5-Audiology

Objectives:

– **Identify type, degree and configuration of hearing loss.**

– **Identify possible site of lesion for each type of hearing loss.**

– **Determine middle ear function from Tympanometry measurement.**

– **Understand origin, indications and clinical applications of OAE, ABR and speech audiometry.**

– **Briefly recognize vestibular assessment test battery and its clinical significance.**

Resources: Slides +Doctor's notes +435 team.

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[Color index: Important | Notes | Extra] Editing File

- **DR said these are the most Important for exam** :

1- **Pure tone audiometry (type, degree of hearing loss)** 1,2 questions + possible causes
2- **Middle ear assessment (tympanogram)** 1,2 questions
3- Auto acoustic emissions 1 question
(first three guaranteed)
4- Auditory brainstem response (hearing threshold in newborn)
5- Introduction vestibular assessment 4,5 maybe one question

Audiometry (IMPORTANT)

- The Most common test.
- **Indication:** The usual primary purpose of pure-tone tests is to determine the type, Degree, and configuration of hearing loss.
- **Information we get from audiogram:**
  - Degree of hearing loss.
  - Type of hearing loss.
  - Configuration of hearing loss.

Ranges of hearing loss

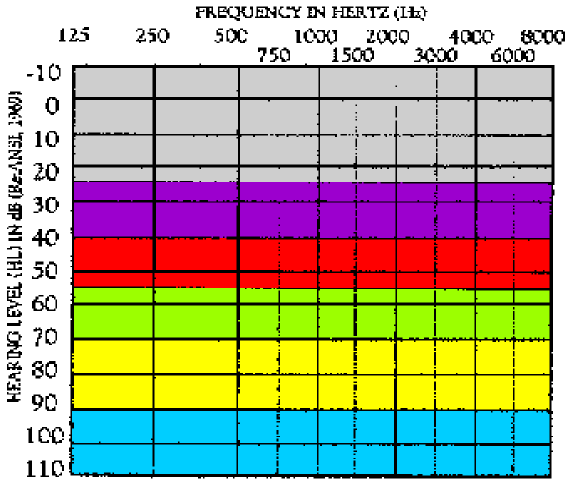
- -10 – 25 dB HL_1 = Normal range
- 26 – 40 dB HL = Mild hearing loss
- 41 – 55 dB HL = Moderate
- 56 – 70 dB HL = Moderately Severe
- 71 – 90 dB HL= Severe
- Greater than 90 dB HL = Profound
- Hearing threshold: the lowest sound intensity you can hear (50 % of trials)
- 0 is a reference point and the average hearing threshold of most patients, it does not mean that is there no sound, so -10 means that the patient's hearing threshold is 10 dB lower than the average population.
- we determine the threshold in different frequencies (250, 500, 1000…). Usually start at 250 Hz, because 125 Hz blends with the background noise.
- If the difference between two octive frequencies is greater than 20 dB, we check the hearing threshold at the midoctive frequencies (750,1500,3000,6000). For example: if the hearing threshold at 500 Hz is 20 dB and at 1000 Hz is 50 dB, we need to check the hearing threshold at 750.
- We test 2 routes : Air conduction & bone conduction,
- How does the bone transmit sound? Bone vibration→ cochlear vibration→ wave endolymph move the basilar membrane (organ of corti) → hair cells (sterocilia) deflect → K go through the channels in high quantity → depolarization.

Y axis: sound intensity dB

- Amplitude/ intensity:
    - The quantity or magnitude of sound
    - Decibel (dB): Unit of amplitude used most frequently in clinical audiology. (Unit of intensity).

X axis: Frequency in Hz

- Humans can hear frequencies ranging from (20-20000HZ).
- Below 20 Hz, we feel a vibration rather than hear a sound.
- Most of the common sounds that humans hear are from(500-8000Hz)
- Most people have very diminished sensitivity for frequencies > 8000---10, 000 Hz.
- High frequency tones stimulate basal turn of the cochlea, and low frequency tones stimulate apical turn of the cochlea.
- Generally, we lose high frequencies first.



- ❖ 0 is not absence of sound. It is the average of hearing thresholds of a group of normal hearing adults that is used as reference (baseline for us to see where the person we are testing falls in comparison to the normal population). There is sound at 0 and even -10. So, a person that can hear at zero is the same as the normal population and a person that hears at -10 hears better than the normal population.
- ❖ We deliver the sound through headphones (air conduction) and through a vibrator (bone conduction) either on the mastoid or the frontal bone. We do that to determine the type of hearing loss. Bone conduction is always equal to or more than air conduction. This means that if air conduction is normal, bone conduction is also normal.

Examples of audiometries (very Important)

- Before we look at the audiometry, we first need to understand the symbols: In audiology noise is used as the masker. Covering the ears just wouldn't work. Instead, noise is introduced to one ear while the other ear is tested with a tone (or speech signal). To indicate that the hearing thresholds were obtained using masking, masked threshold symbols are used on the audiogram.

important

LEGEND / KEY

BLUE is the standard used to signify the LEFT.
RED is the standard used to signify the RIGHT.

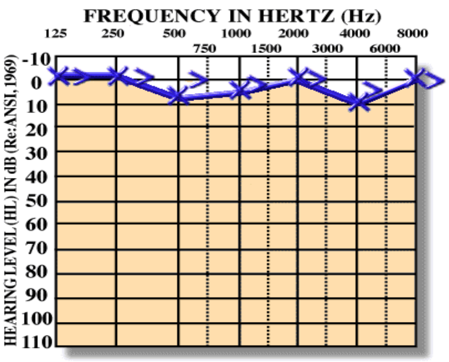
Test Result Markings used on your audiogram:

	Right	Left
Air Conduction	O	X
/ with masking	Δ	☐
Bone Conduction	<	>
/ with masking	[	]
No Response	↙	↘

While these symbols are the standard, they are not used by all hearing professionals. Please ask if they are right for your audiogram.

These graphs were done using a computer program for clarity. Unfortunately, sometimes the actual graph may be more difficult to read due to bad handwriting. If you can not read your audiogram, please ask your hearing professional for assistance.

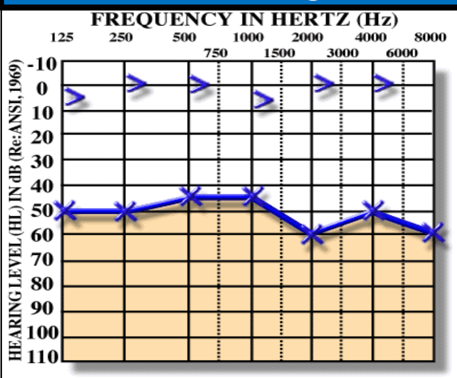
1. Normal Hearing



Comment: We can see in the audiometry above that both air and bone conduction is within the normal rage (-10-25), so this audiometry indicates **normal hearing** (in the left ear).

Usually when Air conduction is normal we do not test bone conduction.

2. Conductive hearing loss



Comments: we can see from the audiometry above the bone conduction is within normal range, but the air conduction is reduced by 30 dB. This audiometry indicates **conductive hearing loss** (in the left ear) .

Limitation: Bone conduction has limitation in the intensity (70 db), so we will not be able to determine the hearing threshold if it exceeds 70 dB using bone conduction.

Causes:

Anything that limit the movement of the tympanic membrane cause conductive hearing loss.

The pathology is either in the middle ear or outer ear

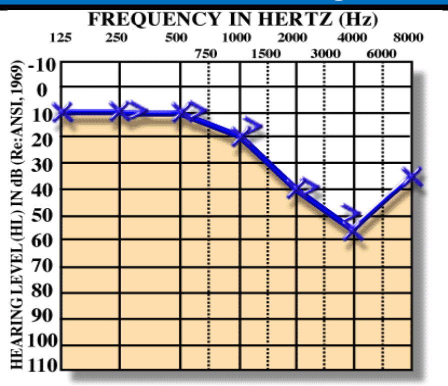
E.g.

outer ear: (Wax impaction, complete obstruction)

middle ear (otitis media with effusion , perforation , ossicular changes, eustachian problems)

the degree of hearing loss is: moderately to moderately severe

3. Sensor neural hearing loss



Comments: we can see that both air and bone conduction is reduced blow the normal range starting from starting from 1500 Hz. This audiometry indicates **sensorineural hearing loss** (in the left ear) .

In such situations, describe the configuration. E.g.: Here, we have normal hearing in low frequencies, then we have a sharp drop at high frequencies with a notch and sensorineural hearing loss.

Organ of Corti (basilar membrane, outer and inner hair cells; without basilar membrane we have deafness.

Notched shape in the audiogram indicates noise associated hearing loss (working factories, airport workers**).**

Causes:

Inner ear (noise, labyrinthitis, fracture cochlea, Meniere's disease)

nerve: tumor (acoustic neuroma)

pathway up to the brain: (tumor in the pathway, trauma)

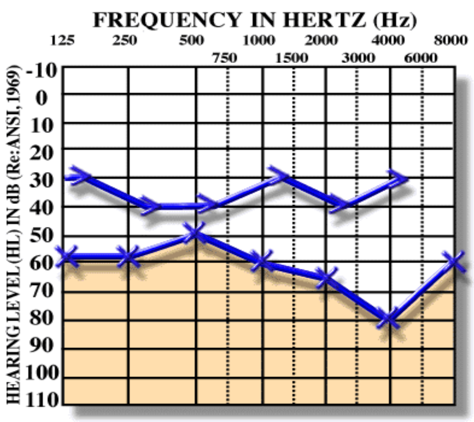
Otosclerosis starts conductive, then mixed, finally pure sensory neural)

the pathology is either inner ear, nerve or CNS

Clinical Masking:

- Non-tested ear can influence thresholds of test ear.
- Masking is exclusion of one ear while doing the test; we do it when there is a possibility of crossing over. Crossing over gives false results in the test.

4- Mixed hearing loss:

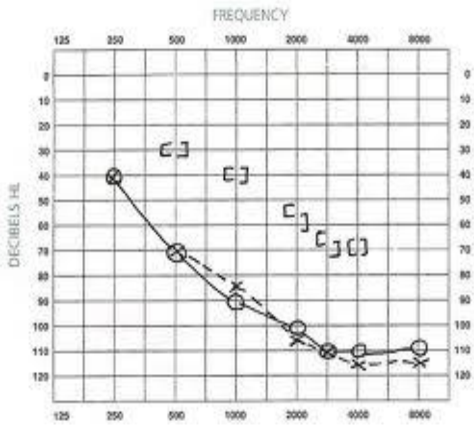


In mixed hearing loss, the degree is determined by the air conduction, (because it is always worse).

The degree is: moderately sever to sever

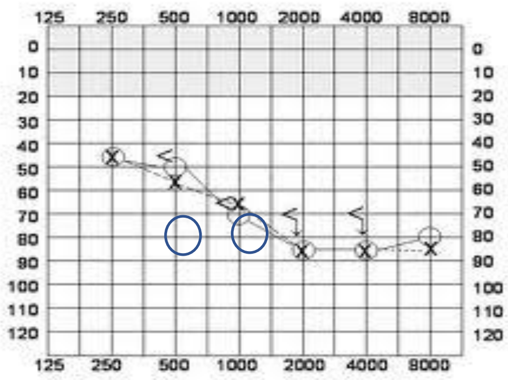
Comment: We can see that both air and bone conduction are below the normal range. In addition, the difference between air and bone conduction is greater than 10 Db. This audiometry indicates mixed hearing loss. (in the left ear)

What do you think te diagnosis in this image?



Comment: there is a reduction in air conduction in both RT and LT ear. So we can see it is conductive hearing loss in both ears. Why not sensorineural? Because in order to confirm that it is sensorineural, you have to check the bone conduction.

Remember: Bone conduction has limitation in the intensity of (70db). Perform other tests like tympanogram.



The sign means that there was no response to the maximum output of the bone conduction vibrator. It doesn't mean that there is a hearing issue it just means that you can't determine the hearing loss in high frequencies based on the audiogram alone.

Summary:

- Air conduction (abnormal) + Bone conduction (normal) = Conductive hearing loss
- Air conduction (abnormal) + Bone conduction (abnormal) + NO GAP = Sensorineural hearing loss
- Air conduction (abnormal) + Bone conduction (abnormal) + GAP = Mixed hearing loss
- What is the definition of the gap? >10 db between air and bone conductions
- You **MUST** know:
  1. What is the type of hearing loss?
  2. What is the degree of hearing loss?

Tympanogram

- Tympanogram: uses pressure and sound to check how much was absorbed and reflected.
- Middle ear analysis is important given that it is the most commonly affected organ in the ear.
- X axis middle ear pressure, Y axis admittance the middle ear is most effective if the pressure is equal to the atmospheric pressure. (ATM=0 in the tympanogram)
- Physiology:
  - When sound travels between air and fluid there will be a mismatch and most of the energy will be reflected. The middle ear amplifies and transduces the sound energy to mechanical energy that can easily penetrate the fluid.

it gives you the status of outer and middle ear

Tympanogram features:

- Tympanometric shapes.
- Static acoustic admittance.
- Tympanometric width (gradient).
- Tympanometric peak pressure.
- Equivalent ear canal volume.

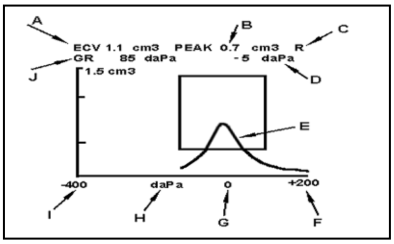
Sensitivity and specificity:

- Sensitivity has been found to be around 82% for MEE.
- Normal type A has 100% specificity.
- Overall sensitivity of around 80% and specificity of around 90%.

Types of Tympanogram

- Questions you need to ask when assessing the tympanogram:
  - Is there a Peak?
  - And at What pressure?

Type A (normal)

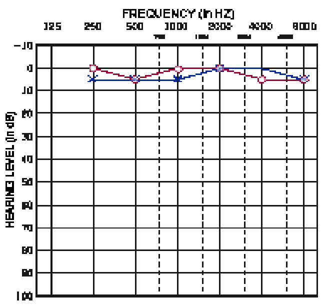


Q1) Is there a peak? Yes
The peak means maximum sound penetration through the tympanic membrane. This happens when the pressure inside and outside the tympanic membrane are equal.
Ranges: Adults: -100 to +50
Children: -150 to +50

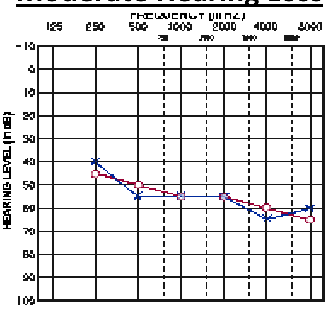
Q2) At what pressure? 0.
Zero here does not mean no pressure. It means that the pressure inside and outside the membrane are equal.
Dr: to make it easy if the peak is in the square or rectangle, then it is normal.
ECV: ear canal volume

Corresponding audiogram:

Normal hearing

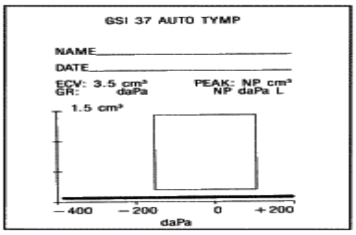


Moderate Hearing Loss



Type A could be either normal or sensorineural hearing loss
Type A is a normal tympanogram, which means normal movement of the tympanic membrane not, it doesn't mean normal hearing.

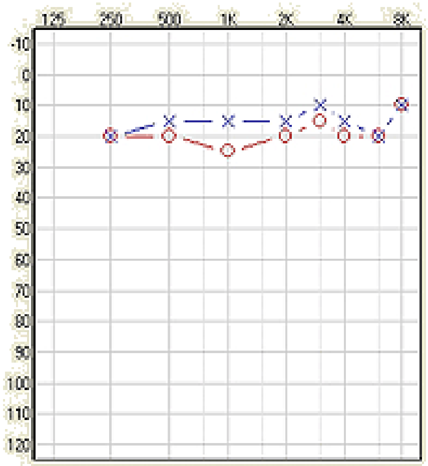
Type B



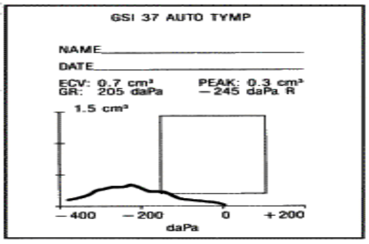
Q1) Is there a peak? No
Q2) With type B you have to ask about the ear canal volume
Why do measure the volume of the ear canal? To detect different pathologies like perforation or wax impaction

Causes
low ECV = Wax Impaction/ Foreign body
Normal ECV = Pathology in middle ear (tympanic membrane is not moving) E.g. Otitis media with effusion
High ECV = perforation with or without middle ear effusion.

Corresponding audiogram:
Slight conductive hearing loss in audiogram



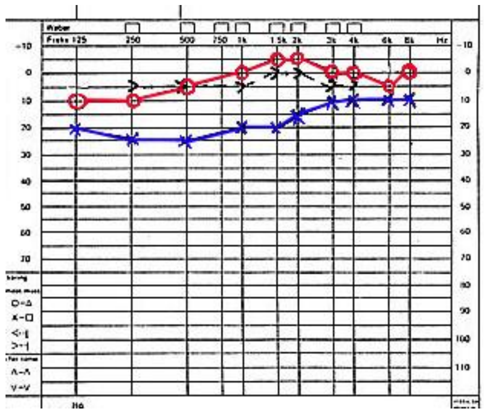
Type C

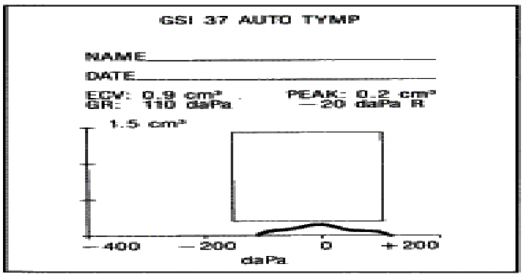
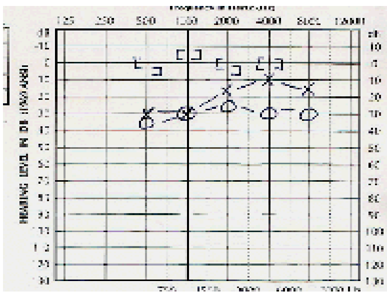
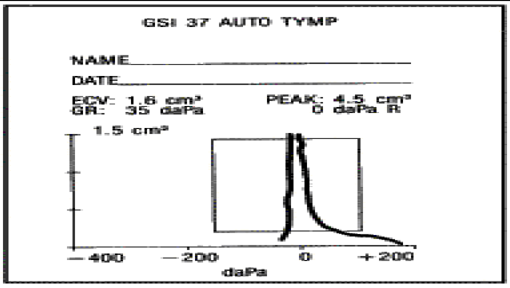
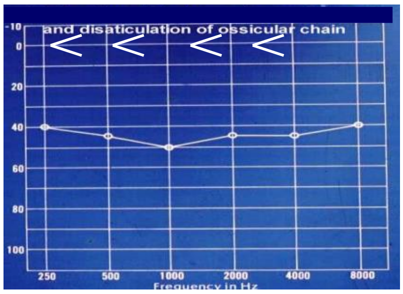


Q1) is there a peak? Yes
Q2) At what pressure? -250 (the reference is atmospheric pressure)
- 250 pressure (severe negative pressure).
There is problem in the Eustachian tube.
Why negative pressure not positive? We have normal flora in the middle ear that consumes oxygen. As a result, the oxygen will be consumed and there is no ventilation.

Cause:
problem in the Eustachian tube.

Corresponding audiogram:
Conductive hearing loss (air)



Type As (s= stiffness)	Type AD (D=dislocation)
 **Q1) Is there a peak?** yes **Q2) at what pressure?** 0 **Q3) Is it a normal tympanogram?** It is a subtype of a normal tympanogram where the peak is short Cause: Otosclerosis of stapes bone. The other structures are still moving (Incus, mallues), but the stapes is not so the intensity is low. It does not always mean otosclerosis. It can appear in cases of decreased elasticity (elderly) **Corresponding audiogram:** **<u>Conductive hearing loss: (air conduction)</u>** 	 **Q1) Is there a peak?** yes **Q2) at what pressure?** 0 **Q3) Is it a normal tympanogram?** It is a subtype of a normal tympanogram where the peak is high Cause: ossicular dislocation (the system is moving too freely) **Corresponding audiogram:** **<u>Conductive hearing loss:(Air conduction)</u>** 

Static Compliance (Peak Compliance):

Adult

	Peak Compliance (mmho or cc)	Ear Canal Volume (cc)
Mean	0.8	1.1
90% range	0.3 to 1.4	0.6 to 1.5

Child

	Peak Compliance (mmho or cc)	Ear Canal Volume (cc)
Mean	0.5	0.7
90% range	0.2 to 0.9	0.4 to 1.0

Tympanometry in infants:

- Studies has found frequent occurrence of double peaked tymps.
- Usually we use higher probe frequency when testing infants like 1000 Hz.

Otoacoustic Emissions (OAE)

(sound from the ear)

Physiology:

- **Round widow has membrane (round window membrane) . helps in decompressing the inner era or remove some pressure, otherwise the fluid will not be able to move.**
- **A complete wave cycle is one complete period of compression and rarefaction of a sound wave.**
- **the sound enters the inner ear, fluid vibrate movement of the outer hair cells. the movement of the hair cells create a wave moving forward (compression) and backward (refraction) to the stabes. then the tympanic will move creation sound. This sound is detected in OAE**

Origin of OAE (Otoacoustic Emissions)

- Initially reported by Kemp in 1978.
- OAE are considered a by-product of sensory Outer Hair Cells (OHCs) transduction and represent cochlear amplifier that thought to be as a result of the contraction of OHCs in synchrony with BM displacement.
- The contraction of the OHCs (movement) is then propagated outward toward the middle ear and moves the TM.
- This in turn creates acoustic energy that is picked by the OAE probe.
- Outer hair cells increase the resolution of the sounds we hear thereby improving our understanding. They provide the majority of otoacoutic emission. They are also the most sensitive structure, therefore if they are normal, the inner ear is assumed to be normal. (retrochochlear lesions though will not be picked up in OAE readings. This test will only give information up to the level of the chochlea.)

Recording OAE's

- OAE can be recorded in both adults and infants.
- Tests the healthiness of the inner ear mainly the healthiness of the sensory cells in the inner ear (Outer hair cells)
- We cannot use this tool to measure threshold of hearing.
- OAEs are measured by presenting a series of very brief acoustic stimuli, clicks, to the ear through a probe that is inserted in the outer third of the ear canal. The probe contains a loudspeaker that generates clicks and a microphone that measures the resulting OAE's that are produced in the cochlea and are then reflected back through the middle ear into the outer ear canal.
- The resulting sound that is picked up by the microphone is digitized and processed by specially designed hardware and software. The very low-level OAEs are separated by the software from both the background noise and from the contamination of the evoking clicks.
- So in order to record OAE in EAC (external auditory canal) we need to have normal middle **ear function.**
- Conductive pathologies can prevent the recording of OAE but this does not mean that OAE is not present.
- Not affected by sleep but needs test subject to be still and compliant Very quick.

Types of OAE

1. <u>Spontaneous OAE: (not usually used)</u>

- Occurs in the absence of any intentional stimulation of the ear. You have the emission without stimulation.
- Prevalence is in about 40-60% of normal hearing people.
- When you record SOAE's, you average the number of samples of sounds in the ear and perform a spectral analysis.
- The presence of SOAE's is usually considered to be a sign of cochlear health,
- but the absence of SOAE's is not necessarily a sign of abnormality.

2. <u>Evoked OAE:</u>

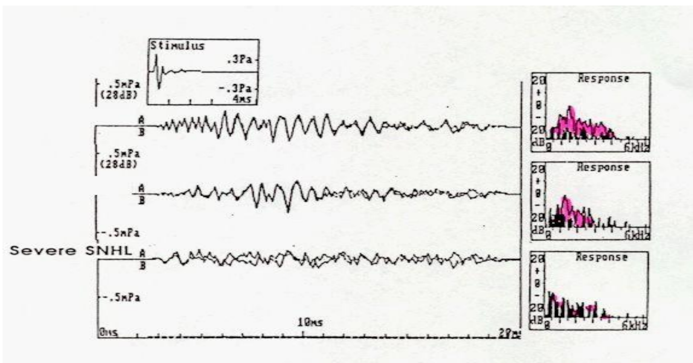
a. Distortion Product OAE

- Result from the interaction of two simultaneously presented pure tones.
- Stimuli consist of 2 pure tones at 2 frequencies (ie, f1, f2 [f2>f1]) and 2 intensity levels (ie, L1, L2). The relationship between L1-L2 and f1-f2 dictates the frequency response.
- DPOAEs allow for a greater frequency specificity and can be used to record at higher frequencies than TOAE. Therefore, DPOAE may be useful.

b. **Transient Evoked OAE (usually used)**

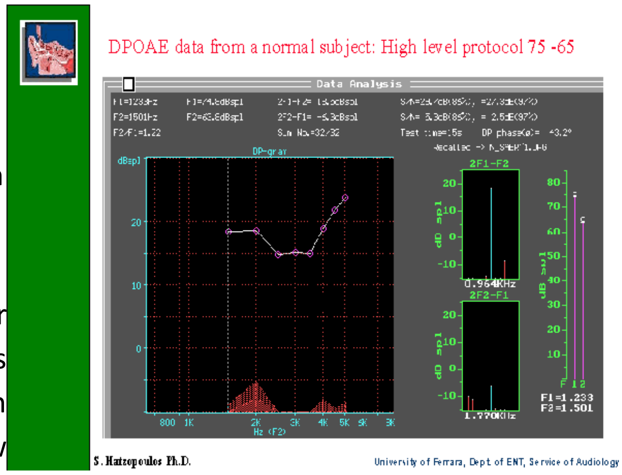
- TEOAE are frequency responses that follow a brief acoustic stimulus, such as a click or tone burst.
- The evoked response from this type of stimulus covers the frequency range up to around 4 kHz.
- In normal adult ears, the click-elicited TEOAE typically falls off for frequencies more than 2 kHz, and is rarely present over 4 kHz, because of both technical limitations in the ear-speaker at higher frequencies and the physical features of adult ear canals so that is why DPOAE would be more efficacious. Not frequency specific.
- For newborns and older infants, the TEOAE is much more robust by about 10 dB and typically can be measured out to about 6 kHz indicating that smaller ear canals influence the acoustic characteristics of standard click stimuli much differently than do adult ears.
- TEOAE do not occur in people with a hearing loss greater than 30dB.
- Accordingly, TEOAE and DPOAE can be used to screen for hearing loss in infants.

Comment: the first reading is normal, second is high frequency hearing loss, third is severe sensorineural hearing loss



Clinical Application of OAE:

1. Can be used in newborn hearing screening. The results will indicate either fail or pass. Fail means that hearing thresholds are worse than 30 dB HL. Pass results means hearing thresholds are 30 dB HL or better.
2. In differential diagnosis of hearing loss (site of lesion). This can help in differentiating sensory from neural.
3. Monitoring of the effect of ototoxicity or noise exposure.
4. Although still under research: DPOAE can be used to screen for the carriers of the recessive hearing loss genes: many studies found that DPOAE is larger (especially at high frequencies) in carriers than in non-carriers when using f2/f1 of 1.3 and low stimulus levels of 50-60 Db.



Clinical limitations:

- Problems because of middle ear disease
- Not sensitive for neonates within 24 hours of birth
- Results affected by test conditions (Noise)
- Not a test of hearing- limited application
- Sometimes the screening will not detect pathologies in the higher centers (auditory cortex).

Criteria for Normal OAE:

1- Signal to noise difference >3dB.

2- In at least 3 bands.

Scenario 1:

conductive hearing loss with type B tympanogram: can we detect OAE? NO, because we have to have an intact conductive pathway. This does not mean that there is no OAE in the inner ear, we simply cannot measure it. Remember: any conductive hearing loss will make it impossible or difficult to detect the OAE.

scenario 2:

Sensorineural hearing loss 50 dB with normal type A tympanogram, can we detect OAE? NO, because outer hair cell damage. remember any insult in the inner ear the first to go is the outer hair cells (weakest organ in the inner ear) damage permanent. inner hair cells have more protection.

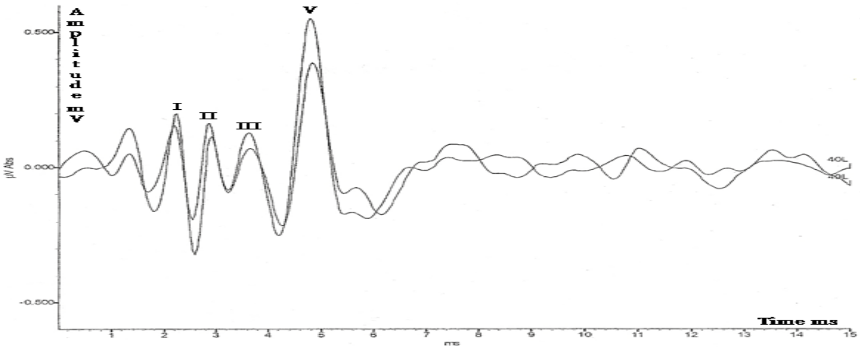
Auditory Brainstem response

- This tests what is beyond the cochlea. So we are testing the nerve up to the brainstem (neural assessment). To pick up the electrical impulses (action potentials) that originated from the ear which are very small (microvolts), we have to cancel out the EEG.
- You need a compound action potential to stimulate the brain (several thousand).
- The most important clinical application of ABR is to estimate hearing threshold. In who? In neonates, mentally retarded individuals or comatose patients. Why? Because they cannot respond and tell you when they hear the sound.

The normal ABR waveform

- Is characterized by 5-7 peaks.
- Occurs in a latency epoch of 1.4 – 8.0 ms.
- Responses are usually displayed with positive peaks reflecting neural activity toward the vertex.
- These peaks are labeled with the roman numerals I through XII.
- A normal reading requires a minimum of 3 waves which are I, III and V.
- The most prominent waves are I, III, and V.

This graph is only in one level, you can't determine the threshold.



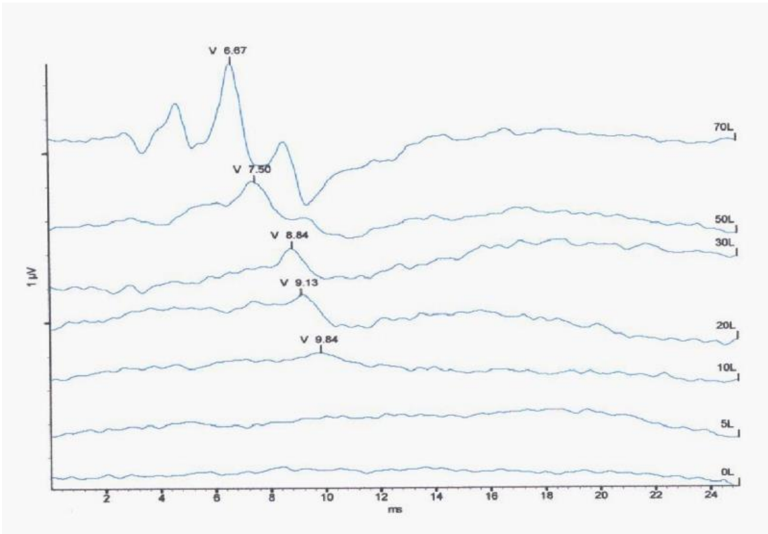
If the inter-peak interval is larger than normal, the pt has latency.
Think about it this way, if you are in highway that has no bumps, your speed will be high. If you're in a road with numerous bumps, you are inclined to slow down. Same thing goes here, if the neural tract is nice and smooth, the waves will flow smoothly and quickly. If there is any kind of bump like tumors, demyelination or any pathology, the waves will take more time to pass through them.
By knowing the normal timing of the waves and the normal inter-peak intervals, you can determine the location of the pathology if there was one. For example, if the time between wave 1 and 3 is longer than normal but the other intervals are ok, I can estimate the location of the pathology if I know where wave 1 and wave 3 normally occur.

What is the hearing threshold?

The least intensity at which the peak appears. Wave 5 is the last one to disappear, hence it is an accurate estimate of hearing threshold. It disappears below 10 dBnHL.

So what is the hearing threshold here?

10 dBnHL.



What you must know?

1. **Which wave?**
2. **What is the hearing threshold?**
3. **It tests the whole pathway**
4. **It most suitable for hard to test subjects (infants.)**

How is an ABR recorded?

Electrodes are placed on the scalp and coupled via leads to an amplifier and signal average. EEG activity from the scalp is recorded while the ear(s) are stimulated via earphones with brief clicks or tones.

A series of waveforms unique to the auditory neural structures is viewed after time locking the EEG recording to each auditory stimulus and averaging several thousand recordings.

<u>**Generators of ABR**</u>

Dr" you don't have to know it"

- Wave 1: distal portion of auditory nerve
- wave 2: proximal portion of auditory nerve
- wave 3: superior olivary complex
- wave 4: medial geniculate body
- wave 5: between pons and midbrain Auditory pathway:

cochlea ⟶Auditory nerve ⟶ventral & dorsal cochlear nucleus ⟶superior olive ⟶lateral lemniscus ⟶inferior colliculus ⟶medial geniculate body ⟶auditory cortex.

<u>**Characteristics of normal ABR:**</u>

Information to determine normal ABR waveform depends on:

1. Waves absolute latency.
2. Waves interpeak intervals.
3. Latency-intensity function.
4. Wave V/I amplitude ratio.
5. Interaural wave V latency difference

- Research established normal ranges of the above parameters.
- Normal ranges for the above parameters are not universal.
- There is some variation among different research findings.
- Many factors affect normal values including age, sex, temp and other factors.
- It is always better for each practice to establish its own norms.

Absolute latency of ABR waves in adults:

- Wave I: at around 1.6 ms +/- 0.2 ms.
- Wave III: at around 3.7 ms +/- 0.2 ms.
- Wave V: at around 5.6 ms +/- 0.2 ms.

Interwave latency intervals:

- I-III: 2.0 ms+/- 0.4 ms.
- III-V: 1.8 ms +/- 0.4 ms.
- I-V: 3.8 ms +/- 0.4 ms.

- Wave V latency-intensity function: increases by around 0.3 ms per 10 dB decrease of the stimulus level.
- V/I amplitude ratio: greater than 1.0.
- Wave V latency difference: less than 0.4 ms.
- Latency helps determine the site of electrical activity in the auditory pathway.

Clinical application of ABR

There are two main applications for ABR in the clinical settings:

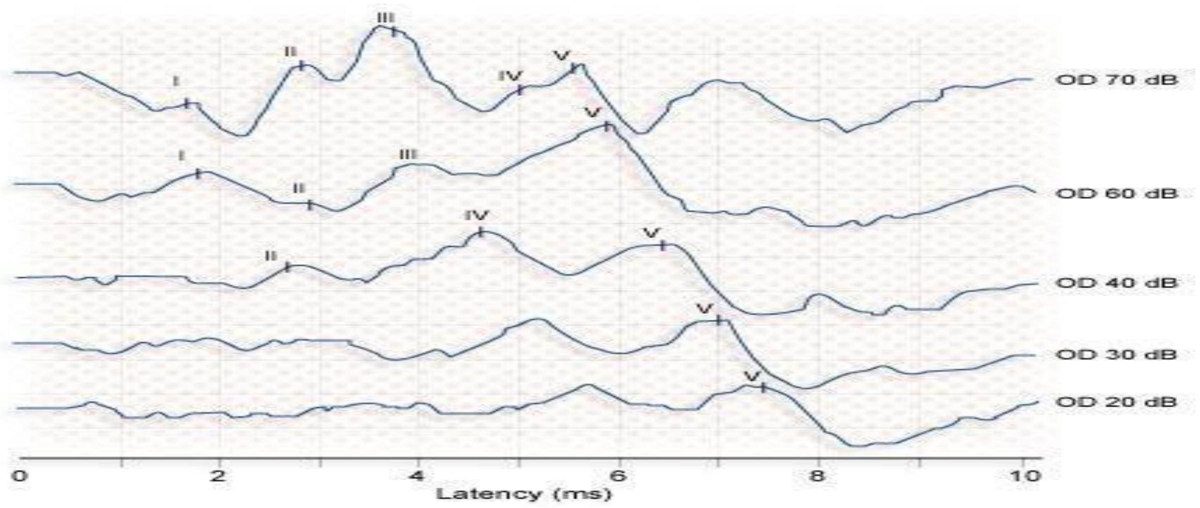
1- Neurodiagnosis: to assess the auditory pathway. This feature is specially used in adult populations.

- Waves absolute latency.
- Interpeak intervals.
- Interaural wave V latency difference.
- Absence of waves.
- **Who should be tested?** Patients with: Dizziness, Unilateral tinnitus, asymmetrical hearing loss, sudden onset of hearing loss, progressive hearing loss.

2- Hearing thresholds estimation: mainly used in infants and children population, non-cooperative patients, and mental retardation.

- Wave V threshold.
- Wave V latency-intensity function.
- Can be obtained by progressively decreasing intensity of the stimulus (click or toneburst) and observing wave V.
- The last intensity that wave V appears at is considered its threshold.
- ABR threshold is within 10-20 dB from the subjective threshold.
- the last to disappear is wave 5 as we decrease the intensity.
- Wave 5 is used to estimate hearing threshold (Question in the Exam!!!)

Dr "The question might be straight forward, or I might give you an ABR graph (next page) and ask you to determine the hearing threshold"



See wave 5, when the peak disappears this the hearing threshold. The peak disappeared at 20 dB, therefore the hearing threshold is at 20dB.

Eye movement recording

- In performing ENG/VNG, the patient eye movements are measured relative to head position, which can be achieved in a number of ways.
- Measuring electric potentials, measuring magnetic potentials, using video cameras or using infrared technology and direct observation.

Balance:

1- vestibular (most important)

2- vision

3- proprioception.

- **If you focus on one object and move your head, the object should still be clear and not hazy. This will happen if all the three systems are intact.**
- **Information from all these systems need to match for us t have clear images. If there is a pathology in the vestibular system (peripheral or central), we make the diagnosis from the eye movement.**
- **misinformation in these modalities lead to vertigo, dizziness, and nystagmus.**

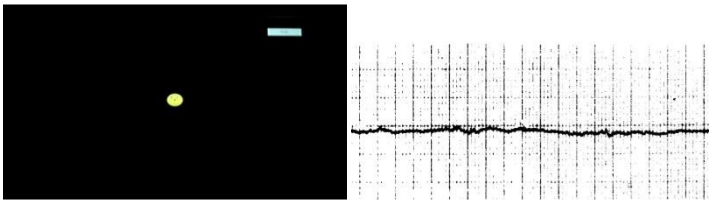
Nystagmus:

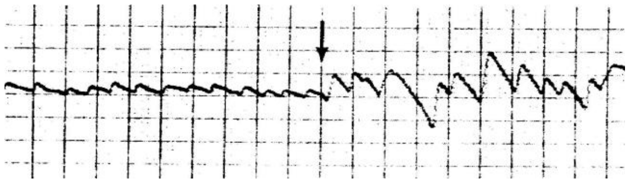
- Is an involuntary conjugated rapid repetitive eye movement.
- Side to side (horizontal), Up and down (vertical), In a circle (torsional) **It could right or left beating depending on the fast component.**
- **Light suppress nystagmus so we need to examine in a dim light room**

Videonystagmography (VNG) test battery

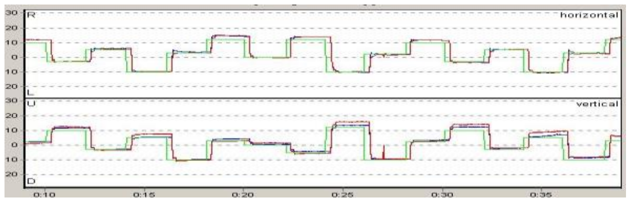
don't go into details only what's here.

- **Calibration**
- **Gaze**
- **Saccade**
- **Pursuit**
- **Optokinetic**
- **Positional**
- **Hallpike**
- **Caloric**

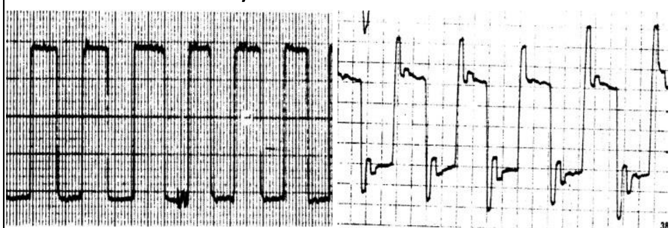
<table>
<tr><th>Gaze test</th><th>Gaze test in peripheral lesion</th></tr>
<tr><td>


- The function of the gaze system is to maintain visual fixation of an object on the fovea of the eye.
- To identify the presence of spontaneous eye movement.
- Normal gaze, patient able to maintain position with eyes opened and closed.
</td><td>


- Horizontal.
- Directional fixed.
- Suppressed with visual fixation.
</td></tr>
<tr><th>Gaze test in central lesion</th><th>Saccade (re-fixation) Test</th></tr>
<tr><td>


- Horizontal, vertical or rotatory.
- Directional changing.
- Enhanced with visual fixation.
</td><td>


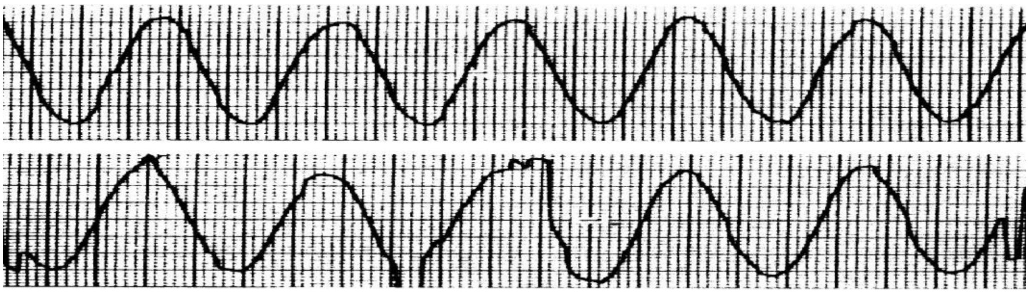
The function of saccadic eye movement system is to redirect the eye from one target to another in the shortest possible time. Inaccurate eye movement, where the eye either undershot or overshot the target is abnormal and seen frequently in patients with cerebellar dysfunction.



Results: Normal saccadic eye movement test should produce rapid and accurate eye movement. Inaccurate eye movement, where the eyes overshot or undershot the target.
</td></tr>
</table>

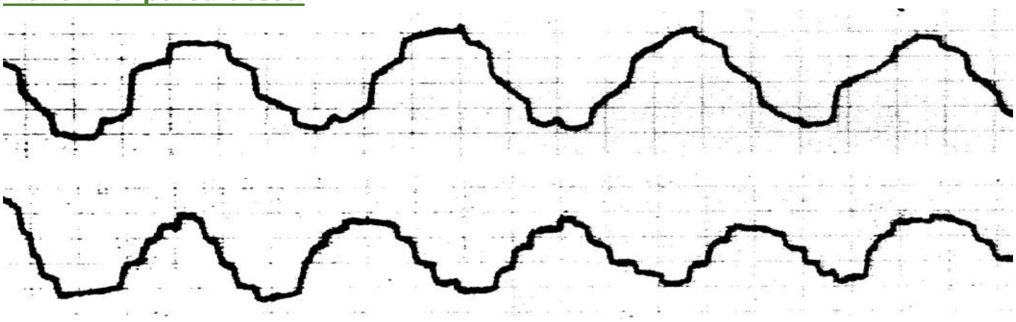
Ocular Pursuit Test:

The function of ocular pursuit system is to stabilize a slowly moving object on the fovea of the eye by matching the angular velocity of the eye with that of the moving object. (Simply: Can the patient follow the moving object smoothly or not).



Results: When the pursuit system is impaired, small corrective saccadic movements replace the smooth pursuit movement, so the eye can catch up the moving target. It may be the most sensitive subtest in ENG battery for detection of brainstem and cerebellar disorders.

Abnormal pursuit test:



Optokinetic Test

- Optokinetic system maintains visual fixation when the head is in motion.
- Target is rapidly passed in front of the subject in one direction, then the other.
- Eye movements are recorded and compared in each direction.
- Asymmetry suggestive of central lesion

Remember: Abnormalities in Pursuit, Optokinetic or Saccade, we have a central vestibular pathology.

Dynamic Positional Test (Hallpike):

- The patient complains a motion related vertigo at certain position
- It is maneuver that places the patient head in the position that creates the response.
- Criteria: Latency period, subjective vertigo, Transient nystagmus, fatigable, lesion in the undermost ear.

Dix Hallpike maneuver:

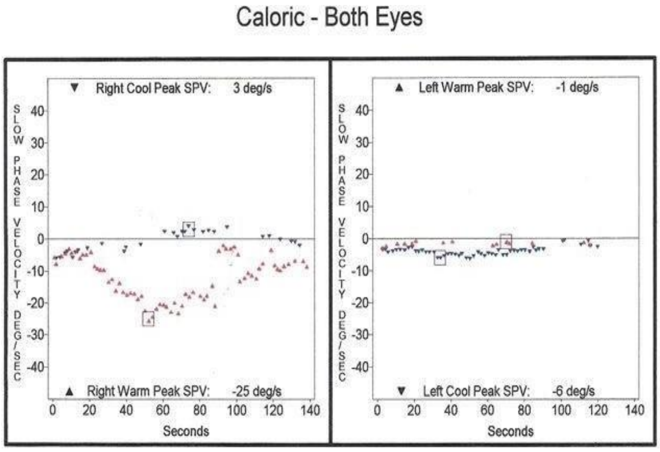
- Used to provoke nystagmus and vertigo commonly associated with BPPV.
- Recent research shows that there is an association between BPPV and vit D deficiency. This is because the crystals in the inner ear are made up of calcium carbonate.
- Head turned 45 degrees to maximally stimulate posterior semicircular canal.
- Head supported and rapidly placed into head hanging position.
- Frenzel glasses eliminate visual fixation suppression of response or can be tested Using VNG.

Caloric Tests

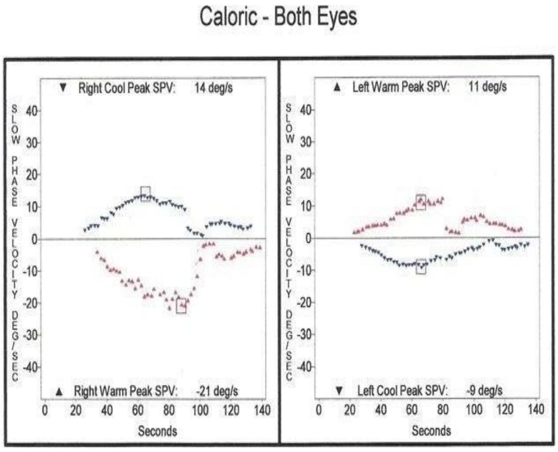
- Caloric test is a part of ENG/VNG.
- It reflects an attempt to discover the degree to which the vestibular system is responsive and also how symmetric the responses are, between left and right.
- t is a test of the lateral semicircular canals.
- We are stimulating the horizontal semicircular canal.
- Most caloric tests are nowadays done using computerized systems, the computer analyzes the caloric data, computing peak slow-phase velocity.
- You can test each side independently (ONLY test)
- If the nystagmus is low or absent, there is hypofunction of the vestibular system.
- Disadvantage of this test: It is a very low frequency test. It does not give you the whole picture of the vestibular system (problems in the high frequency will not be picked up)
- How is the vestibular system stimulated? The difference between the temperature of the body and the stimulus will lead to the transfer of heat to the endolymph and perilymph.

Caloric test procedure:

- Irrigations of EEC performed with cold and warm water or air.
- Water - cool = 30 C; warm = 44 C
- Air - cool = 24 C; warm = 50 C
- Response pattern follows the form of COWS
- Nystagmus induced results are calculated to obtain *Unilateral Weakness* and *Directional* preponderance.



Caloric Weakness: 70% in the left ear
Directional Preponderance: 88% to the right



Caloric Weakness: 27% in the left ear
Directional Preponderance: 9% to the right

Lecture Notes:

Pure tone audiometry

Pure tone audiometry provides a measurement of hearing levels by AC (air conduction) and BC (bone conduction) and depends on the co-operation of the subject. The test should be carried out in a soundproofed room. The audiometer is an instrument that generates pure tone signals ranging from 125 to 12 000 Hz (12 kHz) at variable intensities. The signal is presented to the patient through earphones (for AC) or a small vibrator applied to the mastoid process (for BC). Signals of increasing intensity at each frequency are presented to the patient, who indicates when the test tone can be heard. The threshold of hearing at each frequency is charted in the form of an audiogram, with hearing loss expressed in decibels (dB). Decibels are logarithmic units of relative intensity of sound energy. When testing hearing by BC, it is essential to mask the opposite ear with narrow-band noise to avoid cross-transmission of the signal to that ear.

Impedance audiometry (tympanometry)

Impedance audiometry measures not hearing but the compliance or mobility of the middle ear structures. A pure tone signal of known intensity is fed into the external auditory canal via an ear probe and a microphone in the probe measures reflected sound levels. Thus, the sound admitted to the ear can be measured. Most sound is absorbed when the compliance is maximal, and by altering the pressure in the external canal a measure can be made of the compliance at different pressures. Impedance testing is widely used as a screening method for otitis media with effusion (OME) in children. If there is uid in the middle ear, the compliance curve is flattened.

Otoacoustic emissions

When the ear is subjected to a sound wave it is stimulated to produce itself an emission of sound generated within the cochlea. This can be detected and recorded and has been used as a screening test of hearing in newborn babies. It is now in routine clinical use.

- **Types of Hearing Loss (from Toronto Notes)**

1. Conductive Hearing Loss (CHL)

- the conduction of sound to the cochlea is impaired
- can be caused by external and middle ear disease

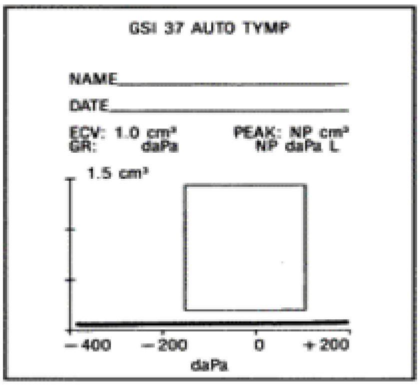
2. Sensorineural Hearing Loss (SNHL)

- **Due to a defect in the conversion of sound into neural signals or in the transmission of those signals to the cortex**
- **can be caused by disease of the cochlea, acoustic nerve (CN VIII), brainstem, or cortex**

3. Mixed Hearing Loss

both a conductive hearing loss and a sensorineural hearing loss.

Q1: patient comes with hearing loss. Tympanometry was done, what's the diagnosis?



A- Acute otitis media with effusion
B- Otosclerosis
C- Eustachian tube dysfunction
D- Ossicular chain disruption

Ans: A

Q2: A child brought by his mother complaining of his lack of response to low noises. On examination tympanogram showed type B with normal canal volume. Which of the following is the interpretation of the tympanogram?

A- Normal tympanic membrane and no middle ear effusion.
B- Normal tympanic membrane with effusion.
C- Perforated tympanic membrane with effusion.
D- Perforated tympanic membrane without effusion.

Ans: B

low ECV = Wax Impaction
normal ECV = Pathology in middle ear
(tympanic membrane is not moving) E.g: Otitis media with effusion
High ECV = perforation with or without middle ear effusion.

Q3: tympanogram

what is the type?

B

what is the diagnosis

effusion or perforation
if volume is 0.5 ml = OME
if volume is 5 ml = perforation or PE tube.