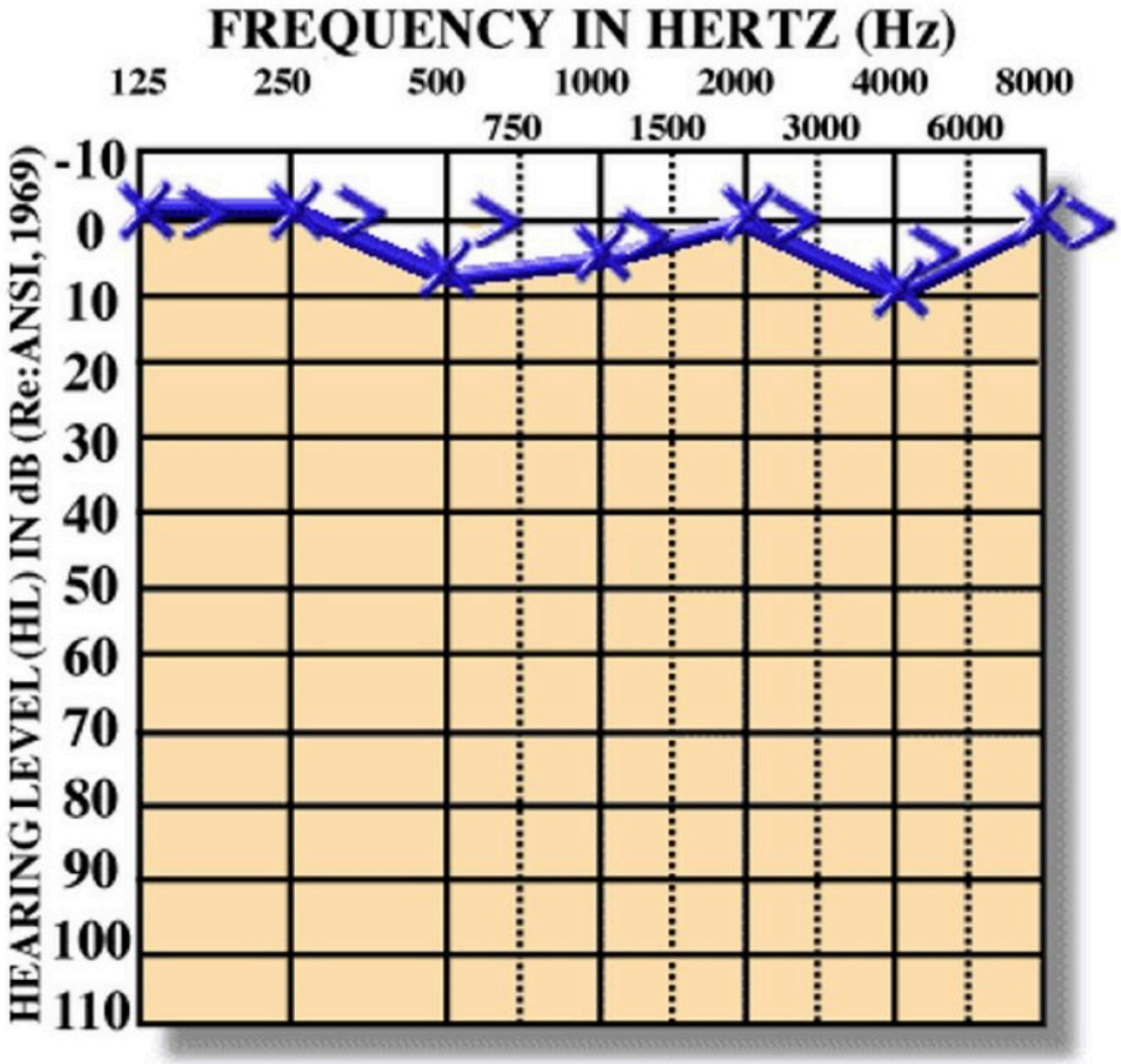
Audiogram

- The ears are most sensitive to frequencies in the range of 1000-4000Hz.
- range of human speech >(400-3000 Hz)
- The hearing threshold **is the sound level below which a person's ear is unable to detect any sound.** For adults, 0 dB is the reference level.

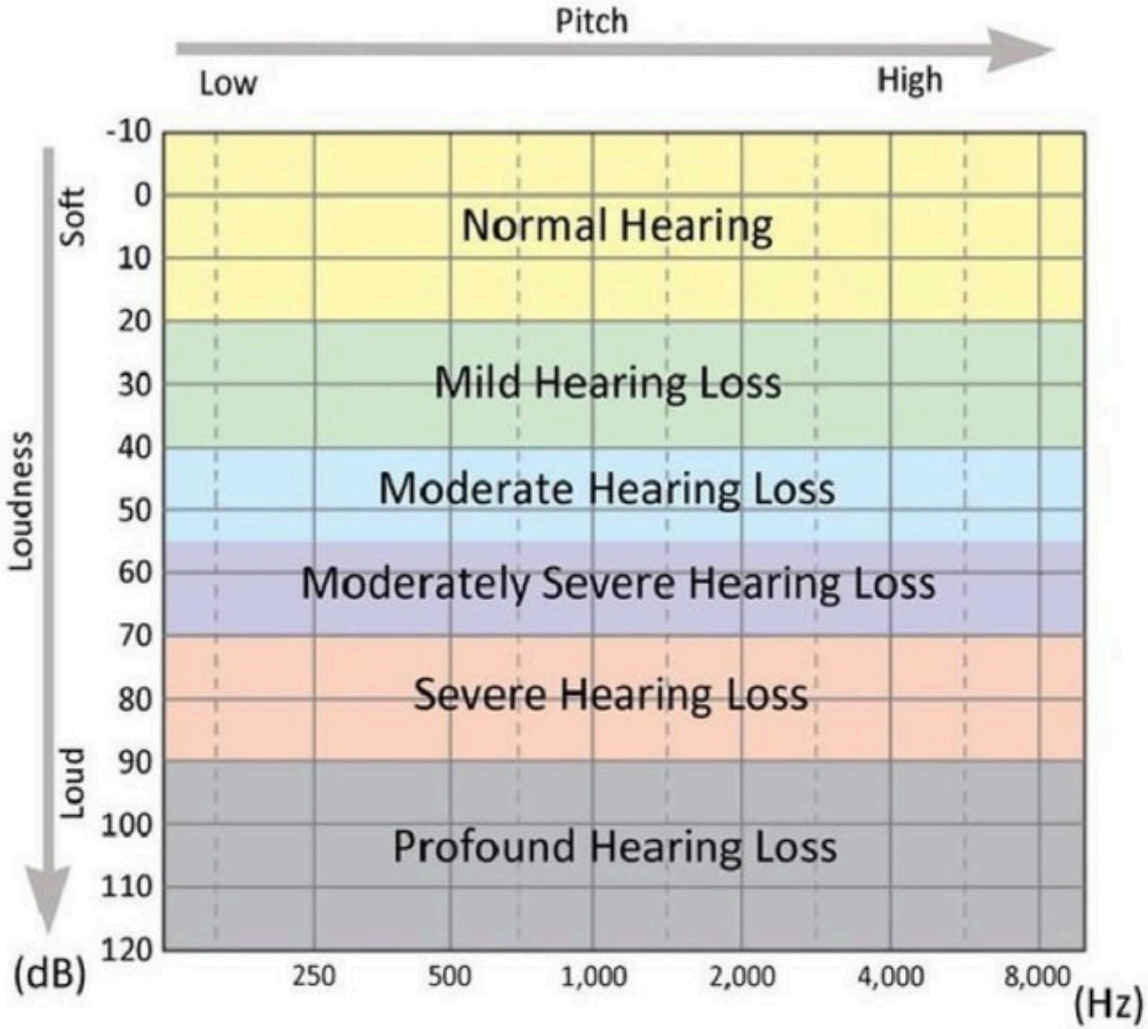


Normal Hearing





Ranges of Hearing Loss

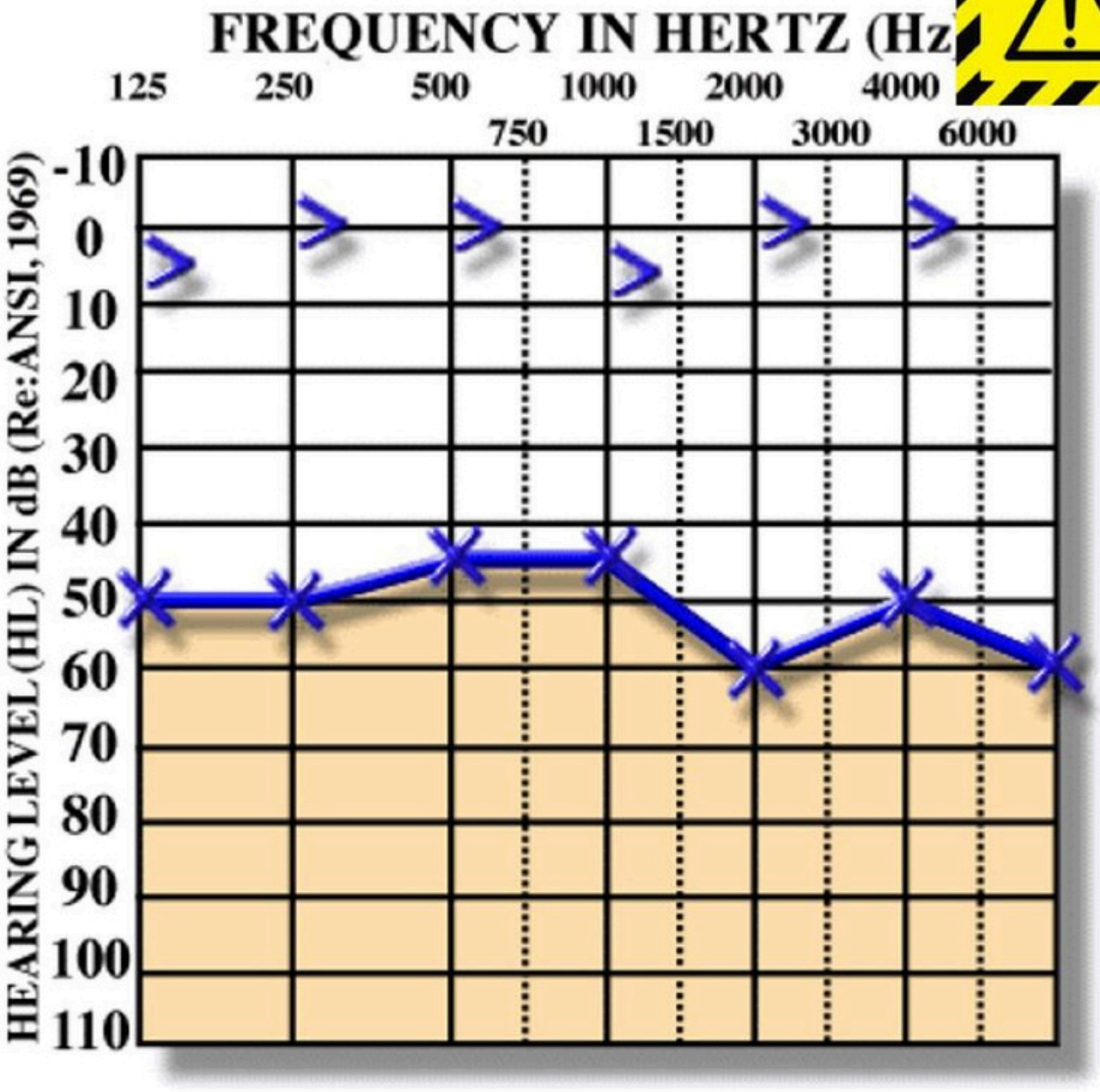


- **-10 – 20 dB HL = Normal range**
- **21 – 40 dB HL = Mild hearing loss**
- **41 – 55 dB HL = Moderate**
- **56 – 70 dB HL = Moderately Severe**
- **71 – 90 dB HL= Severe**
- **Greater than 90 dB HL = Profound**

Conductive Hearing Loss

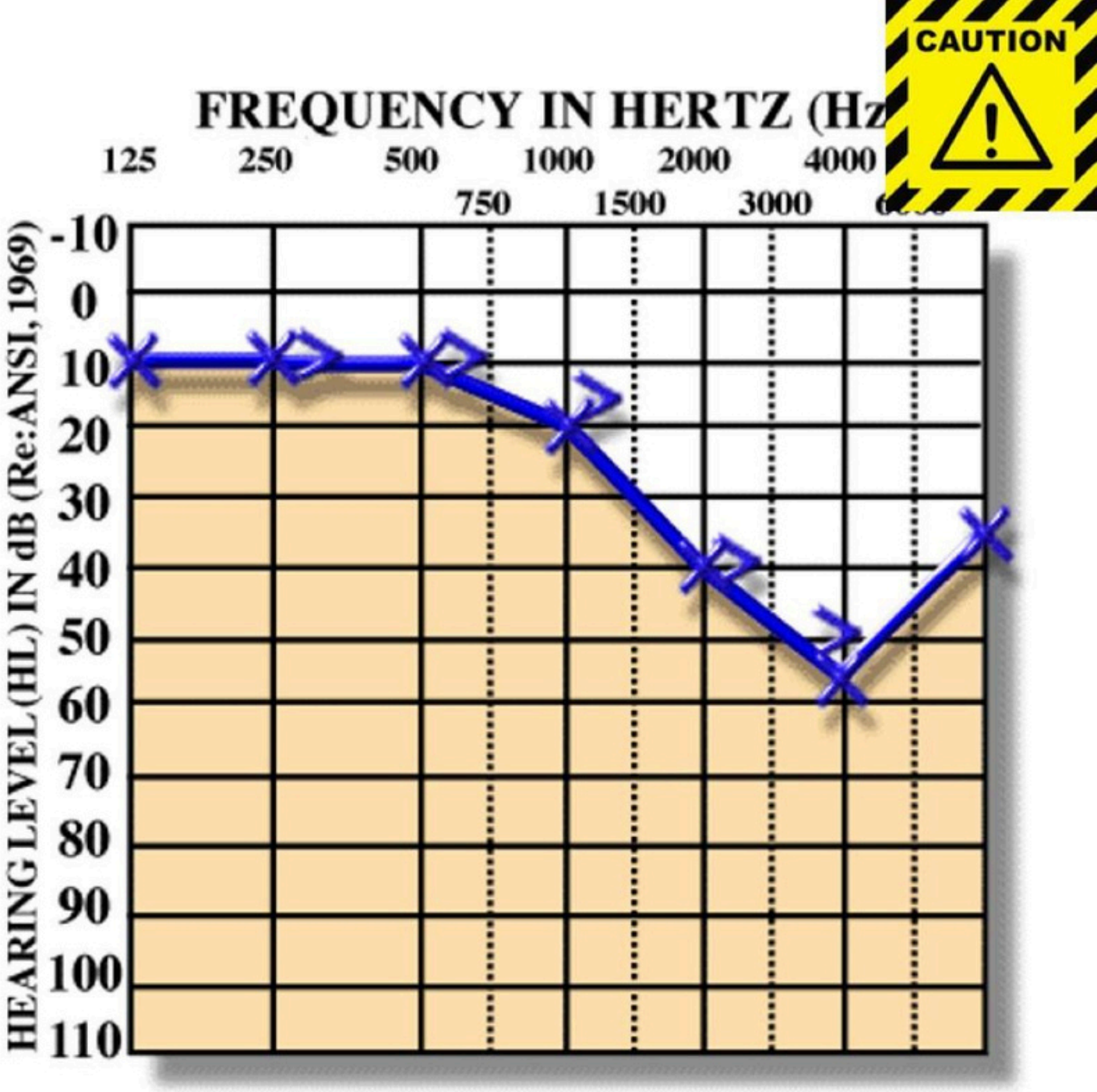
- AC worse than BC
- AC is below normal with at least 10 dB
- outer ear or middle ear abnormality;

1. Occlusion of the external auditory canal by cerumen or a mass
2. Middle ear infection and/or fluid
3. Perforation of the tympanic membrane
4. Ossicular abnormalities



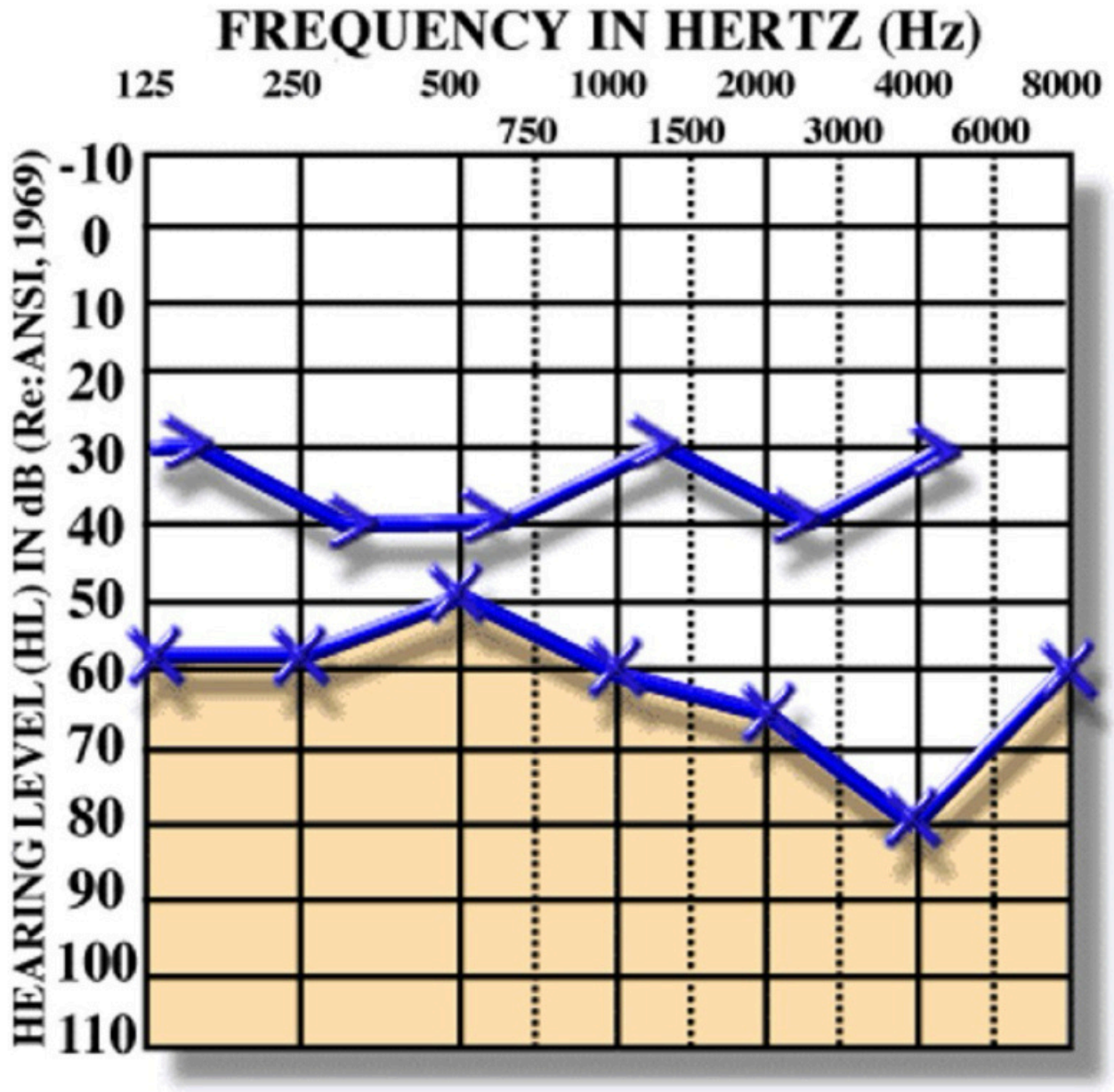
Sensorineural Hearing Loss

- No air-bone gap = normal or SNHL
- and thresholds are higher than 25 dB HL.
- cochlear abnormalities and/or an abnormality of the auditory nerve or central auditory pathways.



Mixed Hearing Loss

- Pure-tone air-conduction thresholds are poorer than bone-conduction thresholds by more than 10 dB.
- Bone-conduction thresholds are higher than 25 dB.



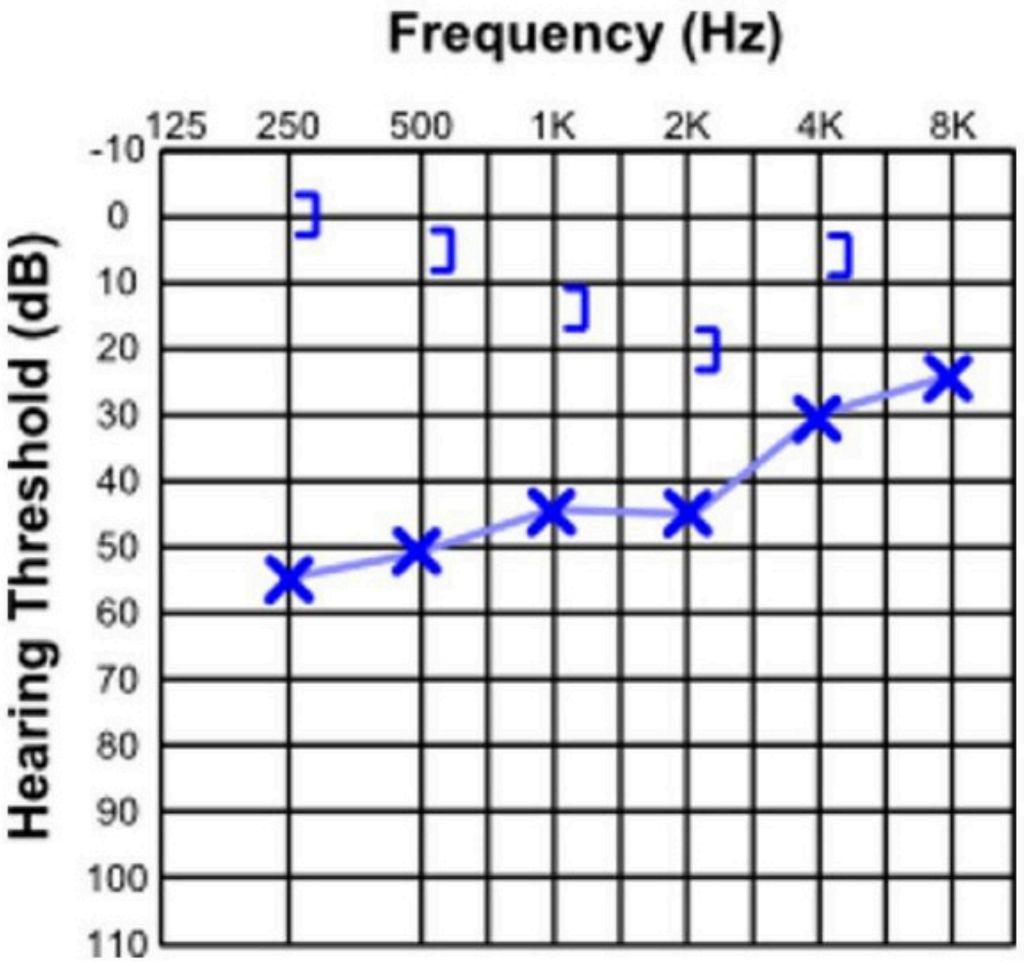
❑Conductive hearing loss

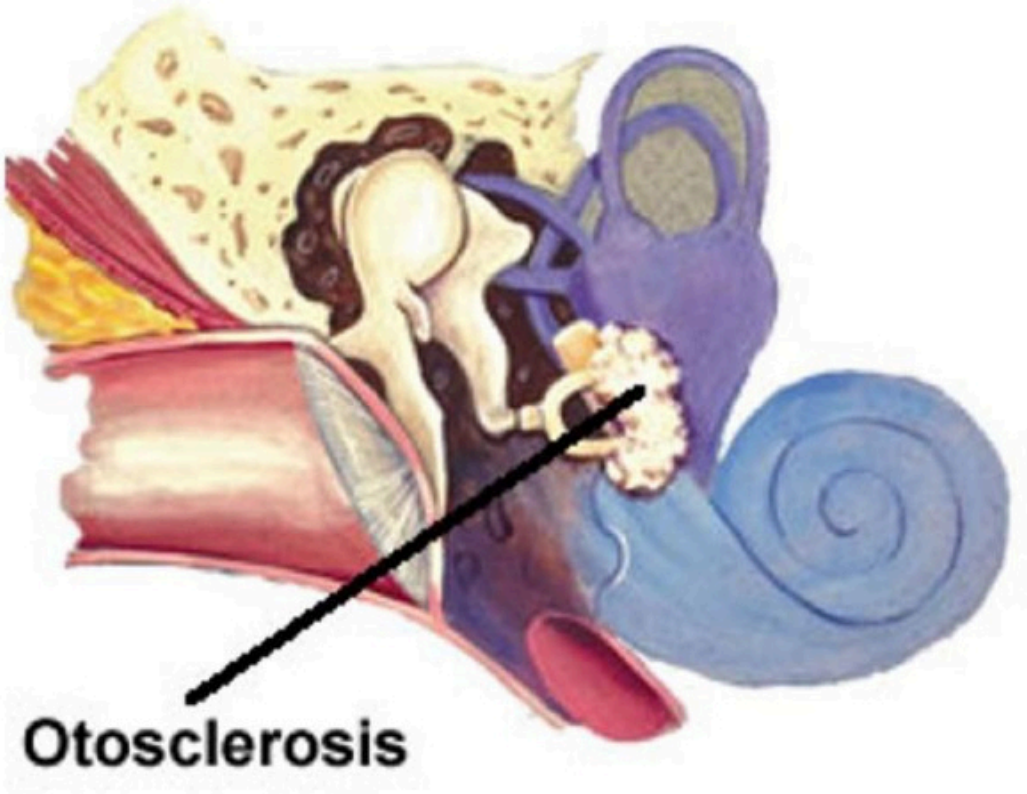
- Otosclerosis

❑Sensorineural Hearing Loss

- Examples include:
  - Noise-induced hearing loss
  - Presbycusis
  - Ménière disease
  - Retrocochlear lesions such as vestibular schwannoma

Otosclerosis

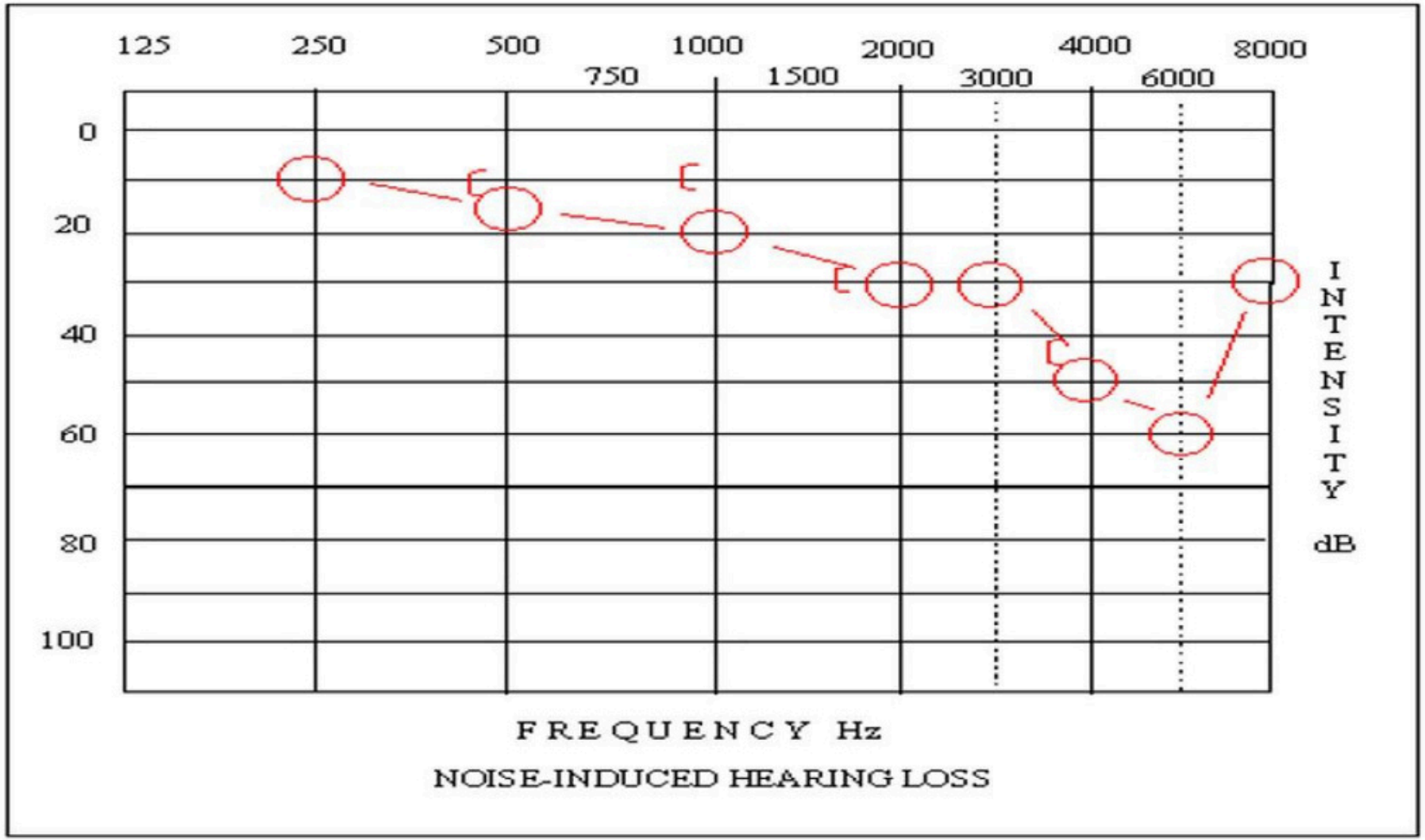




Otosclerosis

- caused by stapedial fixation in the oval window, stiffening the middle ear system.
  - ✓ **Stapes fixation produces an audiometric artifact known as the Carhart notch, (Carhart notch :Isolated depression(20-30 Db) around 2000 Hz in the bone-conduction audiogram of patients with otosclerosis.)**
  - ✓ Onset is 15-45 years, more common in women.
  - ✓ One half of patients report a family history of otosclerosis.

Noise-induced Hearing Loss

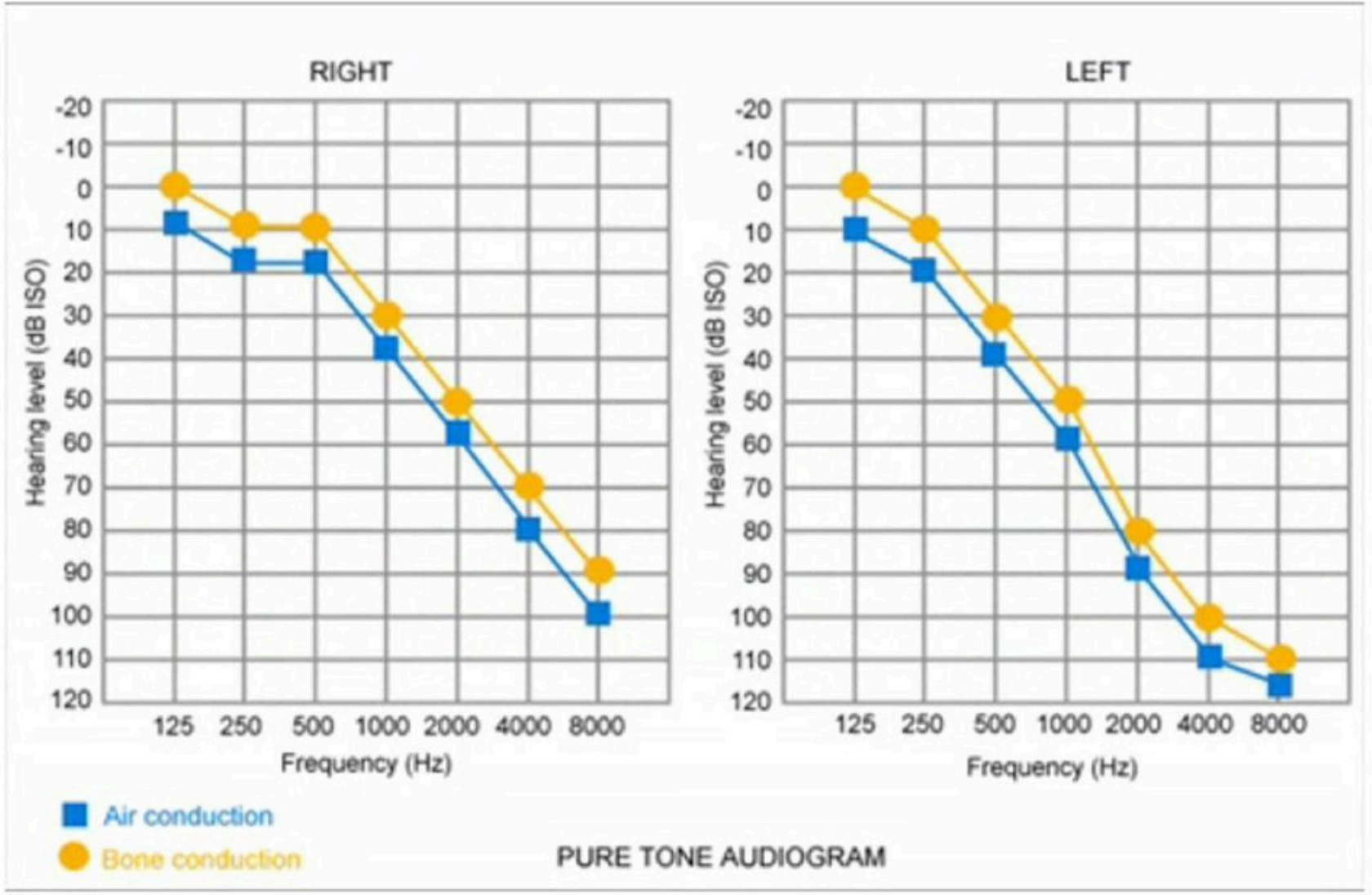


Noise-induced Hearing Loss

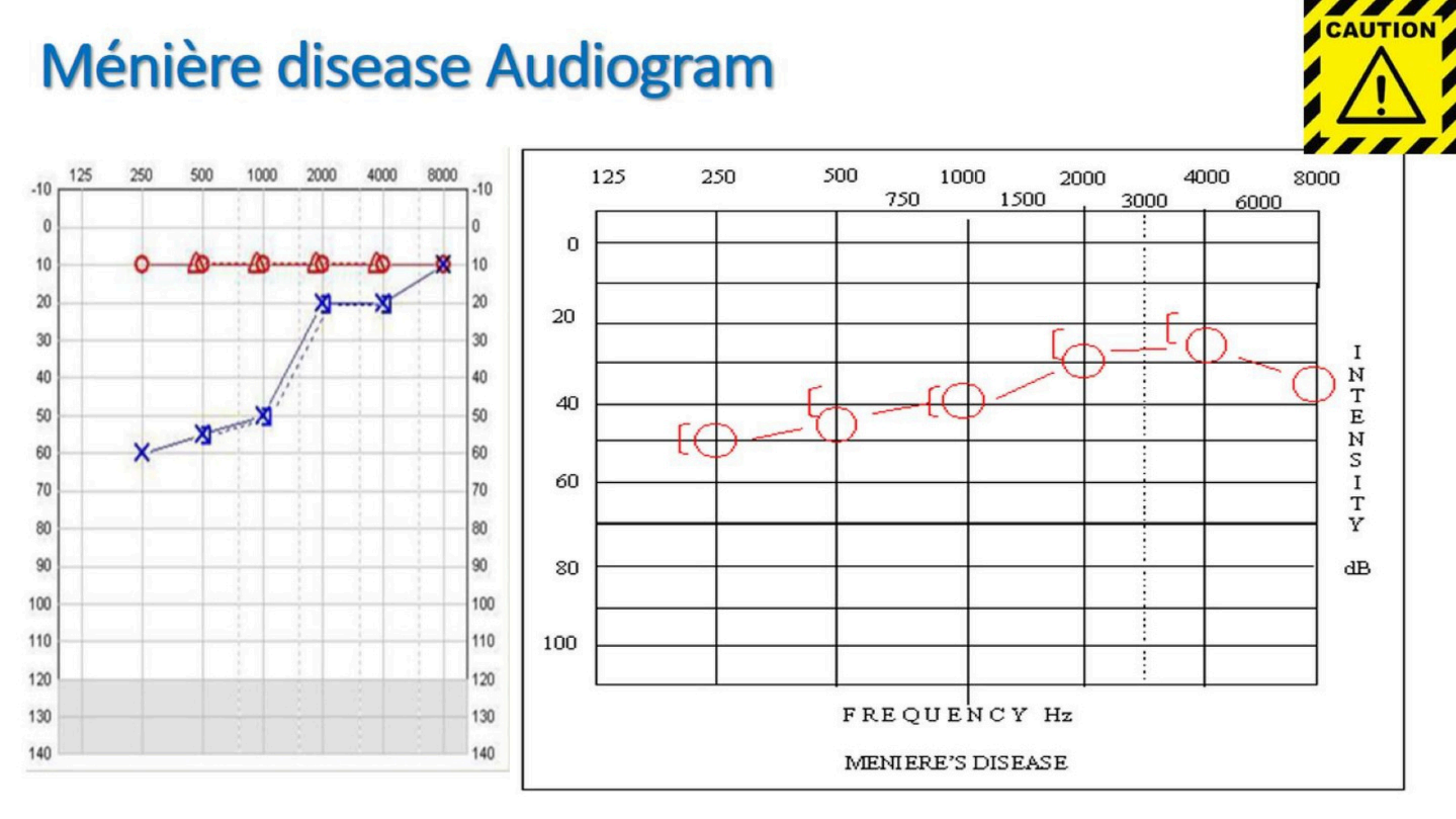
- Exposure to high-intensity noise may cause temporary or permanent hearing loss.
- Noise-induced hearing loss is typically greatest in the 4000- to 6000-Hz region.
- Noise-induced hearing loss is sensorineural except in certain blast injuries with possible tympanic membrane and middle ear damage.

Presbyacusis

- bilateral and symmetrical sensorineural hearing loss.
- the higher frequencies are most severely affected.
- Hearing loss is secondary to degeneration of the cochlea, cranial nerve VIII, and/or the central auditory system.



Ménière disease Audiogram



Ménière disease

- It is idiopathic disease ,but it is believed to be linked to **endolymphatic hydrops, an excess of fluid in the inner ear**. include some combination of **vertigo, hearing loss, and tinnitus.**
- Hearing loss is usually **unilateral**, at least in the early stages,
- Many patients report increased sensitivity to loud noises (recruitment) in addition to the listed symptoms.
- Onset for approximately one half of patients occurs when aged 40-60 years**. The disease is rare in children.**

Speech audiometry

Two parameters are studied:

(i)Speech recognition threshold

(ii)Speech awareness

speech-recognition threshold (SRT)

The speech-recognition threshold (SRT) is sometimes referred to as the speech-reception threshold.

The objective of this measure is to obtain the lowest level at which speech can be identified at least half the time.

Speech-awareness threshold (SAT)

- Speech-awareness threshold (SAT) is also known as speech-detection threshold (SDT).
- The objective of this measurement is to obtain the lowest level at which speech can be detected at least half the time.

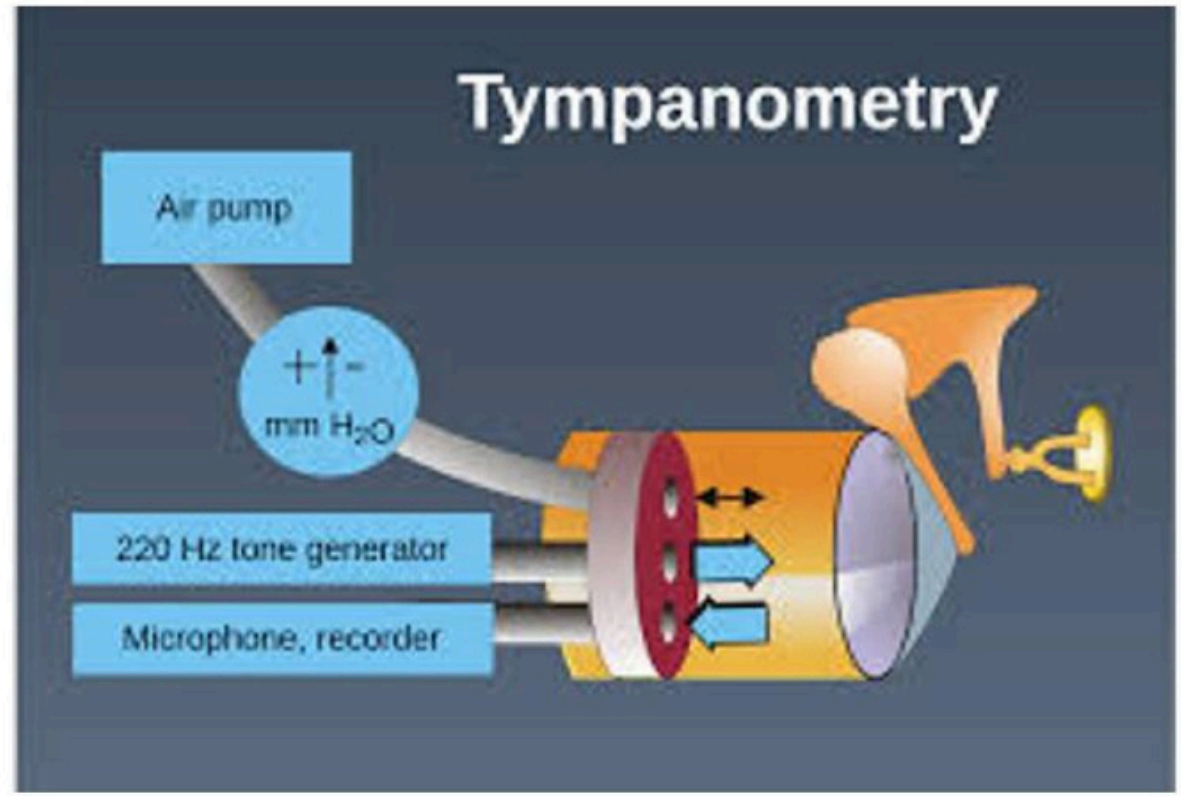
  - The SAT is especially useful for patients too young to understand or repeat words.

  - The SAT may also be used for patients who (1) speak another language or who (2) have impaired language function because of neurological insult.

  - For patients with normal hearing or somewhat flat hearing loss, this measure is usually 10-15 dB better than the speech-recognition threshold (SRT) that requires patients to repeat presented words.

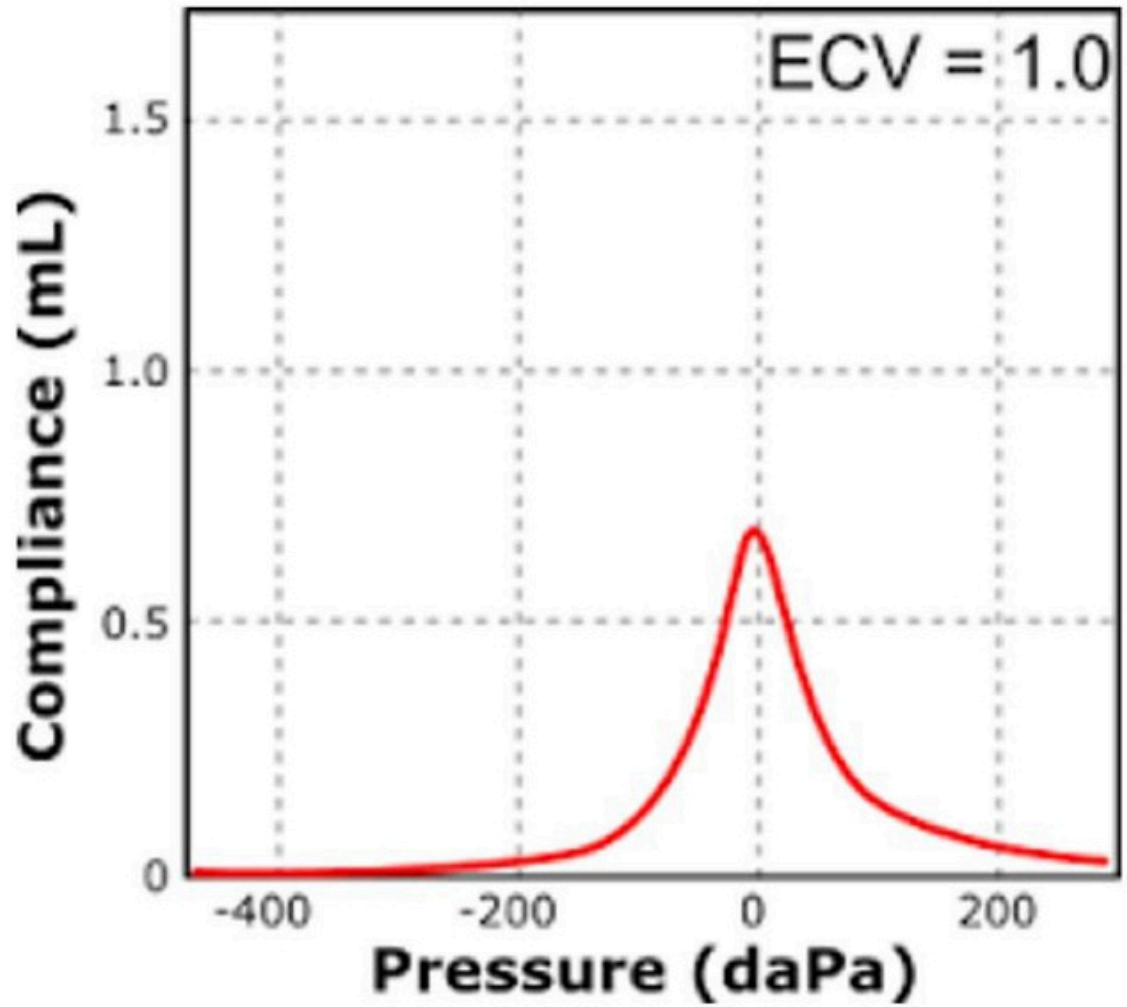
Impedance audiometry (Tympanogram)

- The primary purpose of impedance audiometry is to determine the status of the tympanic membrane and middle ear via tympanometry



- A **type A** response suggests **normal** middle ear function, but it occurs in some otosclerotic ears, particularly in early stages.

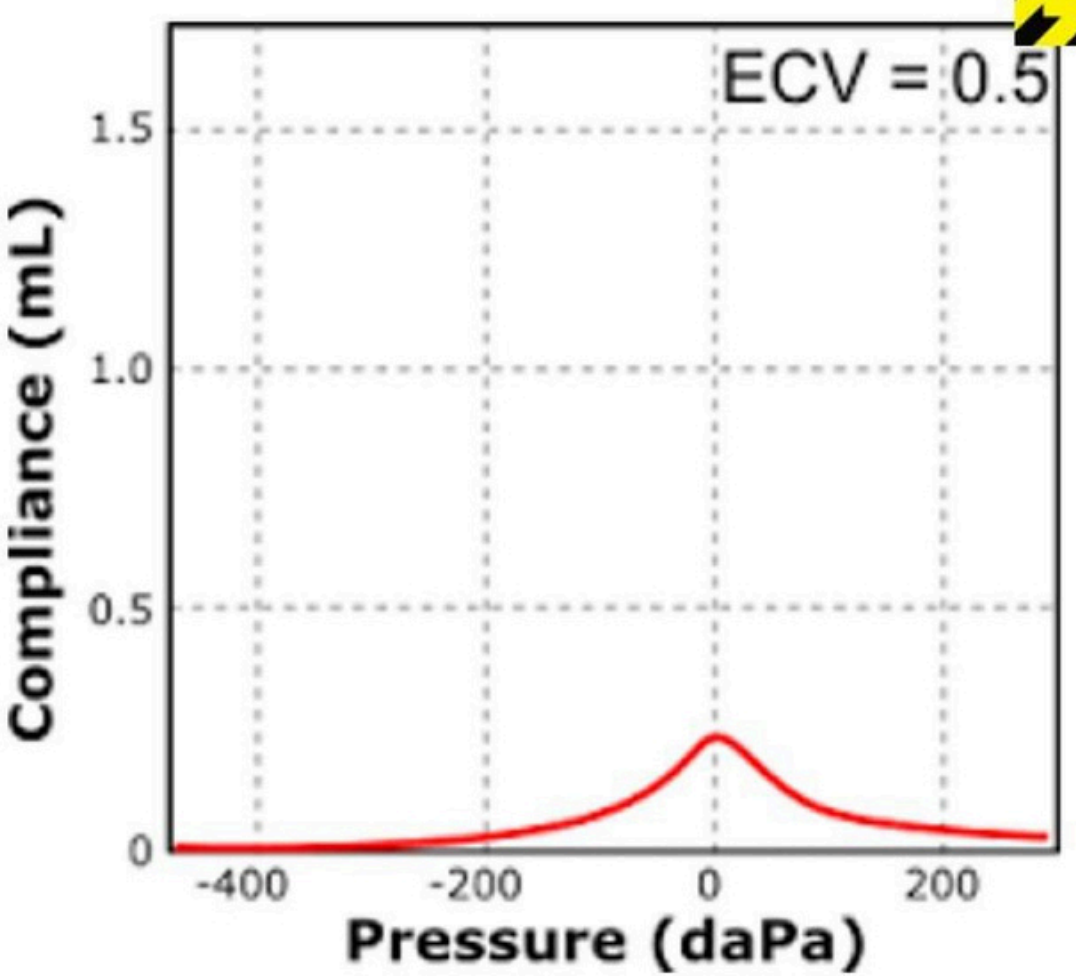
Peak is between +/- 100 daPa
Compliance from 0.3-1.5 ml



Type As (A shallow) suggests a **stiffened** (less compliant) middle ear system.

- Peak is between +/- 100 daPa
- Compliance is less than 0.3 ml

This type may suggest, **otosclerosis and malleus fixation**

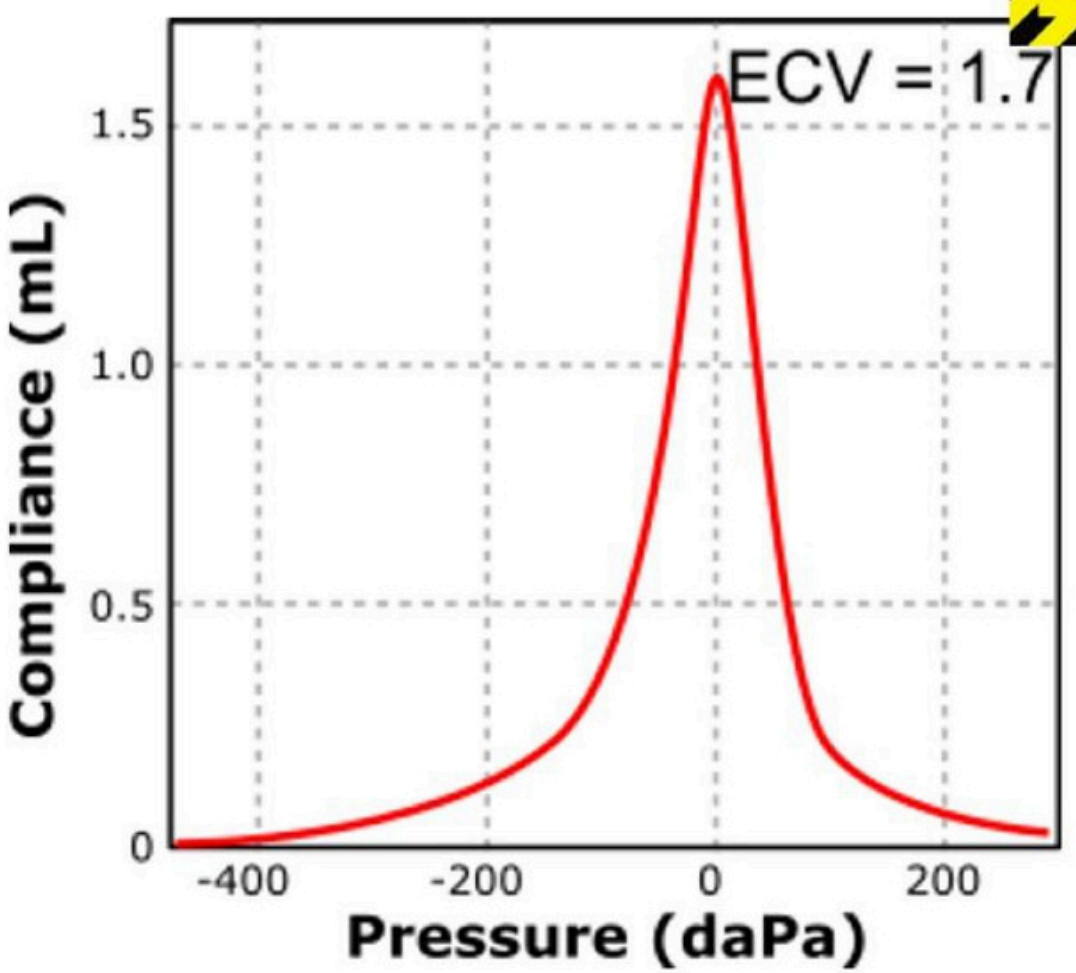


Type Ad High compliance at or near normal pressure.

- Peak is between +/- 100 daPa
- Compliance is more than 1.5 m

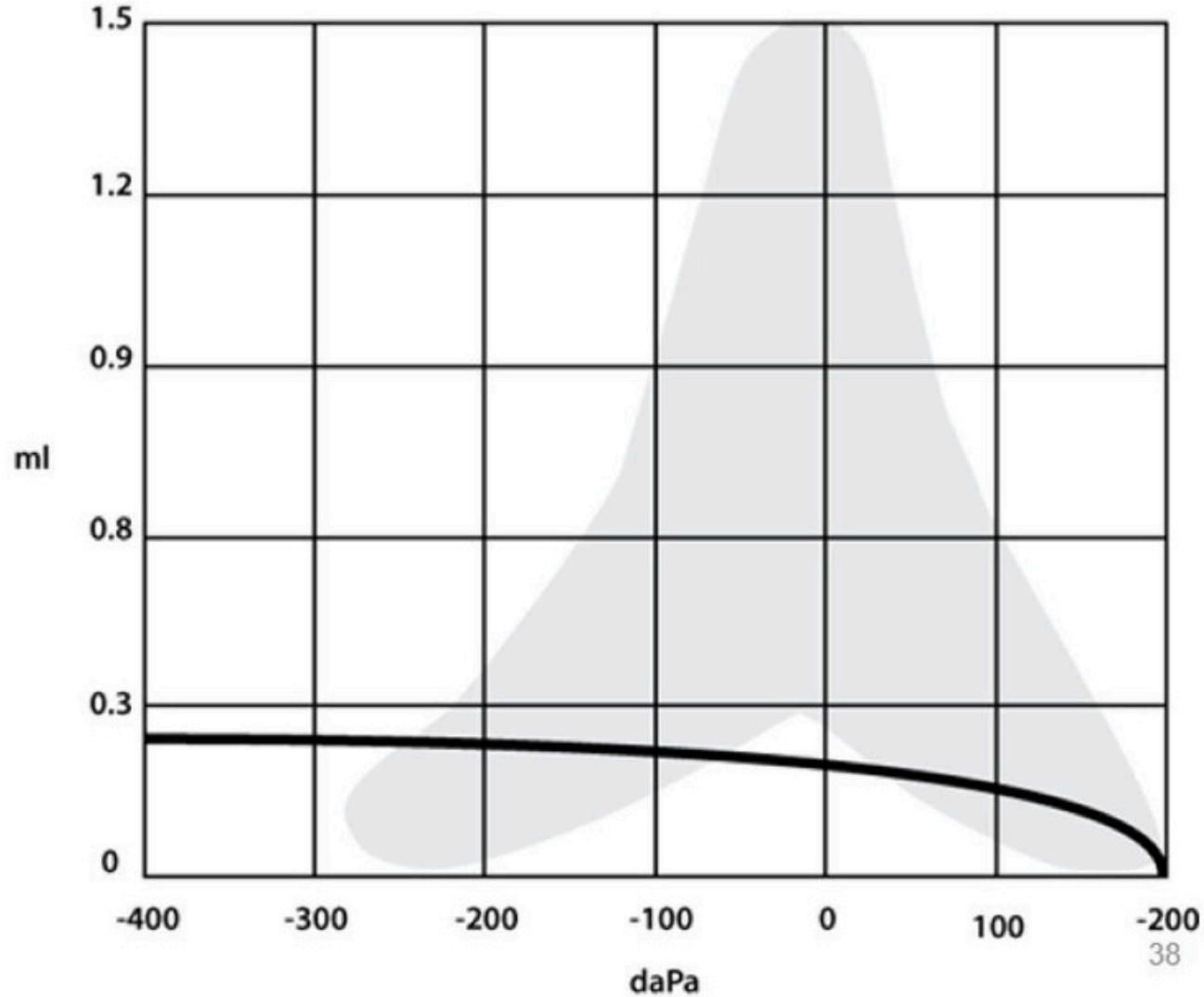
Seen in **ossicular discontinuity or thin and lax tympanic membrane**

Post-stapedectomy.



Type B tympanogram

Type B A flat or dome-shaped graph. No change in compliance with pressure changes.



Type B tympanogram

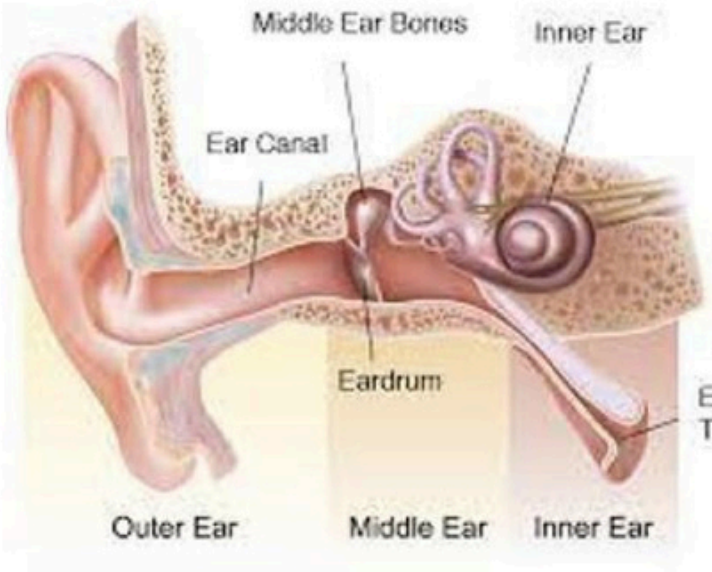
- . Type B tympanograms must be interpreted in conjunction with **ear canal volume** readings.
  - Average ear canal volumes for children are 0.5-1.0 mL.
  - Average adult volumes are 1.0-1.5 mL.
- Type B (**normal** ear canal volume) usually suggests **otitis media.**
- Type B (**small** ear canal volume) may suggest that the ear canal is occluded with **wax/debris** or that the immittance **probe** is pushed against the side of the ear canal.

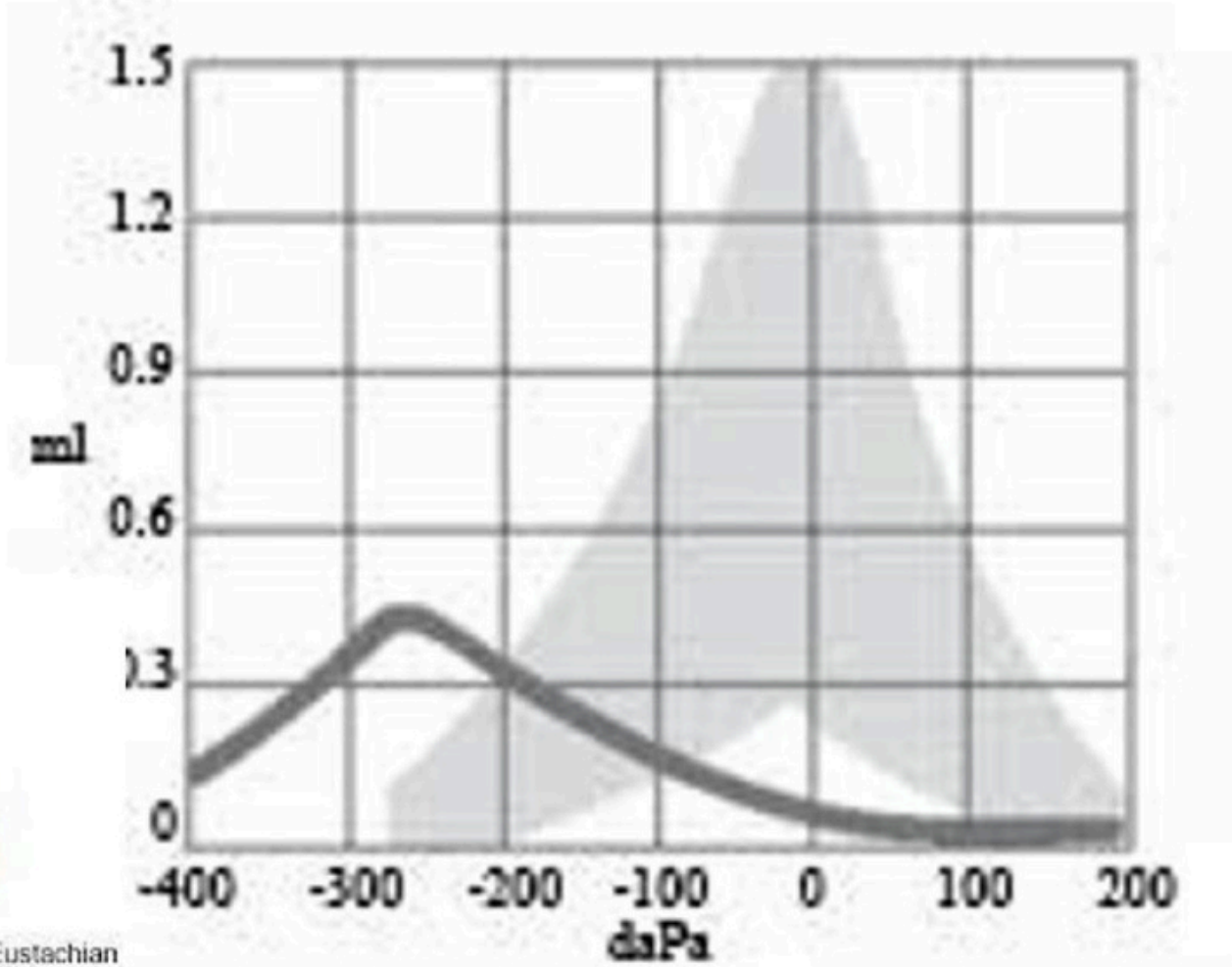
Type B (**large** ear canal volume) suggests a **perforation of the tympanic membrane**. (because middle ear volume is added up to the volume of external ear canal)

Peak is below –100 daPa
Compliance from 0.3-1.5 ml

Type C suggests significant negative pressure in the middle ear system

Additionally, this type indicates a **malfunctioning eustachian tube.**





Etiologies

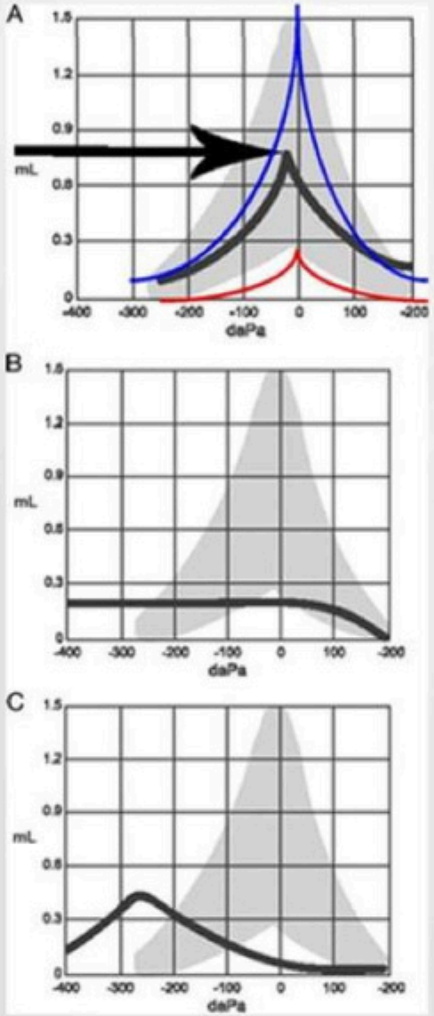


Figure 2. Tympanograms

Type A → Normal

Type A_d → Ossicular Discontinuity (scaling)

Type A_s → TM Scarring, Otosclerosis

Type B "Flat" → Otitis Media w/ Effusion, Occluded Cerumen, Probe against canal (ECV), Perforation/Patent PE tube, Head Trauma, Otosclerosis, Cholesteatoma

Type C → ETD, Pre/Post OM, Barometric pressure changes

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Harlor & Bower, 2009

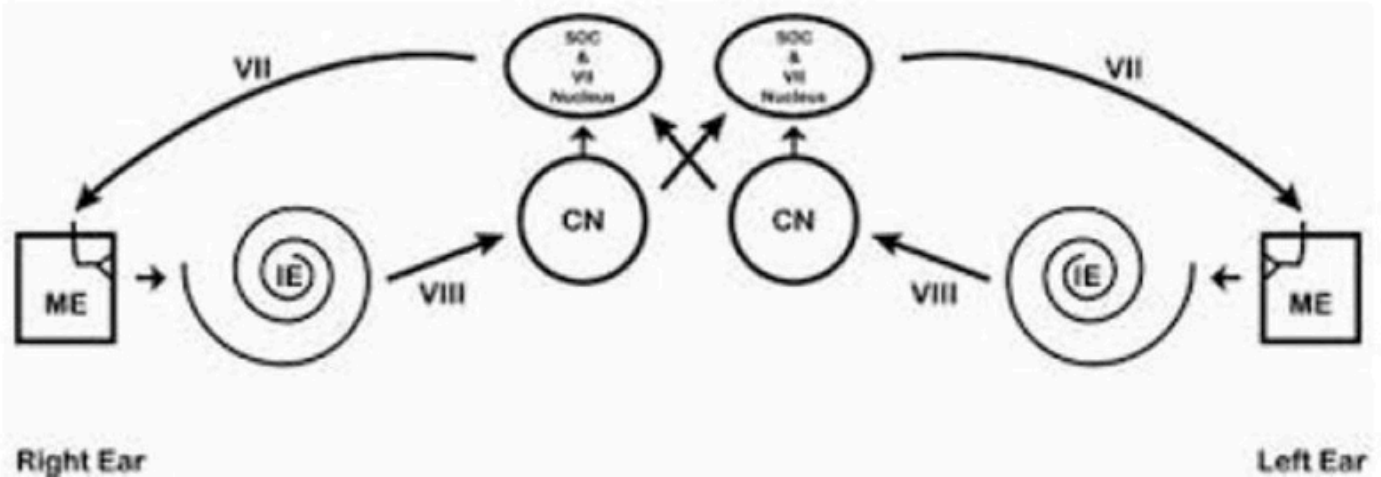
Acoustic reflex

It is based on the fact that a loud sound, 70 - 100 dB above the threshold of hearing of a particular ear, causes bilateral contraction of the stapedial muscles which can be detected by tympanometry

- A person who feigns total deafness and does not give any response on pure tone audiometry but shows a positive stapedial reflex is

a malingerer

- In otosclerosis >decreased reflex

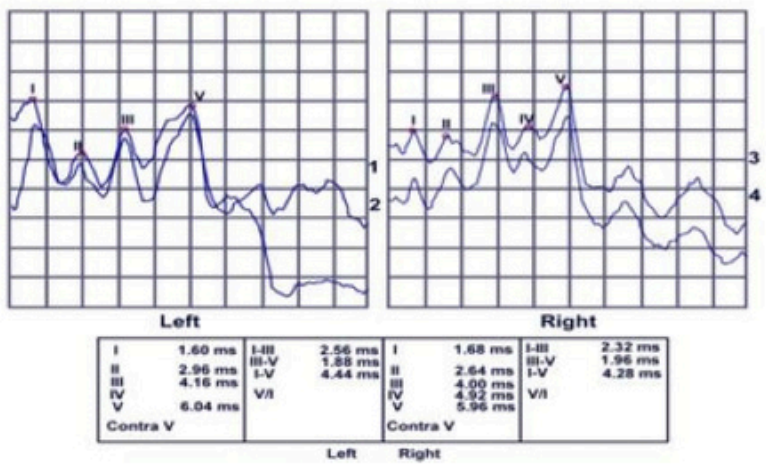


*B*rainstem *E*voked *R*esponse *A*udiometry (BERA)

Alternative Name: Auditory Brainstem Response (ABR) Audiometry

ABR Audiometry

- Auditory brainstem response (ABR) audiometry is a neurologic test of auditory brainstem function in response to auditory (click) stimuli.
  - It is a test of the ***central pathways***.
- Used for **screening for retrocochlear pathology(**such as **an acoustic neuroma** or **vestibular schwannoma.), universal newborn hearing screening**, and **intraoperative monitoring**.



Normal adult ABR waveform response. I-V absolute latencies and interpeak intervals (I-III, III-V, I-V) are within normal limits bilaterally. Interaural differences for the I-V interpeak intervals (1.16ms) and wave V absolute latencies (.08 ms) are within normal limits.

Otoacoustic Emission

- The primary purpose of otoacoustic emission (OAE) tests is to determine **cochlear status, specifically hair cell function**.
- This information can be used to:
  - Screen hearing (particularly in neonates, infants, or individuals with developmental disabilities)
  - Partially estimate hearing sensitivity within a limited range
  - Differentiate between the sensory and neural components of sensorineural hearing loss.
  - Test for functional (feigned) hearing loss
- Does not measure the central pathway