Assessment of Hearing and Management of hearing loss

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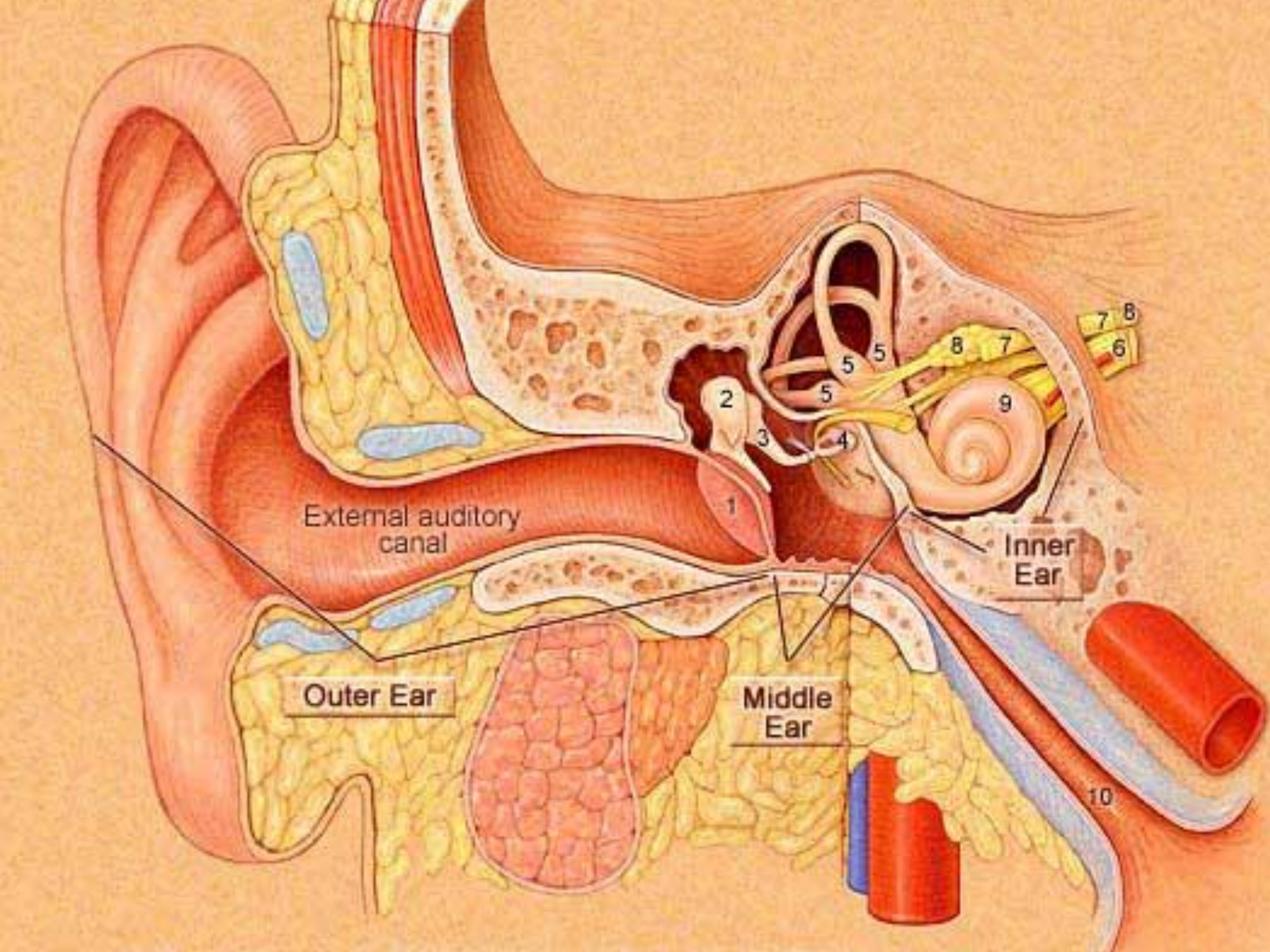
External auditory canal
Outer Ear
Middle Ear
Inner Ear
1
2
3
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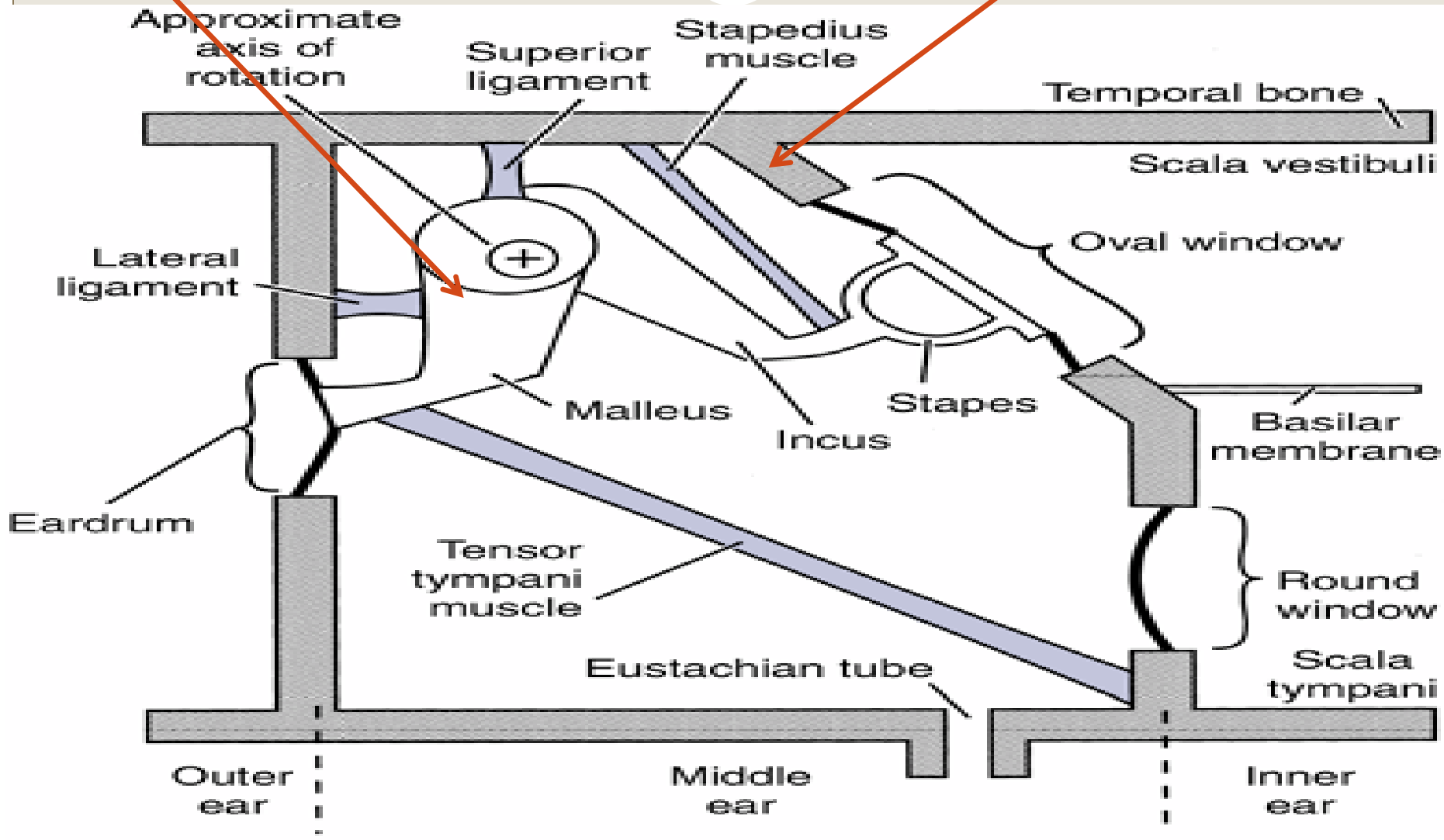
Principles of hearing

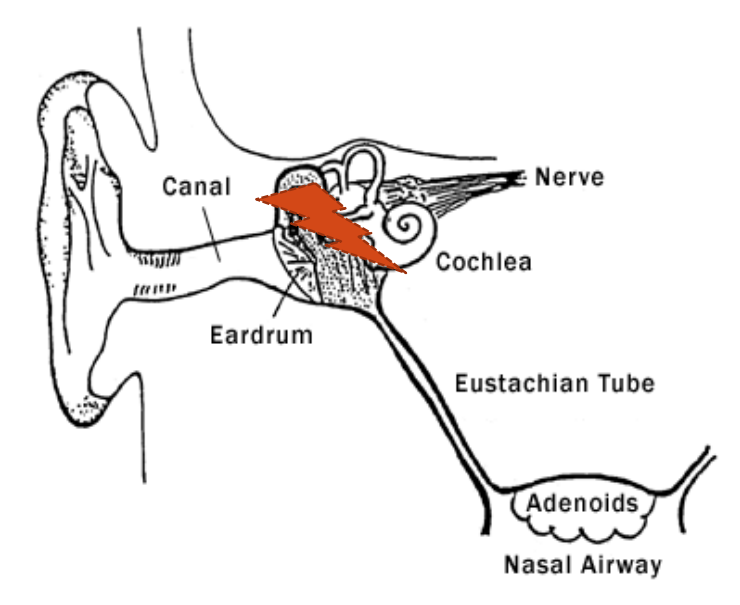
Air-conduction

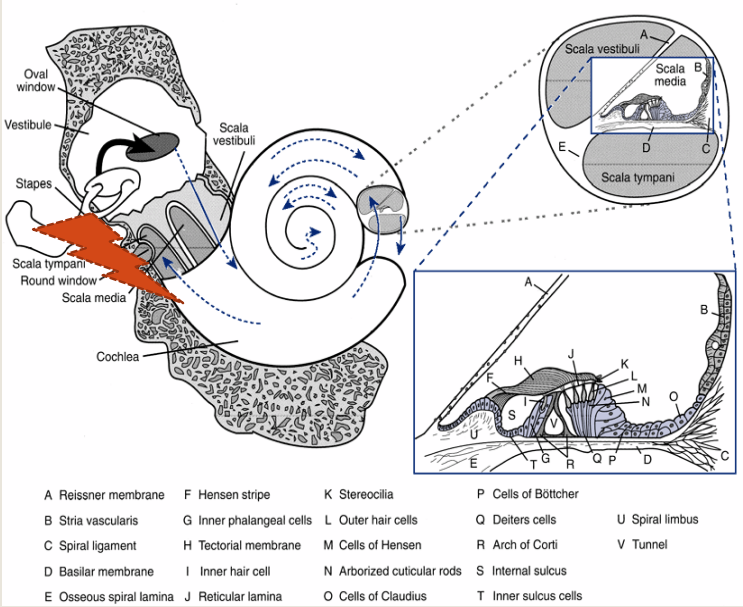
Bone-conduction



Why do we test hearing

- To detect one of major hearing impairment
  - Quality: Sensorineural (perception) or Conductive
  - Quantity: how much dB loss





Types of Hearing Loss

- **Conductive**: External or Middle ear pathology
- **Sensorineural**: Damage at the inner ear (cochlea)
- **Mixed**: Both cochlear damage & outer/middle ear pathology

Tests for detection of hearing loss

- Finger friction
- Watch test
- Speech test
  - Loud conversation at 12 meter
  - Whisper at 6 meter
- Tuning fork test
  - Weber test
  - Rinne test
  - Bing test
  - Schwabach's test
  - Gelle's test
- Audiometry
  - Objective
  - Subjective

Speech test

- App. 6 meter distance
- Each ear must be test separately

- Patient should repeat 5 words whispered by the doctor, 5 words told loudly
  - High-frequency words (silence, similarly, sitting)
  - Low-frequency words (drum, button)

RESULTS:

loss of high frequencies – perception disease (i.e. presbyacusis)
low frequencies – conductive disease (i.e. otitis media)

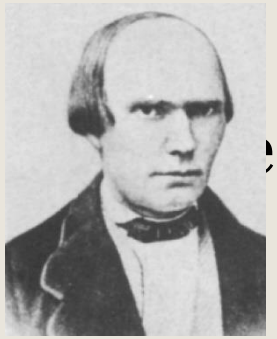
TUNING FORK TESTS

these allow one to distinguish (much more clearly) between conductive and sensorineural deafness

Frequencies: 128, 256, 512, 1024, 2048 & 4096 Hz

RINNE´S TEST

- comparison is made between bone and air conduction
- base of a tuning fork is placed to the mastoid area (bone), and then after the sound is no longer appreciated, the vibrating top is placed near the external ear canal (air)
- Positive Rinne–healthy or perceptive disease(SNHL)
- Negative – conductive disease
- Rinne indicates a minimum A-B gap of 15-20 dB



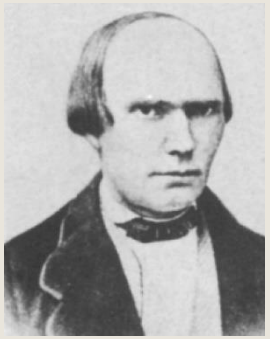
WEBER´S TEST

- tuning fork is placed on the patient's forehead (or in the middle line)
- If the sound lateralizes (is louder on one side than the other), the patient may have either an ipsilateral conductive hearing loss or a contralateral sensorineural hearing loss
- Minimum 15-20 dB loss is needed for laterisation of the weber

RINNE´S TEST

- Negative rinne for 256, 512 & 1024 indicates a minimum air bone gap of 15,30 & 45 dB respectively

- To check the transcranial transmission Barany's noise box is used (masking)



SCHWABACH´S TEST

- compares the patient's bone conduction to that of the examiner's
- If the patient stops hearing before the examiner, this suggests a sensorineural loss
- If the patient hears it longer than the examiner, this suggests a conductive loss

This test is contingent on the examiner having normal hearing..

ABSOLUTE BONE CONDUCTION (ABC)TEST

BING TEST

- fork is struck and placed on the patient's mastoid tip
- examiner alternately occludes the patient's external meatus
- patient with normal hearing or a sensorineural loss, he or she will notice a change in intensity with occlusion
- patient with conductive hearing loss, he or she will notice no change

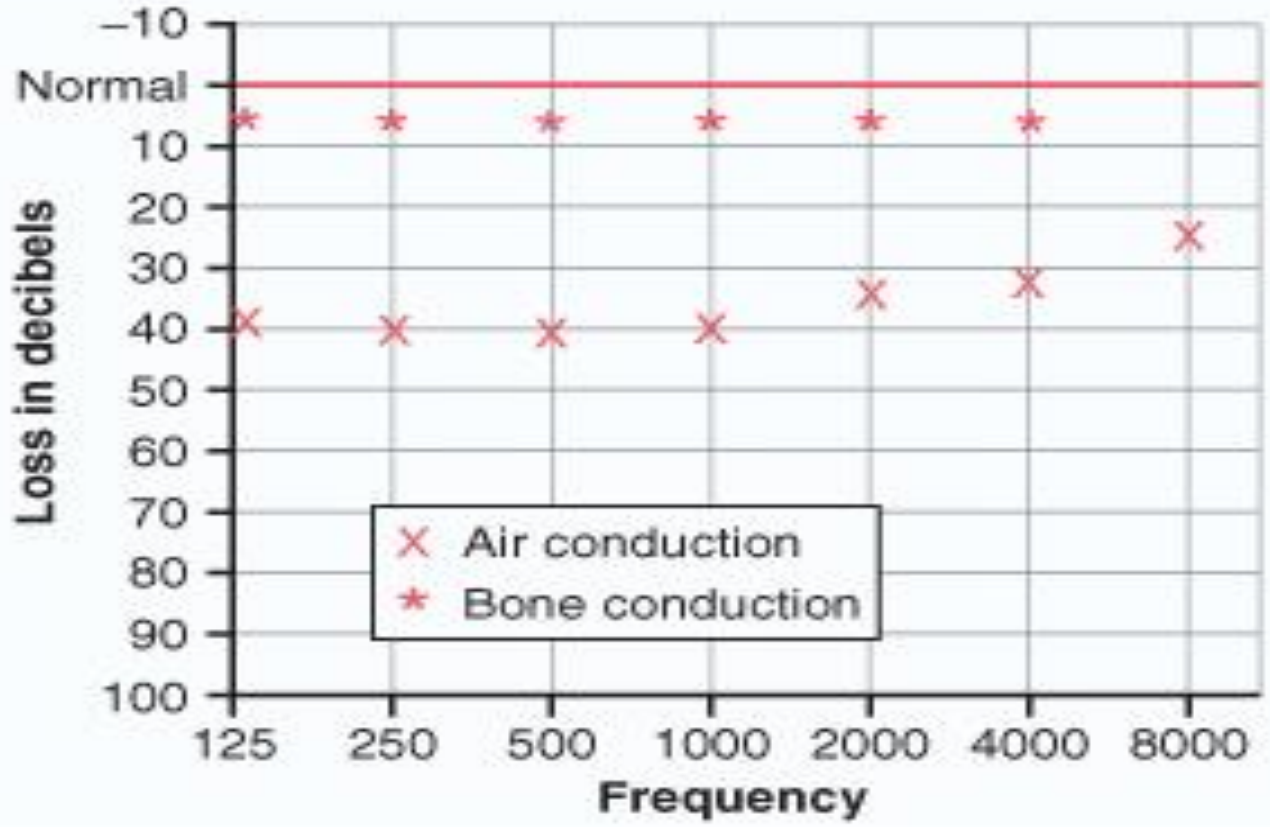
GELLE'S TEST

- fork is struck and placed on the patient's mastoid tip.
- examiner increase the pressure in the patient's external meatus with the help of siegle's speculum.
- patient with normal hearing or a sensorineural loss, he or she will notice a change in intensity with pressure change.
- patient with conductive hearing loss, he or she will notice no change.

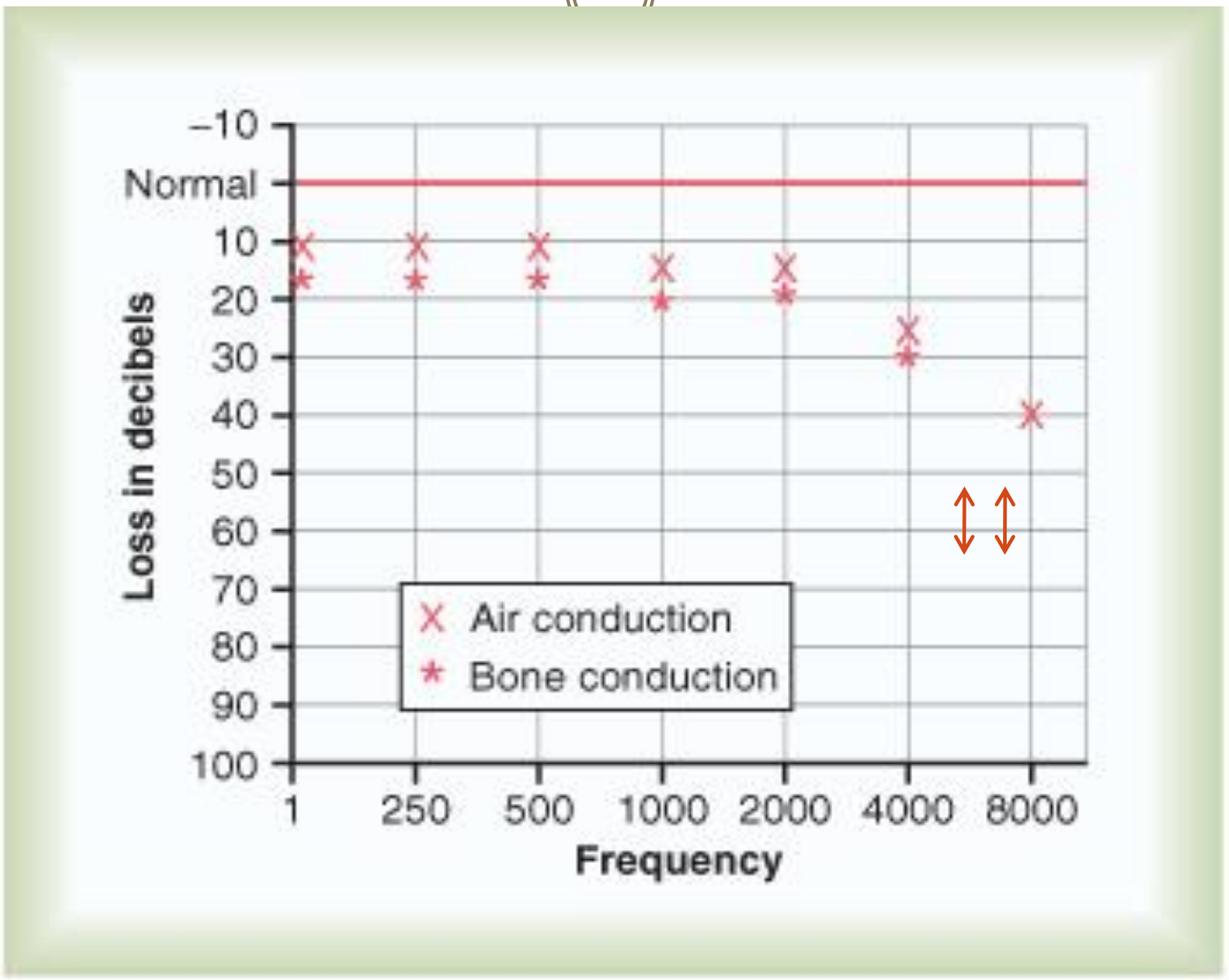
AUDIOMETRY…

- Subjective (needs patient's response)
- Objective (combination with EEG)

CONDUCTIVE DISEASE

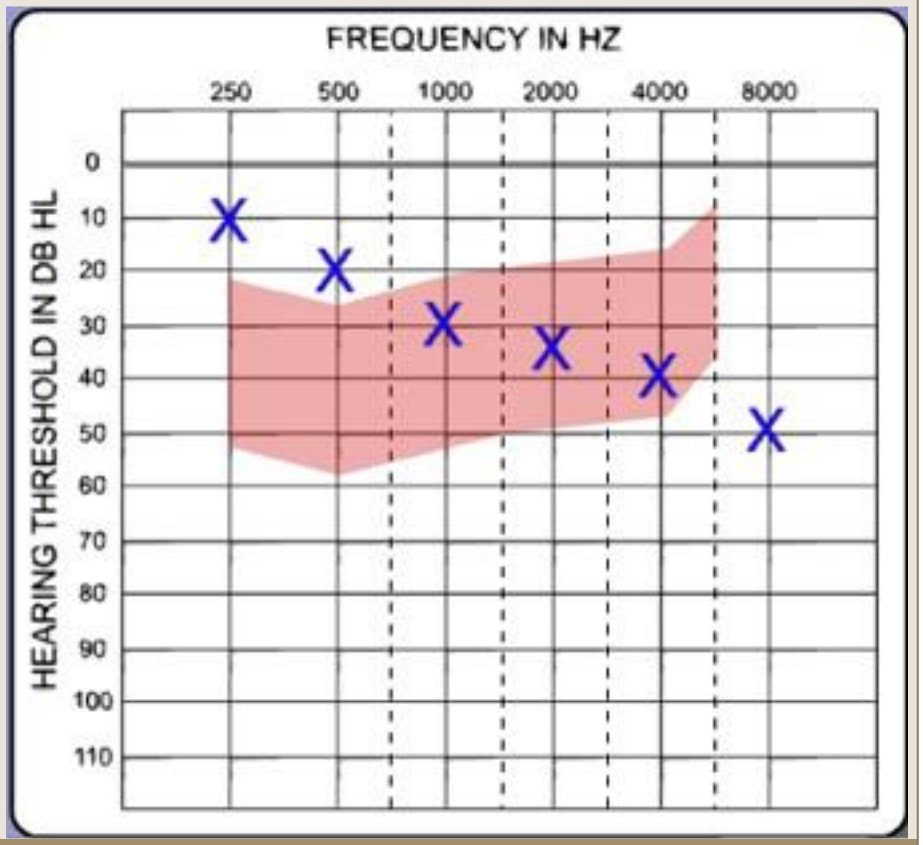


SENZORINEURAL IMPAIRMENT



Degrees of Hearing Loss

- 0 - 20 dB HL: Within normal limits (WNL)
- 20-40 dB HL: Mild
- 40-70 dB HL: Moderate
- 70-90 dB HL: Severe
- > 90 dB HL: Profound



Speech Audiometry

- In this test, the patient's ability to hear and understand speech is measured. Two parameters are studied:

(i) speech reception threshold

(ii) Speech discrimination score

- Speech reception threshold (SRT)- It is the minimum intensity at which 50% of the words are repeated correctly by the patient. **An SRT better than pure tone average by more than 10 dB suggests a functional hearing loss.**
- Speech discrimination score- Also called *speech recog*nition or *word recognition score*. It is a measure of patient's ability to understand speech. In normal persons and those with conductive hearing loss a high score of 90-100% can be obtained.

Usefulness of speech audiometry

(i) To find speech reception threshold which correlates well with average of three speech frequencies of pure tone audiogram.

(ii)To differentiate organic from non-organic (functional) hearing loss.

(iii) To find the intensity at which discrimination score is best. This is helpful in fitting a hearing aid and setting its volume for maximum discrimination.

(iv) To differentiate a cochlear from a retrocochlear sensorineural hearing loss.

Bekesy Audiometry

- It is a self-recording audiometry where various pure tone frequencies automatically move from low to high while the patient controls the intensity through a button. Two tracings, one with continuous and the other with pulsed tone are obtained. The tracings help to differentiate a cochlear from retrocochlear and an organic from a functional hearing loss.
- Various types of tracings obtained are:

Type I Continuous and pulsed tracings overlap. Seen in normal hearing or *conductive hearing loss*.

Type II Continuous and pulsed tracings overlap up to 1000 Hz and then continuous tracing falls. *Seen in cochlear loss*.

Type III Continuous tracing falls below pulsed tracing at 100 to 500 Hz even up to 40-50 dB. Seen in *retrocochlear/neural lesion*.

Type IV Continuous tracing falls below pulsed lesion at frequencies up to 1000 Hz by more than 25 dB. Seen in *retrocochlear/neural lesion*.

Type V Continuous tracing *is* above pulsed one. Seen in *non-organic hearing loss*.

Bekesy audiometry is seldom performed these days.

Impedance Audiometry

- Objective test, widely used in clinical practice.
- Is particularly useful in children.
- It consists of:

(a) Tympanometry

(b) Acoustic reflex measurements

Tympanometry

- It is based on a simple principle, i.e. when a sound strikes tympanic membrane, some of the sound energy is absorbed while the rest is reflected.
- A stiffer tympanic membrane would reflect more of sound energy than a compliant one.
- By changing the pressures in a sealed external auditory canal and then measuring the reflected sound energy, it is possible to find the compliance or stiffness of the tympano-ossicular system and thus find the healthy or diseased status of the middle ear.

Impedence audiometer

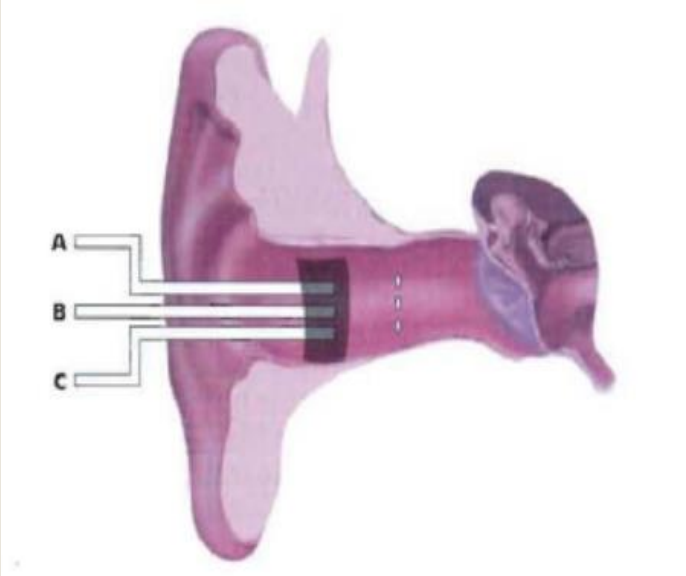
- the equipment consists of a probe which snugly fits into the external auditory canal and has three channels;

(i) to deliver a tone of 220 Hz,

(ii) to pick up the reflected sound through a microphone

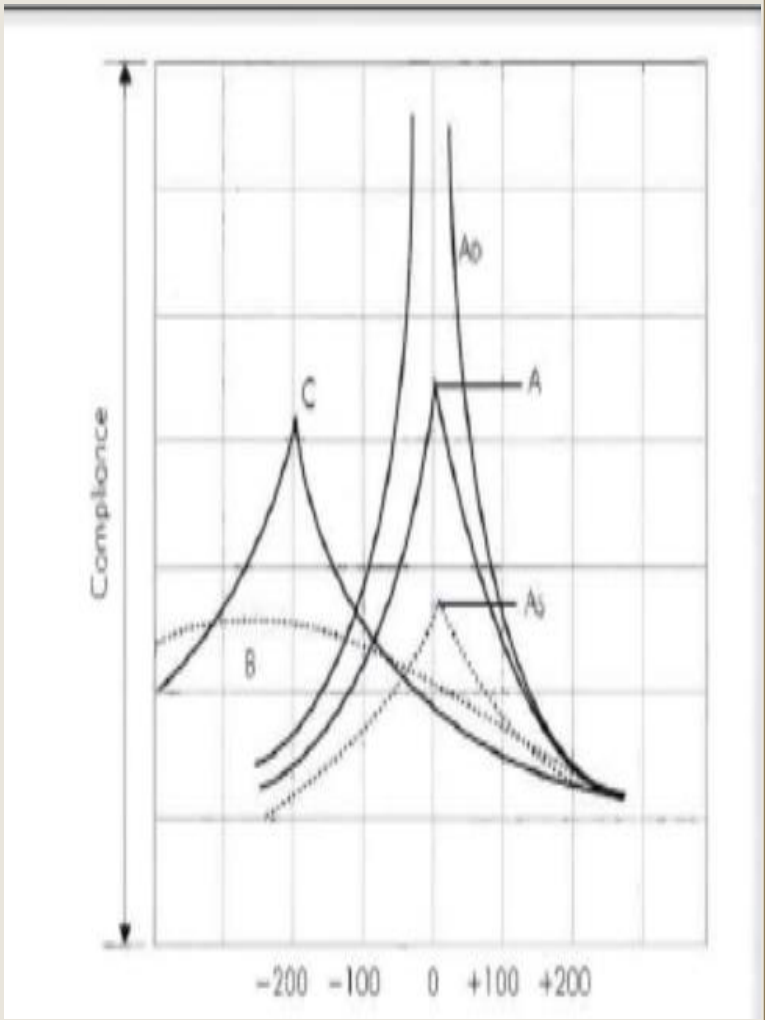
(iii) to bring about changes in air pressure in the ear canal from positive to normal and then negative.

By charting the compliance of tympano-ossicular system against various pressure changes, different types of graphs called *tympanograms* are obtained which are diagnostic of certain middle ear pathologies.


A
B
C

Types of tympanograms

- Type A-Normal tympanogram.
- Type As-Compliance is lower at or near ambient air pressure. Seen in *fixation* of *ossicles,* e.g. otosclerosis or malleus fixation.
- Type Ad- High compliance at or near ambient pressure. Seen in ossicular discontinuity or thin and lax tympanic membrane.
- Type B- Flat or dome-shaped graph i.e. No change in compliance with pressure changes. Seen in OME or thick tympanic membrane.
- Type C-Maximum compliance occurs with negative pressure in excess of 100 mm of H20. Seen in retracted tympanic membrane and may show some fluid in middle ear.



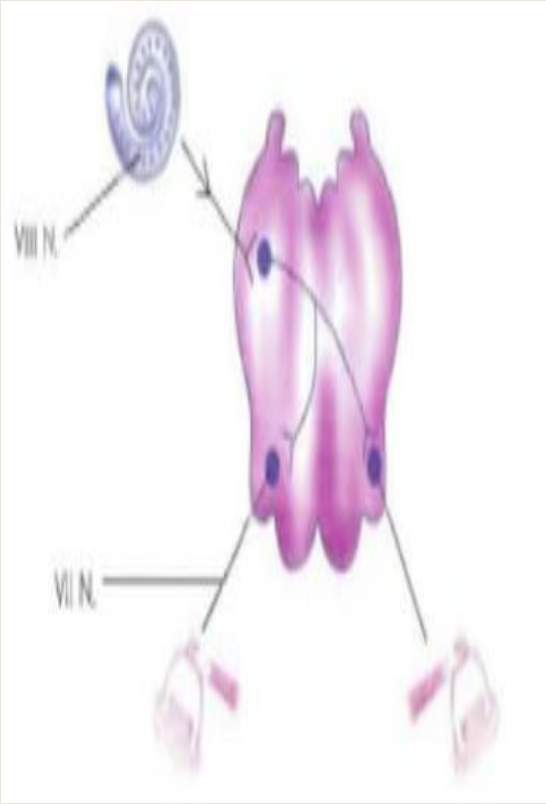
Testing function of eustachian tube

- Tympanometry has also been used to find function of eustachian tube in cases of intact or perforated tympanic membrane. A negative or a positive pressure (-200 or +200 mm of H2O) is created in the middle ear and the person is asked to swallow 5 times in 20 seconds. The ability to equilibrate the pressure indicates normal tubal function.

- The test can also be used to find the patency of the grommet placed in the tympanic membrane in cases of serous otitis media.

Acoustic reflex

- Principle- 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.
- Tone can be delivered to one ear and the reflex picked from the same or the contralateral ear. The reflex arc involved is-



Ipsilateral: CN VIII -> ventral cochlear nucleus -> CN VII *nucleus* -> *ipsilateral* stapedius *muscle*.

Contralateral: CN VIII -> ventral cochlear nucleus -> contralateral medial superior olivary nucleus - >contralateral CN VII nucleus -> contralateral stapedius muscle

usefulness

(i) ***To test the hearing in infants and young children***. It is an objective method.

(ii) **To *find malingerers*.** 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.

(iii) **To *detect cochlear pathology*.** Presence of stapedial reflex at lower intensities, e.g. 40 to 60 dB than the usual 70 dB indicates recruitment and thus a cochlear type of hearing loss.

(iv) **To *detect VIIIth nerve lesion*.** If a sustained tone of 500 or 1000 Hz, delivered 10 dB above acoustic reflex threshold, for a period of 10 seconds, brings the reflex amplitude to 50%, it shows abnormal adaptation and is indicative of VIIIth nerve lesion (stapedial reflex decay).

(v) **Lesions *of facial nerve***. Absence of stapedial reflex when hearing is normal indicates lesion of the facial nerve, proximal to the nerve to stapedius. The reflex can also be used to find prognosis of facial paralysis as the appearance of reflex, after it was absent, indicates return of function and a favorable prognosis.

(vi) ***Lesion of Brainstem*.** If ipsilateral reflex is present but the contralateral reflex is absent, lesion is in the area of crossed pathways in the brainstem.

Special Tests of Hearing

Recruitment

- It is a phenomenon of abnormal growth of loudness. The ear which does not hear low intensity sound begins to hear greater intensity sounds as loud or even louder than normal hearing ear. Thus, a loud sound which is tolerable in normal ear may grow to abnormal levels of loudness in the recruiting ear and thus becomes intolerable.
- The patients with recruitment are poor candidates for hearing aids. Recruitment is typically seen in lesions of the cochlea (e.g. Meniere's disease, presbycusis) and thus helps to differentiate a cochlear from a retrocochlear SNHL.

Alternate binaural loudness balance test

- It is used to detect recruitment in unilateral cases. A tone, say of 1000 Hz, is played alternately to the normal and the affected ear and the intensity in the affected ear is adjusted to match the loudness in normal ear. The test is started at 20 dB above the threshold of deaf ear and then repeated at every 20 dB rise until the loudness is matched or the limits of audiometer reached. In conductive and neural deafness, the initial difference is maintained throughout while in cochlear lesions, partial, complete or over-recruitment may be seen.

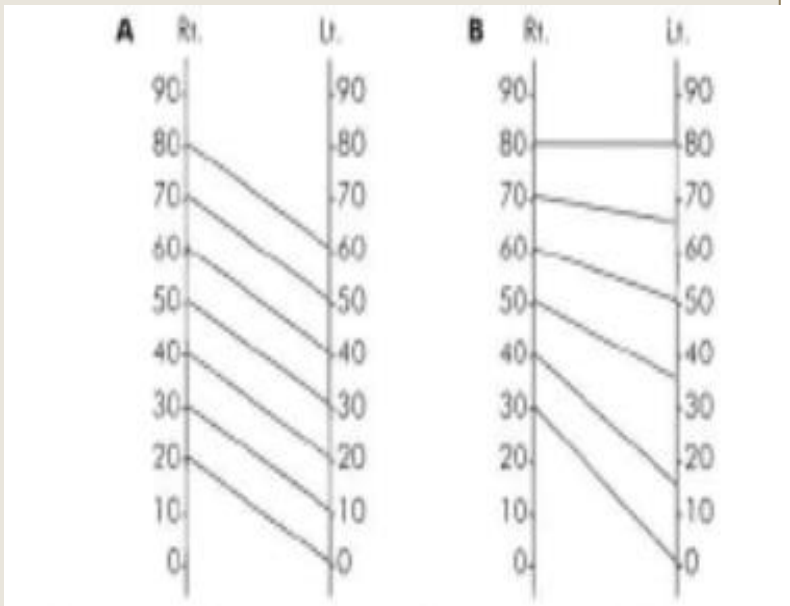


Fig. 4.8 Alternate binaural loudness balance test. (A) Non-recruiting ear. The initial difference of 20 dB between the right and left ear is maintained at all intensity levels. (B) Recruiting ear right side. At 80 dB loudness perceived by right ear is as good as left ear though there was difference of 30 dB initially.

Short Increment Sensitivity Index (SISI)

- Patients with cochlear lesions distinguish smaller changes in intensity of pure tone better than normal persons and those with conductive or retrocochlear pathology.
- SISI test is thus used to differentiate a cochlear from a retrocochlear lesion. In this test, a continuous tone is presented 20 dB above the threshold and sustained for about 2 minutes. Every 5 seconds, the tone is increased by 1 dB and 20 such blips are presented. Patient indicates the blips heard.
- In conductive deafness, SISI score is seldom more than 15%; it is 70-100% in cochlear deafness; and 0-20% in nerve deafness.

Threshold Tone Decay Test

- It is a measure of nerve fatigue and is used to detect retrocochlear lesions. Normally, a person can hear a tone continuously for 60 seconds. In nerve fatigue, he stops hearing earlier.
- A tone of 4000 Hz is presented at 5dB above the patient's threshold of hearing, continuously for a period of 60 seconds. If patient stops hearing earlier, intensity is increased by another 5 dB. The procedure is continued till patient can hear the tone continuously for 60 seconds, or no *level* exists above the threshold where tone is audible for full 60 seconds.
- The result is expressed as number of dB of decay. A decay more than 25 dB is diagnostic of a retrocochlear lesion .

Evoked Response Audiometry

- It is an objective test which measures electrical activity in the auditory pathways in response to auditory stimuli.
- It requires special equipment with an averaging computer. There are several components of *evoked* electric response but only two have gained clinical acceptance.

1. Electrocochleography (EcoG)
2. Auditory brainstem response (ABR). Also called BAER or BAEP (brainstem auditory evoked response or potential) or **BERA** (brainstem evoked response audiometry)

Electrocochleography (EcoG)

- It measures electrical potentials arising in the cochlea and CN VIII in response to auditory stimuli within first 5 milliseconds. The response is in the form of three phenomena-
- 1.cochlear microphonics, 2.summating potentials and 3.action potential of VIIIth nerve.
- The recording electrode is usually a thin needle passed through the tympanic membrane onto the promontory. In adults, it can be done under local anesthesia but in children or anxious persons sedation or general anesthesia is required. Sedation has no effect on these responses.
- EcoG is useful (i) to find threshold of hearing in young infants and children to within 5-10 dB, (ii) to differentiate lesions of cochlea from those of the VIIIth nerve. Normally the ratio between the amplitude of summating potential to the action potential is less than 30%. An increase in this ratio is indicative of Meniere's disease.

BERA

- Brainstem responses are elicited by giving auditory stimulation by clicks or tone bursts. It is a non-invasive technique to find the integrity of central auditory pathways through the VIIIth nerve, pons and midbrain.
- In this method, electrical potentials are generated in response to several click stimuli or tone-bursts and picked up from the *vertex* by surface electrodes. It measures hearing sensitivity in the range of 1000~000 Hz. In a normal person, 7 waves are produced in the first 10 milliseconds. The first, third and fifth waves are most stable and are used in measurements. The waves are studied for absolute *latency* , *inter-wave latency*, (usually between wave I and V) and *the amplitude*.

- Wave I- Distal part of CN VIII
- Wave II- Proximal part of CN VIII near the brainstem
- Wave III- Cochlear nucleus
- Wave IV- Superior olivary complex
- Wave V- Lateral lemniscus
- Waves VI and VIII- Inferior colliculus

EE COLI (eight, eight, cochlear nucleus, olivary complex, lateral lemniscus, inferior colliculus)

Uses of ABR

(i) As a screening procedure for infants.

(ii) To determine the threshold of hearing in infants; also in children and adults who do not cooperate and in malingerers.

(iii) To diagnose retrocochlear pathology particularly acoustic neuroma.

(iv) To diagnose brainstem pathology, e.g. multiple sclerosis or pontine tumours.

(vi) To monitor CN VIII intraoperatively in surgery of acoustic neuromas to preserve the function of cochlear nerve.

Otoacoustic Emissions (OAEs)

- They are low intensity sounds produced by outer hair cells of a normal cochlea and can be elicited by a very sensitive microphone placed in the external ear canal and an analysis by a computer.
- Sound produced by outer hair cells travels in a reverse direction: outer hair cells -> basilar membrane -> perilymph -> oval window-> ossicles -> tympanic membrane -> ear canal.
- OAEs are present when outer hair cells are healthy and are absent when they are damaged and thus help to test the function of cochlea. They do not disappear in eighth nerve pathology as cochlear hair cells are normal.

Types of OAEs

- *Spontaneous* OAEs: They are present in healthy normal hearing persons where hearing loss does not exceed 30 dB. They may be absent in 50% of normal persons.
- *Evoked OAEs:* They are further di vided into two types depending on the sound stimulus used to elicit them.

(a) Transient evoked OAEs (TEOAEs)- Evoked by clicks.

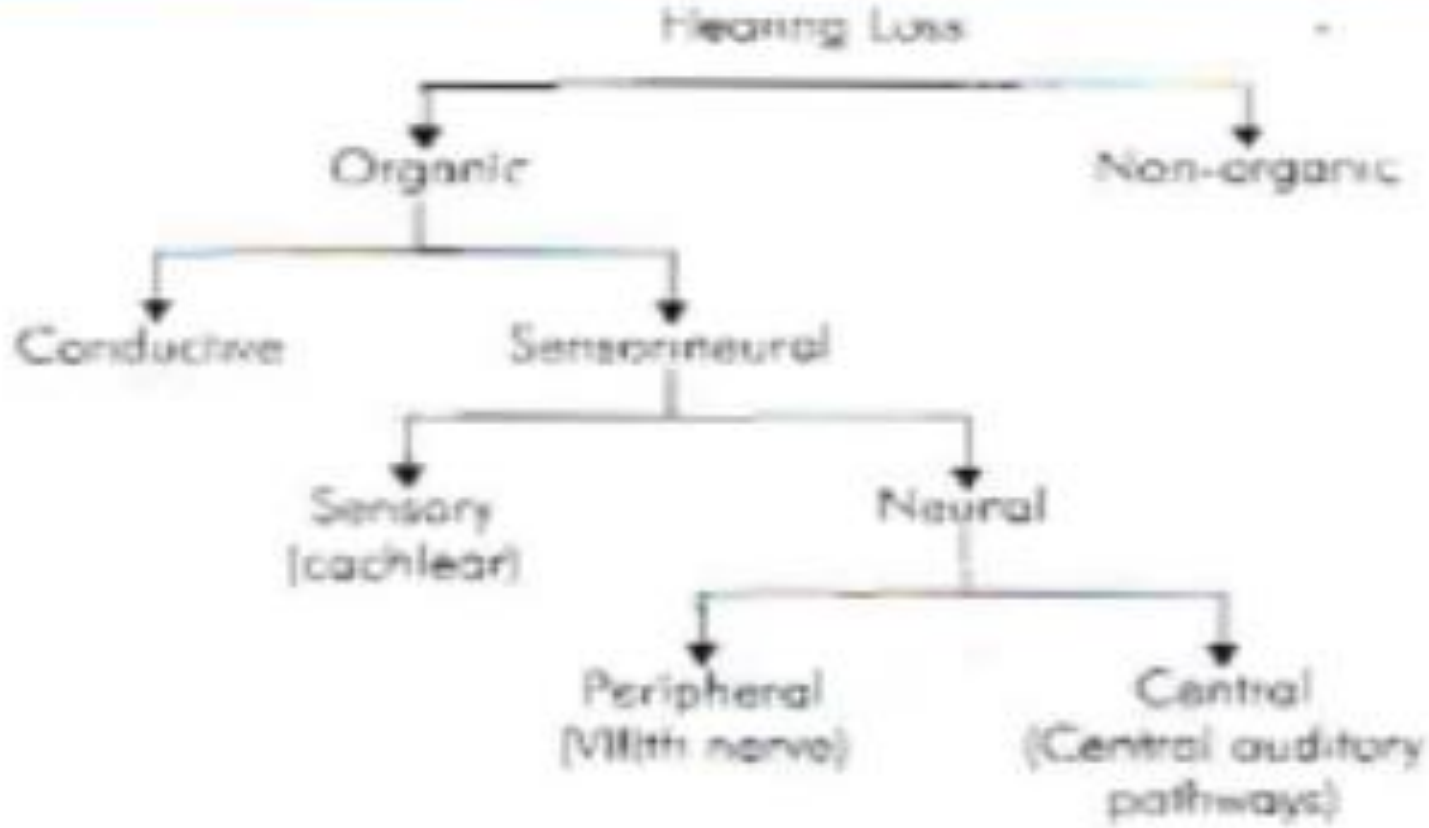
(b) Distortion product OAEs (DPOAEs)- Two tones are simultaneously presented to the cochlea to produce distortion products.

Uses of OAE

- 1. as a screening test of hearing in neonates and to test hearing in uncooperative or mentally challenged individuals after sedation.
- 2. to distinguish cochlear from retrocochlear hearing loss. OAEs are absent in cochlear lesions, e.g. ototoxic sensorineural hearing loss. They detect ototoxic effects earlier than pure-tone audiometry.
- 3. to diagnose retrocochlear pathology, especially auditory neuropathy.

HEARING LOSS

CLASSIFICATION



CONDUCTIVE HEARING LOSS AND ITS MANAGEMENT

Characteristics

1. Negative Rinne test , i.e. BC> AC.
2. Weber lateralized to poorer ear.
3. Normal absolute bone conduction.
4. Low frequencies are affected more.
5. Audiometry shows bone conduction better than air conduction with air-bone gap. Greater the air-bone gap, more is the conductive loss.
6. Loss is not more than 60 dB.
7. Speech discrimination is good.

Causes of conductive hearing loss

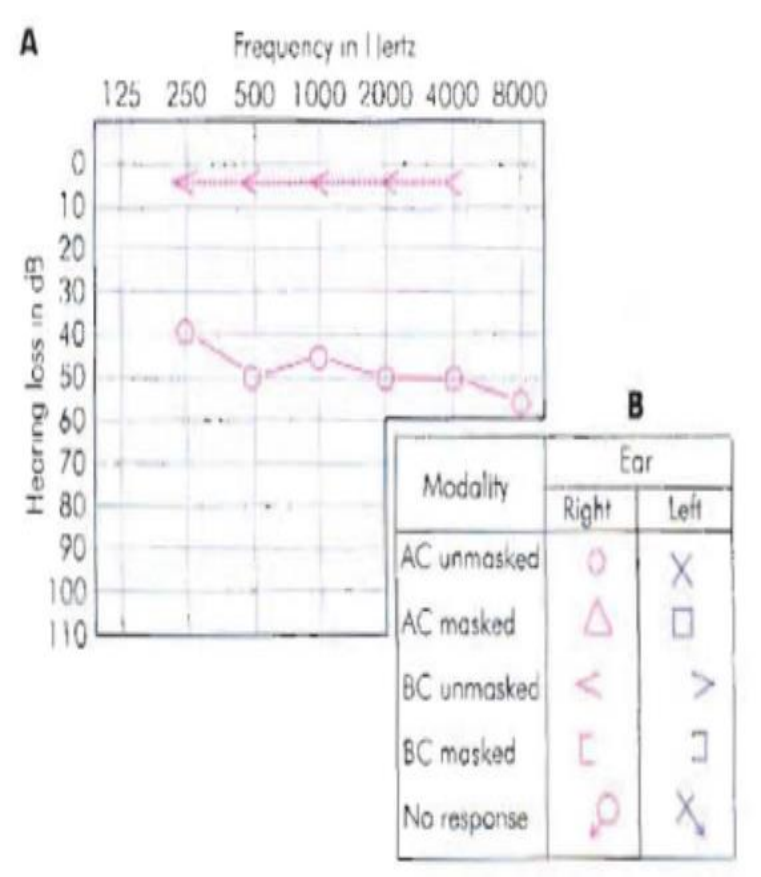
Congenital causes

Meatal atresia
Fixation of stapes footplate
Fixation of malleus head
Ossicular discontinuity
Congenital cholesteatoma

Acquired causes

External ear	Any obstruction in the ear canal, e.g. wax, foreign body, furuncle, acute inflammatory swelling, benign or malignant tumour or atresia of canal.
Middle ear	(a) Perforation of tympanic membrane, traumatic or infective (b) Fluid in the middle ear, e.g. acute otitis media, serous otitis media or haemotympanum (c) Mass in middle ear, e.g. benign or malignant tumour (d) Disruption of ossicles, e.g. trauma to ossicular chain, chronic suppurative otitis media, cholesteatoma (e) Fixation of ossicles, e.g. otosclerosis, tympanosclerosis, adhesive otitis media (f) Eustachian tube blockage, e.g. retracted tympanic membrane, serous otitis media.

Average Hearing Loss Seen in Different Lesions of Conductive Apparatus



1.Complete obstruction of ear canal: 30 dB

2.Perforation of tympanic membrane:(It varies and is directly proportional to the size of perforation)-10-40 dB

3.Ossicular interruption with intact drum: 54 dB

4.Ossicular interruption with perforation: 38 dB

5.Closure of oval window: 60 dB

Management

- medical or surgical means.

1. Removal of canal obstructions, e.g. Impacted wax, foreign body, osteoma or exostosis, keratotic mass, benign or malignant tumours, meatal atresia

2. Removal of fluid. Myringotomy with or without grommet insertion.

3. Removal of mass from middle ear. Tympanotomy and removal of small middle ear tumours or cholesteatoma behind intact drum.

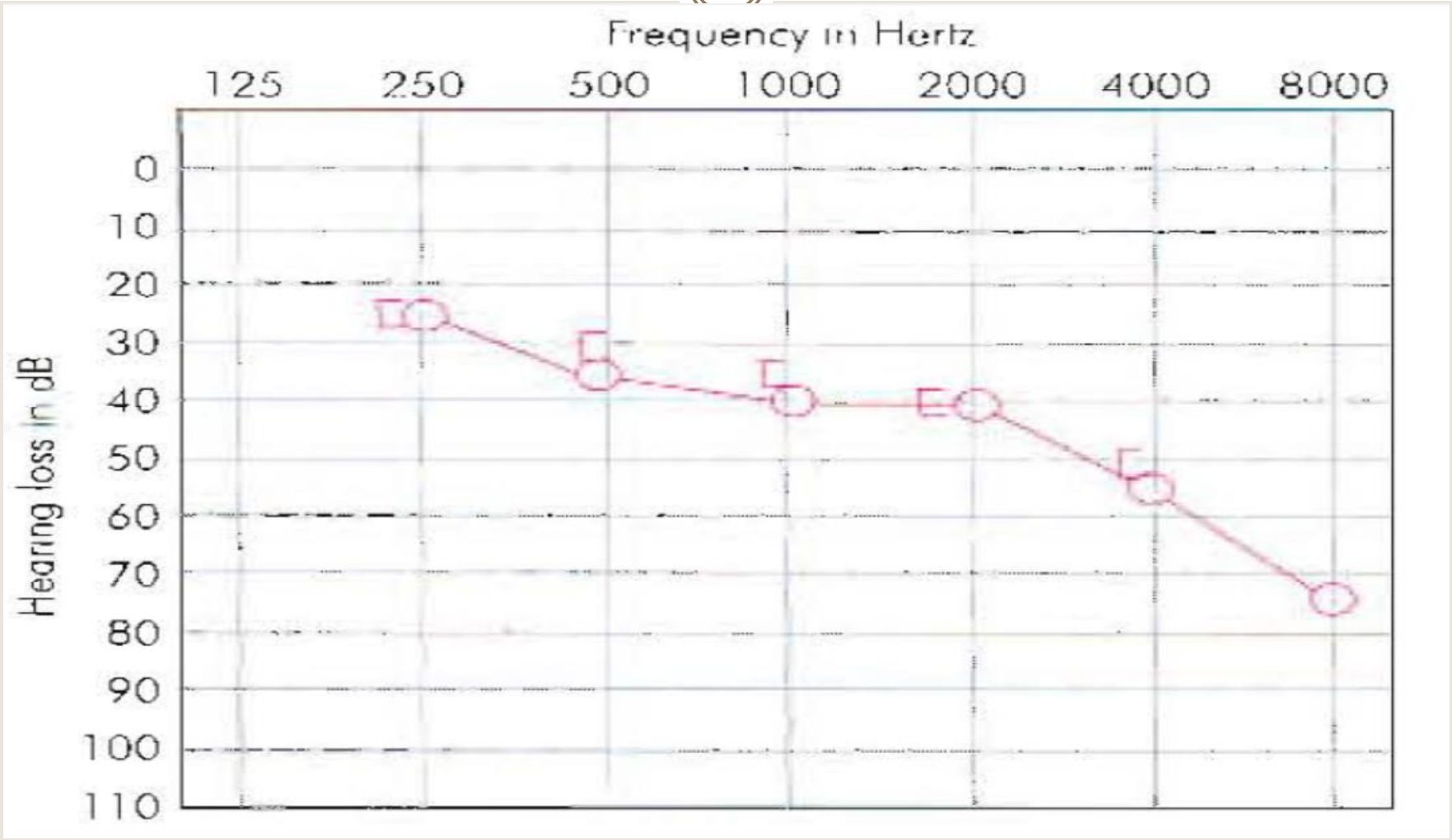
4. Stapedectomy. as in otosclerotic fixation of stapes footplate.

S. Tympanoplasty. Repair of perforation, ossicular chain or both.

6. Hearing aid. In cases, where surgery is not possible, refused or has failed.

SENSORINEURAL HEARING LOSS

1. A positive Rinne test, i.e. AC > BC.
2. Weber lateralized to better ear.
3. Bone conduction reduced on Schwahach and absolute bone conduction tests.
4. More often involving higher frequencies.
5. No gap between air and bone conduction curve on Audiometry
6. Loss may exceed 60 dB.
7. Speech discrimination is poor.
8. There is difficulty in hearing in the presence of noise.


Frequency in Hertz
125
250
500
1000
2000
4000
8000
Hearing loss in dB
0
10
20
30
40
50
60
70
80
90
100
110

Aetiology

1. Congenital- it is present at birth and is the result of anomalies of the inner ear or damage to the hearing apparatus by prenatal or perinatal factors.

2. Acquired

1. Infections of labyrinth; viral, bacterial or spirochaetal.
2. Trauma to labyrinth or VIIIth nerve, e.g. fractures of temporal bone or concussion of labyrinth or ear surgery,
3. Noise-induced hearing loss
4. Ototoxic drugs
5. Presbycusis,
6. Meniere's disease,
7. Acoustic neuroma,
8. Sudden hearing loss,
9. Familial progressive SNHL,
10. Systemic disorders, e.g. Diabetes, hypothyroidism kidney disease, autoimmune disorders, multiple sclerosis, blood dyscrasias.

SPECIFIC FORMS OF HEARING LOSS

- Inflammations of Labyrinth
- Ototoxicity
- Noise Trauma
- Sudden Hearing loss
- Presbycusis
- Familial Progressive Sensorineural hearing Loss

Inflammations of Labyrinth

- Viral labyrinthitis.
- Bacterial labyrinthitis.
- Syphilitic labyrinthitis.

Ototoxicity

A. ***Aminoglycoside antibiotics***
- Streptomycin
- Gentamicin
- Tobramycin
- Neomycin
- Kanamycin
- Amikacin
- Sisomycin

B. ***Diuretics***
- Furosemide
- Ethacrynic acid

C. ***Antimalarials***
- Quinine
- Chloroquin

D. ***Cytotoxic drugs***
- Nitrogen mustard
- Cisplatin
- Carboplatin

E. ***Analgesics***
- Salicylates
- Indomethacin
- Phenyl butazone
- Ibuprofen

F. ***Chemicals***
- Alcohol
- Tobacco
- Marijuana
- Carbon monoxide poisoning

G. ***Miscellaneous***
- Erythromycin
- Ampicillin
- Propranolol
- Propyl thiouracil
- Deferoxamine

Noise Trauma

1. Acoustic trauma- Permanent damage to hearing caused by a *single brief exposure* to very intense sound, e.g. an explosion, gunfire or a powerful cracker.
2. Noise-induced hearing loss (NIHL)- follows *chronic exposure* to less intense sounds mainly because of noisy occupations.

Pathology in Noise Trauma

(a)Temporary threshold shift-The hearing is impaired immediately after exposure to noise but recovers after an interval of a few minutes to a few hours.

(b)Permanent threshold shift-The hearing impairment is permanent and does not recover at all.

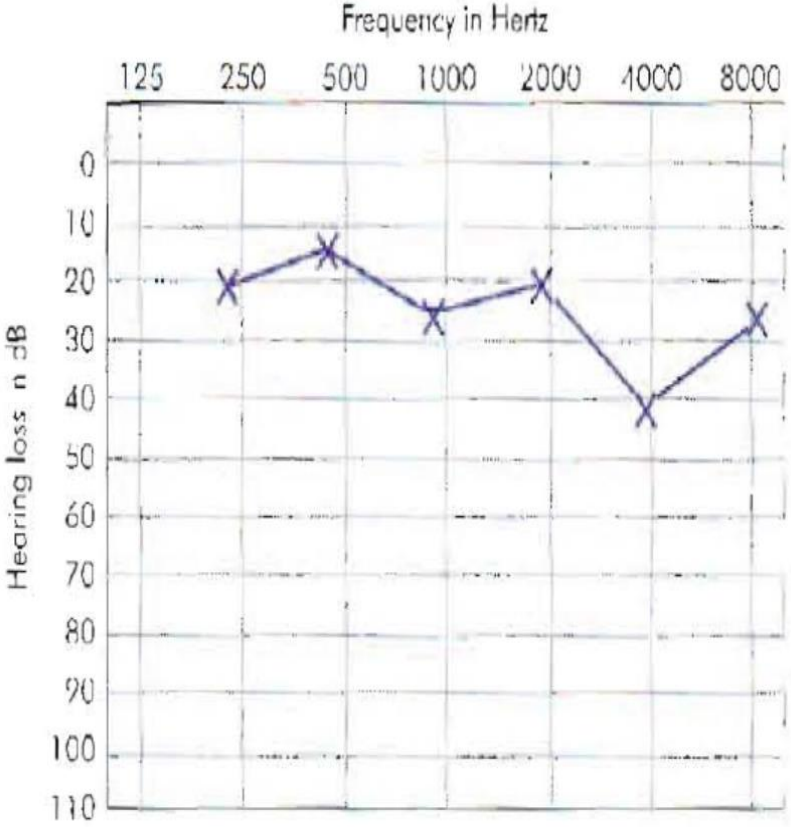


Fig. 5.7 Early case of noise-induced hearing loss. Note dip at 4000 Hz.

Sudden Hearing loss

1. Ideopathic
2. Infections. Mumps, herpes zoster, meningitis, encephalitis, syphilis, otitis media.
3. Trauma. Head injury, ear operations, noise trauma, barotrauma, spontaneous rupture of cochlear membrane
4. Vascular. Haemorrhage (leukemia) , embolism or thrombosis of Labyrinthine or cochlear artery or their vasospasm.
5. Otologic. Meniere's disease, Cogan's syndrome, large vestibular aqueduct.
6. Toxic. Ototoxic drugs, insecticides.
7. Neoplastic. Acoustic neuroma, metastases in cerebellopontine angle, carcinomatous neuropathy
8. Miscellaneous. Multiple sclerosis, hypothyroidism, sarcoidosis.
9. Psychogenic.

Management

- To be treated according to the cause.
- When cause remains obscure, treatment is empirical and consists of:

1. Bed rest.
2. Steroid therapy. Prednisolone
3. Inhalation of carbogen (5% CO_2 + 95% O_2).
4. Vasodilator drugs.
5. Low molecular weight dextran.
6. Hyperbaric oxygen therapy.

- Prognosis: Fortunately, about half of the patients of idiopathic SNHL recover spomaneously within 15 days. Chances of recovery are poor after 1 month. Severe hearing loss and association with vertigo have poor prognosis. Younger patients below 40 and those with moderate losses have better prognosis.

Presbycusis

- SNHL associated with physiological aging process in the ear is called presbycusis. It usually manifests at the age of 65 years but may do so early if there is hereditary predisposition, chronic noise exposure or generalized vascular disease.

1. Sensory. Higher frequencies are affected bur speech discrimination remains good.

2. Neural. This manifests With high frequency loss but speech discrimination is poor and out of proportion.

3. Strial or metabolic. This is characterized by atrophy of stria vascularis of cochlea. Audiogram ls flat but speech discrimination is good.

4. Cochlear conductive. This is due to stiffening of the basilar membrane thus affecting its movements. Audiogram is sloping type.

- Patients of presbycusis have great difficulty in hearing in the presence of background noise though they may hear well in quiet surroundings.
- They may complain of speech being heard but not understood. Recruitment phenomenon is positive and all the sounds suddenly become intolerable when volume is raised.
- Tinnitus is another bothersome problem and in some it is the only complaint.
- Patients of presbycusis can be helped by a hearing aid. They should also have lessons in speech reading through visual cues. Cessation of smoking and drinks like tea and coffee may help to decrease tinnitus.

Familial Progressive Sensorineural hearing Loss

- It is a genetic disorder in which there is progressive degeneration of the cochlea starting in late childhood or early adult life.
- Deafness is bilateral with Hat or basin-shaped audiogram bur an excellent speech discrimination.

Non-organic hearing loss (NOHL)

- either due to malingering or psychogenic.

1. High index of suspicion.
2. Inconsistent results on repeat pure tone and speech audiometry tests.
3. Absence of shadow curve.
4. Inconsistency in PTA and SRT.
5. Stenger test.
6. Acoustic reflex threshold
7. EIectric response audiometry (ERA).

For Whom Hearing Aids are?

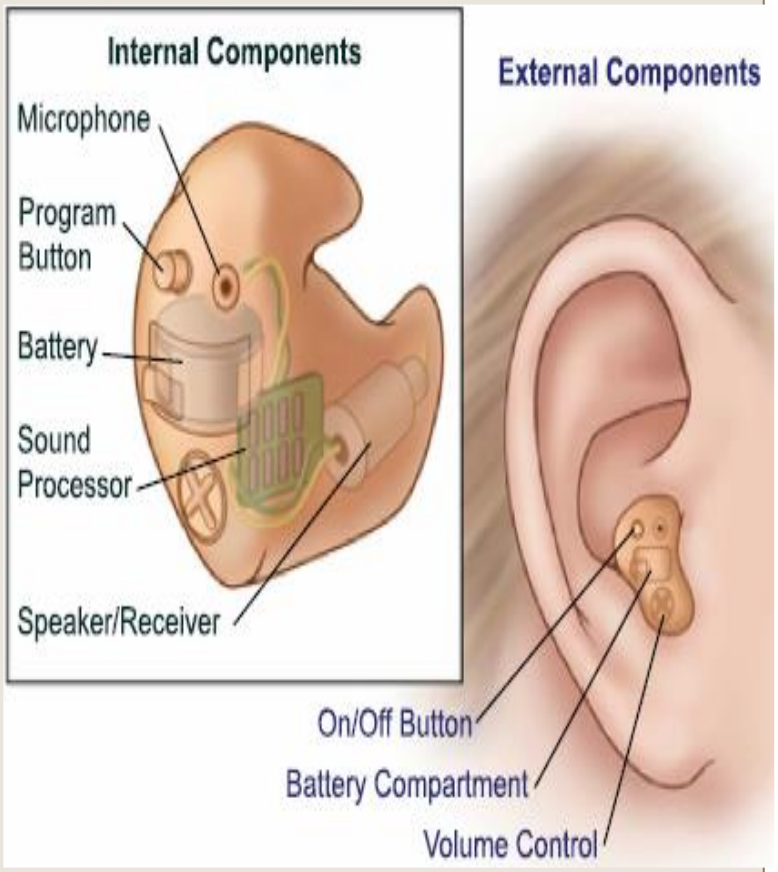
- Sound-amplifying medical devices to aid individuals with hearing loss.
- Hearing aids may be useful for- Hearing loss that may or may not be medically treatable.
- Any type of hearing loss, as long as the individual needs compensation for the reduction in hearing.

- Selection of hearing aids should be based on the type and severity of hearing loss, listening needs, and lifestyle.

Hearing Aids: Basic Components & How They Work

- Electronic components: Microphone
- Amplifier circuitry
- Miniature loudspeaker/receiver
- Battery

- How does a hearing aid work?



Hearing Aid Styles

- **Behind-the-ear (BTE) aids:** A plastic case containing most parts; resting behind the ear connected to an earmould
- Easy to be cleaned and handled, relatively sturdy

- **"Mini" BTE (or "on-the-ear") aids:** A very thin tube connects the aid to the ear canal
- May have an open-fit ear tip or a regular earmould
- With “open fit” – Reduced occlusion ("plugged up“) sensations, increased comfort, relatively less visible


Receiver in ear canal
Behind-the-ear (BTE)
"Mini" BTE

Hearing Aid Styles

- **In-the-ear (ITE) aids:** All parts contained in a shell, which fills in the ear canal
- Relatively easier to handle than smaller aids such as ITC & CIC

- **In-the-canal (ITC) aids & completely-in-the-canal (CIC) aids:** All parts contained in tiny cases, which fits partly or completely in the ear canal
- Smallest in size, which makes it difficult to handle and adjust for some users

ITE

ITC

CIC

Hearing Aid Technology: Analog vs. Digital

- **Analog-** Converting physical sound waves into electrical waves

Making the continuous sound waves larger.

- **Digital-** Converting sound waves to their binary format where the sound is represented by a series of 1's and 0's.

  Allowing manipulating sounds in relatively flexible ways to achieve more programming options.

Common Hearing Aid Features

- **Directional microphones:** Sound from a specific direction amplified to a greater level

  May help listeners to understand speech in noisy environments

- **Feedback suppression:** Squeals suppressed when the hearing aid gets too close to the phone or has a loose-fitting ear mould

- **T-coil (Telephone switch):** Sound picked up from the telephone when switching to the "T- coil" setting

  Help to reduce the chance of hearing aid "whistling"

  Also works well in environments (e.g., theaters, auditoriums, etc.) where there is induction loop or FM installation

Hearing Aid Fitting

- **Questions to consider:**
  - What styles and features would fit my daily needs?
  - Cost: What is the total cost of the hearing aids?
  - Do the benefits of newer technologies outweigh the higher costs?
  - Trial/adjustment period: Is there a trial or adjustment period for me to try out the hearing aids?
  - What fees are non-refundable if I decide to return the hearing aids?
  - Care & Warranty: How should I care for my hearing aids?
  - What is covered during the period of warranty?
  - How long is the warranty? Can it be extended?

Hearing Aid Care & Maintenance

- Keep hearing aids away from any moisture and heat, which may cause damage to the internal electronics.
- Clean hearing aids as instructed.

  Power consumption & battery safety: Turn off hearing aids when not in use.

  Keep batteries and hearing aids away from children and pets.

- Visit the hearing healthcare professional on a regular basis to have hearing aids inspected.

Hearing Aid Benefits & Limitations

- **Benefits**

Ability to hear sounds that could not be heard previously, and help oral communication

Ability to hear speech over the telephone

- **Limitations**

Do not restore normal hearing

All sounds, including background noise and undesired sounds, are made louder.

Sounds, including own voice, might seem too loud at first.

May need to be replaced every several years

COCHLEAR IMPLANT

- Designed for those who are profoundly deaf
- Can be used alone or with traditional hearing aid
- **TWO MAIN SYSTEMS:**

- External

  Sound processer, microphone and transmitter

- Internal

  Receiver and electrode array

Future for hearing aids

- BAHA(Bone Anchored Hearing Aid)- Bypass normal hearing system
- Helps severe sensorineural, conductive or mixed hearing loss
- Attaches to bones in middle ear
- Bypasses auditory canal and middle ear

CONCLUSION

- Hearing aids are smaller and more powerful
- Aiming for higher sound quality in the future
- Accommodate virtually every type of listening environment
- Continually adjust themselves to improve sound quality and reduce feedback
- Closer to achieving gift of hearing