Sec. Year

Hearing Tests and Pure Tone Audiometry

Objectives:

At the end of the session, the students should be able to:

- Determine the type, degree, and configuration of hearing loss.
- Describe the techniques of Tuning Fork tests.
- Plot the frequency-intensity recording and construct the audiograms.
- Interpret the audiograms.

Some Important Terminology Related To This Practical

Air conduction

This test assesses the transmission of sound waves through air to the auditory cortex via auditory nerve involving outer, middle and inner ears. The sound is amplified 22 times when it is transmitted through air conduction by the tympanic membrane (17 times) and the ossicles (1.3 times). That is why, air conduction is always better than bone conduction in a normal person.

Bone conduction

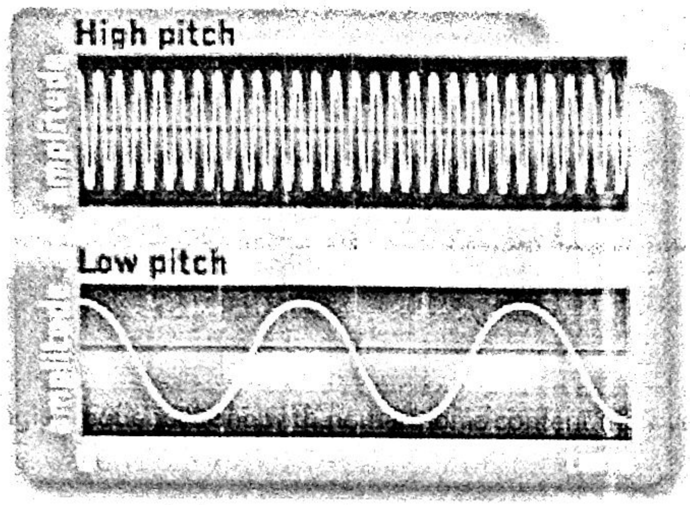
This test assesses the transmission of sound waves through the bones of the skull to the cochlea and then through the auditory pathways to the auditory cortex, bypassing the outer and middle ears.

Masking Sound

Masking sound is the sound present in the background that interferes with the sound that we want to listen. It is provided constantly to the right ear during the whole audiometry procedure if the left ear is tested so that whatever pure tone is given to the left ear is heard only by the left ear, because the right ear will be busy in listening to the masking sound. In the same way, the masking sound will be provided to the left ear, if the right ear is tested.

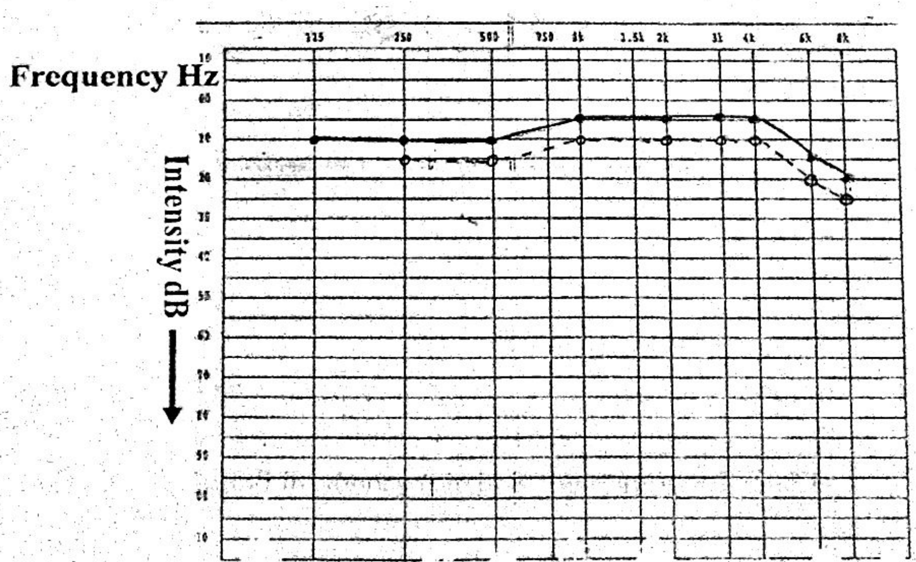
Pure tone

A **pure tone** is a single frequency tone with no harmonic content (no overtones). This corresponds to a sine wave.



Audiogram

An **audiogram** is a chart of hearing sensitivity with the frequency of sound plotted on the X- axis and the intensity of sound on the Y-axis. Intensity (loudness) is the level of sound power measured in decibels and frequency (pitch) is the number of sound waves per second measured in Hertz.



Pure tone Audiometry

Audiometry is the procedure by which the nature of hearing disabilities e. g. conductive or sensory neural deafness is determined. The instrument used is known as Audiometer which is simply an electronic oscillator capable of emitting pure tones of various frequencies through earphone to the subject.

The instrument is calibrated in such a way so that zero intensity (0 dB) level of sound at each frequency is the loudness that can be barely heard by the normal person.

The audiometer is also equipped with an electronic vibrator for testing bone conduction from the mastoid process to the cochlea.

When performing the test, one should test approximately 8 to 10 frequencies covering the auditory spectrum, one at a time and the hearing loss is determined for each of these frequencies. Then the air and bone conduction audiograms are plotted for interpretation.

Technique:

1] The subject is seated comfortably in a sound proof room.

2] Earphones are applied which are color coded (Red for right ear, Blue for left ear).

3] Masking sound is delivered to the non-test ear.

4] Pure tones are delivered to the test ear starting with a frequency of 125Hz. & intensity of 0 dB.

5] The intensity (dB) is gradually increased till the subject hears the sound & respond.

6] That intensity is marked on the audiogram paper and is termed as the hearing threshold.

7] The frequency is changed and the hearing threshold is determined for each frequency and is marked on the audiogram paper.

8] Marks are joined to produce a curve for air conduction.

9] Bone vibrator is placed over the mastoid process.

10] Pure tones are delivered through the bone vibrator & the hearing threshold is determined for different frequencies of sound and marked with a different sign on the audiogram paper.

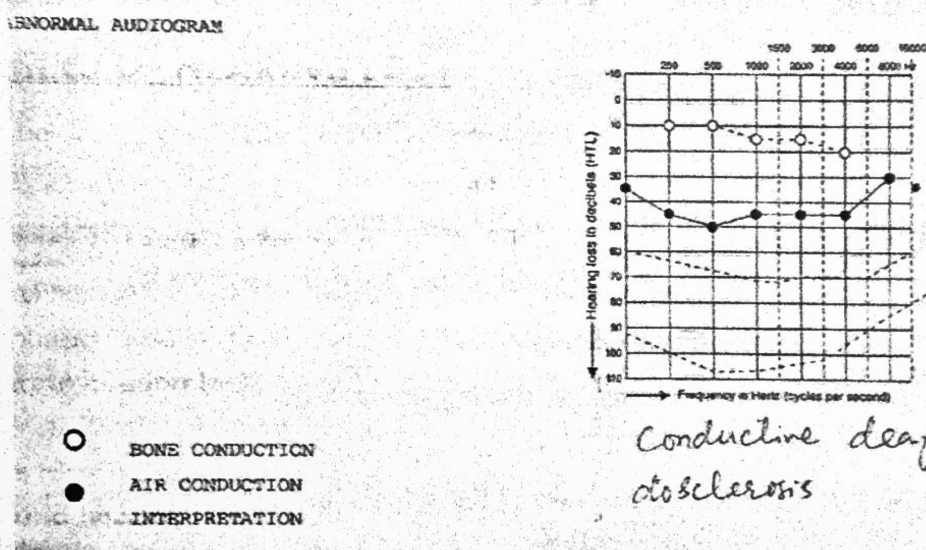
11] Marks are joined to produce a curve for bone conduction.

12] Whole procedure is repeated for the other ear.

DEGREES OF HEARING LOSS

Given below are the ranges of hearing thresholds for a given frequency of sound that determine the severity of hearing loss in a subject tested by audiometry:

DEGREE OF HEARING LOSS	RANGE OF HEARING THRESHOLD
Normal hearing	**0-25 dB**
Mild hearing loss	**26-40 dB**
Moderate hearing loss	**41-55 dB**
Moderate-severe hearing loss	**56-70 dB**
Severe hearing loss	**71-90 dB**
Profound hearing loss	**>90 dB**



Conductive deafness
otosclerosis

The above audiogram is showing conductive deafness, caused by Otosclerosis.

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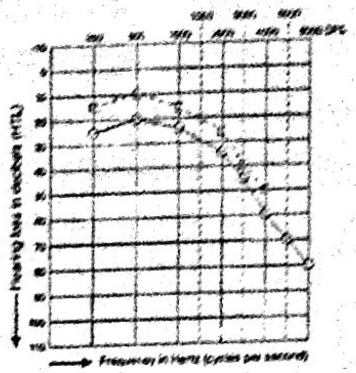
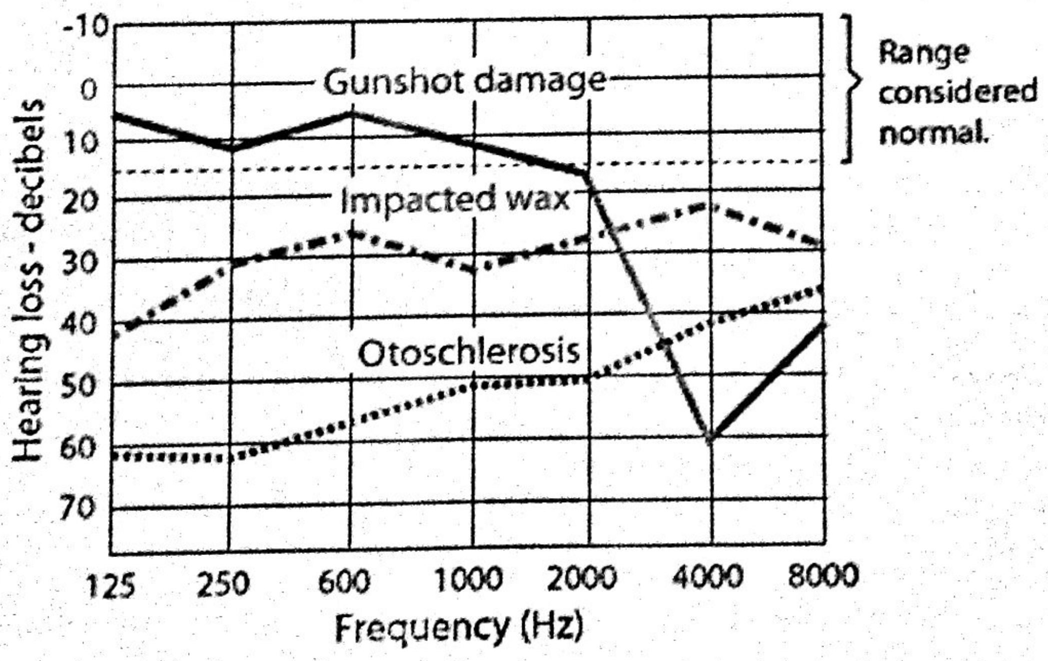
BONE CONDUCTION
AIR CONDUCTION
INTERPRETATION



Presbyacusis
Old age hearing loss

The above audiogram is showing sensorineural deafness at higher frequencies, and is commonly seen in old age and the condition is called Presbyacusis.



The above depicted diagrams of audiograms show various patterns of air conduction curves seen in different cases such as gunshot, impacted wax and otosclerosis.

In the Noise-induced hearing loss, the hearing threshold is affected in only one particular frequency; most likely 4000 Hz as shown in the above air conduction curve in a case of gunshot damage.

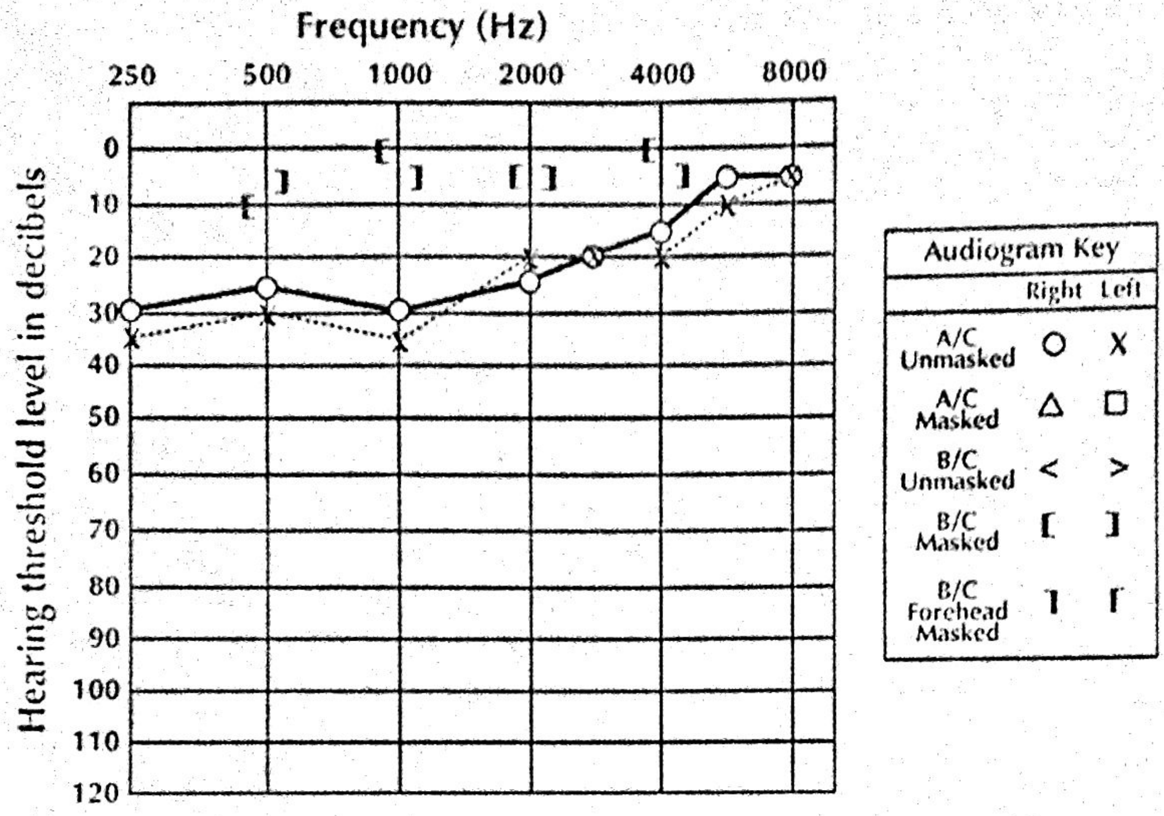
TYPES OF HEARING LOSS (DEAFNESS)

- Conductive hearing loss
- Sensorineural hearing loss
- Mixed hearing loss

Conductive Hearing loss (deafness)

Conductive deafness reduces the effective transmission of sound through air conduction but it does not affect the bone-conduction because it bypasses the outer or middle ear and in the conductive deafness, the problem is either in the outer or in the middle ear. So bone conduction becomes better than air conduction due to the loss of amplification of sound in all cases of conductive deafness.

The causes of conductive deafness include wax in the ear canal, ruptured tympanic membrane, fluid in the middle ear system (otitis media), and fixation of the footplate of stapes to the oval window (Otosclerosis).



In the above audiogram, bone conduction is better than air conduction, so it is a case of Conductive deafness. Most likely cause of conductive deafness in this case is Otosclerosis, as we can see the two curves for air conduction and bone conduction are merging with each other at higher frequencies.

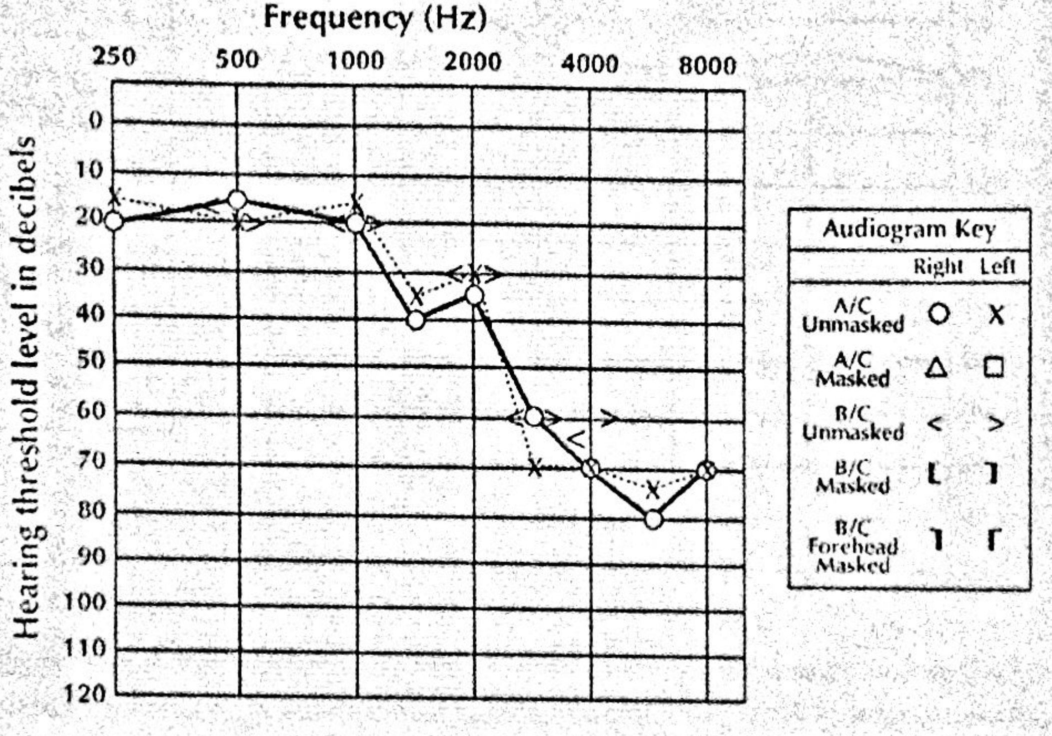
Sensorineural Hearing loss (deafness)

Sensorineural hearing loss occurs when there is damage to the inner ear (cochlea), or to the nerve pathways from the inner ear to the brain. Sensorineural hearing loss reduces the ability to hear faint sounds. Even when speech is loud enough to hear, it may be unclear or sound muffled. Air conduction is better than bone conduction but the difference between them is within 10 db in each frequency of sound. The hearing threshold should be more than 25 db in one frequency of sound at least.

Some possible causes of Sensorineural hearing loss include:

- Illnesses like labyrinthitis (inner ear infection) and Meniere's disease
- Drugs that are toxic to hearing

- Hearing loss that runs in the family (genetic or hereditary)
- Aging
- Head trauma
- Malformation of the inner ear
- Exposure to loud noise

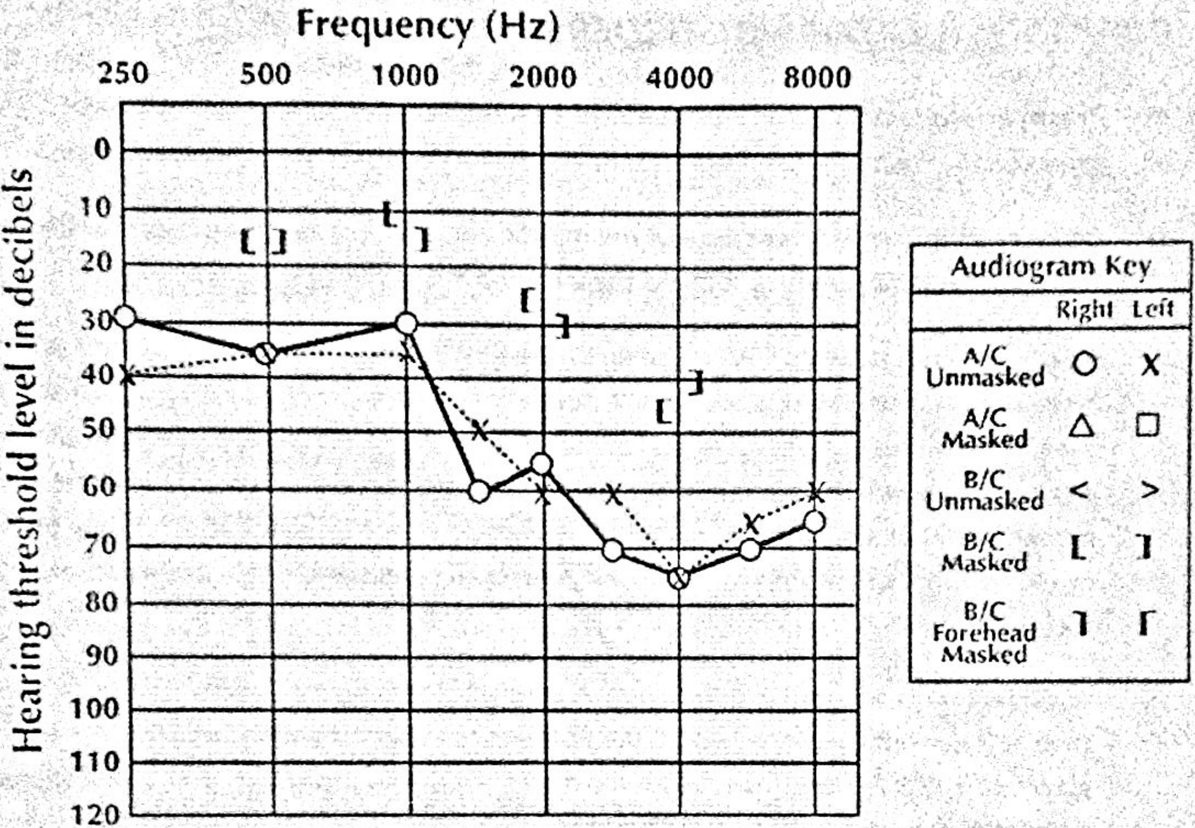


In the above audiogram, air conduction is better than bone conduction and the hearing threshold is more than 25 db at higher frequencies, so it is a case of sensorineural deafness at higher frequencies or **Presbycusis** due to old age.

Mixed Hearing loss

Sometimes a conductive hearing loss occurs in combination with a sensorineural hearing loss. In other words, there may be damage in the outer or middle ear and in the inner ear (cochlea) or auditory nerve. When this occurs, the hearing loss is referred to as a **mixed hearing loss.**

In these cases, bone conduction is better than air conduction and the difference between them is more than 10 db and the hearing thresholds for air conduction in most of the frequencies is more than 25 db.



In the above audiogram, bone conduction is better than air conduction and the difference between them is more than 10 db in all frequencies and also the hearing threshold for air conduction in most of the frequencies is more than 25 db, so it is a clear case of mixed hearing loss.

COMMON AUDITORY DISORDERS

- **Presbyacusis** is defined as a progressive bilateral symmetrical age-related sensorineural hearing loss. The hearing loss is most marked at higher frequencies.
- **Otitis media** is an inflammation of the middle ear, usually caused by bacteria, that occurs when fluid builds up behind the eardrum in the middle ear cavity.
- **Noise-induced hearing loss** is usually caused by exposure to excessively loud sounds. Noise-induced hearing loss can result from a one-time exposure to a very loud sound, blast, or impulse, or from listening to loud sounds over an extended period of time. It can be conductive deafness if only ear drum is ruptured by loud sound, or it may be sensorineural deafness if only cochlea is damaged by the loud sound, or it may be mixed hearing loss if both the tympanic membrane and the cochlea are damaged by the loud sound.
- **Otosclerosis** is a hereditary condition in which the hearing loss occurs slowly, over time. It is caused by the growth of the fibrous tissue over the margin of footplate of stapes (3rd Ossicle) that fixes it with the margin of the oval window, immobilizing the ossicles and causing conductive deafness.
- **Ménière disease** is an inner ear disorder that affects balance and hearing. It is characterized by episodes of vertigo and tinnitus and progressive hearing loss, usually in one ear. It is thought to be caused by increased pressure of endolymph within the inner ear cavity.

TUNING FORK TESTS

The Rinne's Test:

This test compares the air conduction with the bone conduction.

Technique

1] Strike a 512 Hz tuning fork softly on the palm to produce vibration.

2] Place the vibrating tuning fork on the base of the mastoid bone.

3] Ask the subject to tell you when the sound is no longer heard.

4] Immediately bring the tuning fork just in front of the ear.

5] Ask the subject to tell you whether he still hears it or not.

Interpretation:

- Normal subjects will hear sound through air conduction twice as long as bone conduction. They will still hear it in front of the ear when they can't hear anymore from the base of the mastoid bone.
- With conductive deafness, bone conduction will be better than air conduction. In this case, when the subject stops hearing sound from the mastoid bone and brings the tuning fork in front of the ear, he will not hear any sound there too.
- With sensorineural deafness, the sound through air conduction is heard longer than bone conduction in affected ear, but less than twice longer as is the case in normal subjects.

The Weber's Test:

This test distinguishes between conductive and sensorineural deafness.

Technique:

1] Strike a 512 Hz tuning fork softly on the palm to produce vibration.

2] Place the vibrating tuning fork on the vertex of the subject.

3] Ask the subject if the sound is heard better in one ear or the same in both ears.

Interpretation:

- If the hearing is normal, the sound is heard equally in both ears.
- The sound is heard better in the affected or diseased ear in a subject with conductive deafness because of the loss of masking effect of the environment and all the receptors for hearing in the affected ear are free to hear the sound.
- The sound is obviously heard better in the normal ear than the affected ear in a subject with sensorineural deafness because the cochlea and the neural pathway is intact on the normal side.