Physiology Team 439

MED439
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Special thanks to Raina Almutiri

Practical 1:
EMG and Nerve Conduction

Objectives:

- Understand the basic principle of EMG and NCS.
- Perform the EMG and NCS by themselves.
- For the EMG: students should know the appearance and characteristics of a normal EMG study and enumerate a few abnormalities that may be seen in neuromuscular diseases.
- For the NCS: Determine and calculate motor nerve conduction velocity of the major peripheral nerves.

Electromyography (EMG)

Know the definition

Definition: EMG is an electrodiagnostic technique for recording the electrical activity of (action potentials) skeletal muscles.

Procedure:

- EMG is performed by inserting a small sharp needle (recording electrode) through the skin into the muscle under study. The needle electrode is inserted into the belly of the muscle, near the expected region of the motor endplate. Depending on the muscle, this is either midway through the length or at the junction between the proximal and middle thirds of the muscle, **Fig-1**. In general, the endplate region is the thickest part of the muscle belly

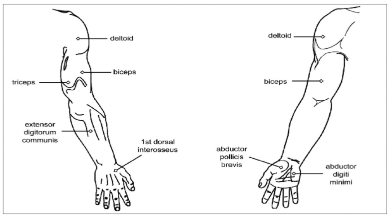


Figure 1. Shows electrode placement sites for needle EMG. Needle electrode positions for some commonly tested muscles. The electrodes are inserted perpendicularly to the skin.

- After insertion of the needle, the electrical activity of the muscle will be recorded at rest, during mild-moderate muscle activity, and during maximal muscle contraction, **Fig-2**. The recording is observed in each case. The potentials recorded upon muscle contraction are derived from the motor units of the muscle, and are known as motor unit potentials (MUPs). A motor unit is defined as one motor neuron and all the muscle fibers it innervates, **Fig-3.**

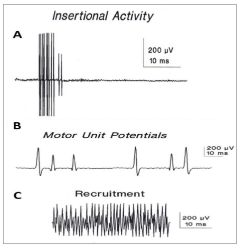


Figure 2

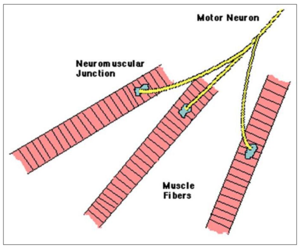


Figure 3

- In physiology student lab, surface electrodes will be used instead of needle electrodes and the same steps will be followed. However, one major difference should be kept in mind. Instead of showing the MUPs, surface electrodes record the sum of all MUPs occurring in the muscle which is called "the compound motor action potential".

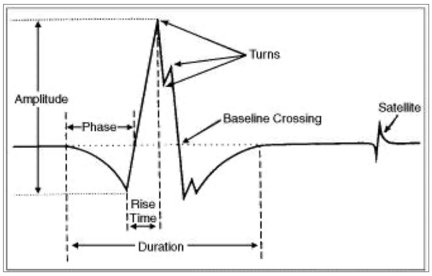
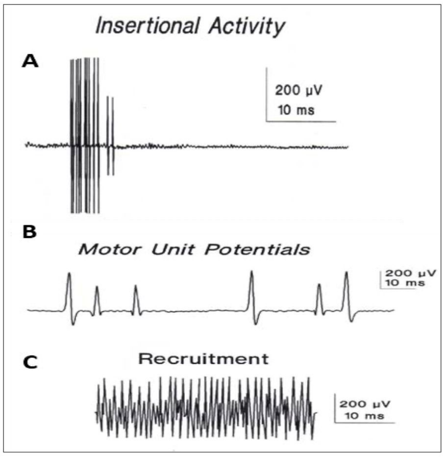


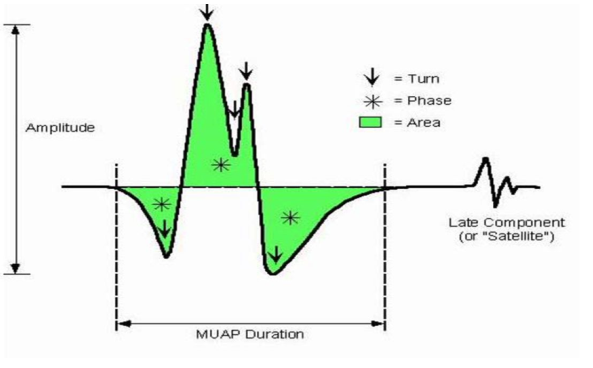
Figure 4. A normal MUP.

Electromyography (EMG)

Procedure:

1. Three surface electrodes need to be placed on the volunteer. An electrode gel should be applied to each electrode before placement:
    a. the ground is placed on the dorsum of the hand
    b. The recording electrode is place on the belly of the muscle
    c. The reference electrode is place 2-3 cm away from the recording electrode
2. When you start recording:
    a. ask the subject to relax and record muscle electrical activity during this period
    b. ask the subject to exert **mild to moderate** contraction
    c. Finally, ask the subject for **maximum** contraction





Insertional activity **(during rest)**: The electrical activity from insertion of the electrode and disruption of the muscle cell membrane

- It is **Decreased** in atrophied muscle or fatty tissue
- It is **Increased** in many abnormal condition that cause membrane instability such as neuropathies, radiculopathies, and inflammatory myopathies

	Normal MUP
Duration (ms)	3-15 ms
Amplitude	300-5000 µV
Phases	Biphasic/Triphasic
Resting activity	Absent
Interference pattern	Full

Indications for EMG:

You should Know the indications of EMG

EMG is a major diagnostic tool for identifying and characterizing disorders of the motor unit, including anterior horn cells, peripheral nerves, neuromuscular junctions, and muscles.

Along with nerve conduction studies (NCS), EMG can help;

- Confirm diagnosis.
- Grade the severity of the disease.
- Define evolution, stage, and prognosis.

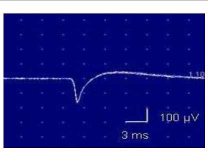
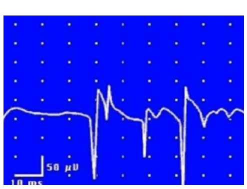
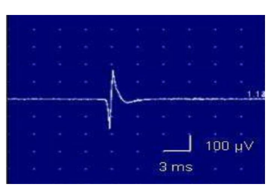
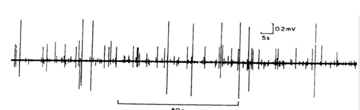
Important

Electromyography (EMG)

Abnormailities of EMG:

You should know the abnormalities + causes + how it looks like

- **During rest:**
  - Positive Sharp waves
  - Fibrillation
  - Fasciculations
- **During MUPs**
- **During Recruitment**

At rest			
	Positive Sharp waves	**Fibrillation**	**Fasciculations**
Overview	-	**Action potentials of single muscle fibers** that are twitching spontaneously **in the absence of innervation**	Randomly discharging potential of a **group of muscle fibers due to partial re-innervation of denervated muscle fiber**
Causes	Neuropathy, myopathy	Neuropathy, Myopathy	Motor neuron disease, Radiculopathy, Neuropathy
Description	Positive sharp potentials with fast downstrokes and slower return to baseline	Low amplitude, Biphasic, Short duration	Visible to the naked eye` High voltage polyphasic long duration potentials (giant potentials)
Appearance	 		

Important

Electromyography (EMG)

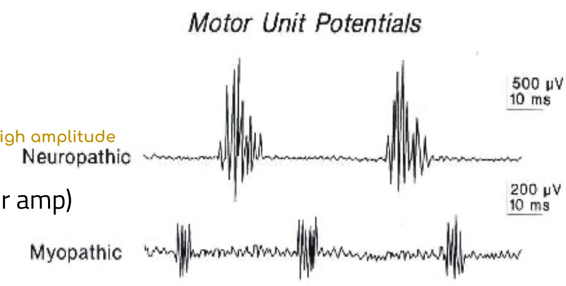
You should know the abnormalities of MUP and the recruitment + causes + (how it looks in waves)

Abnormalities of EMG during the muscle contraction:

❖ Abnormal MUPs

Neuropathic: giant poly phasic Long duration,high amplitude

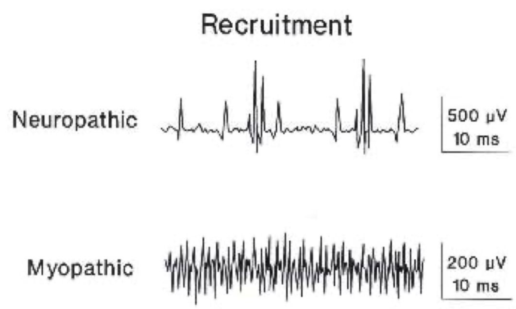
Myopathic: brief abundant polyphasic (lower amp)



❖ Abnormal Recruitment

Neuropathic: Reduced firing rate
You can see the baseline

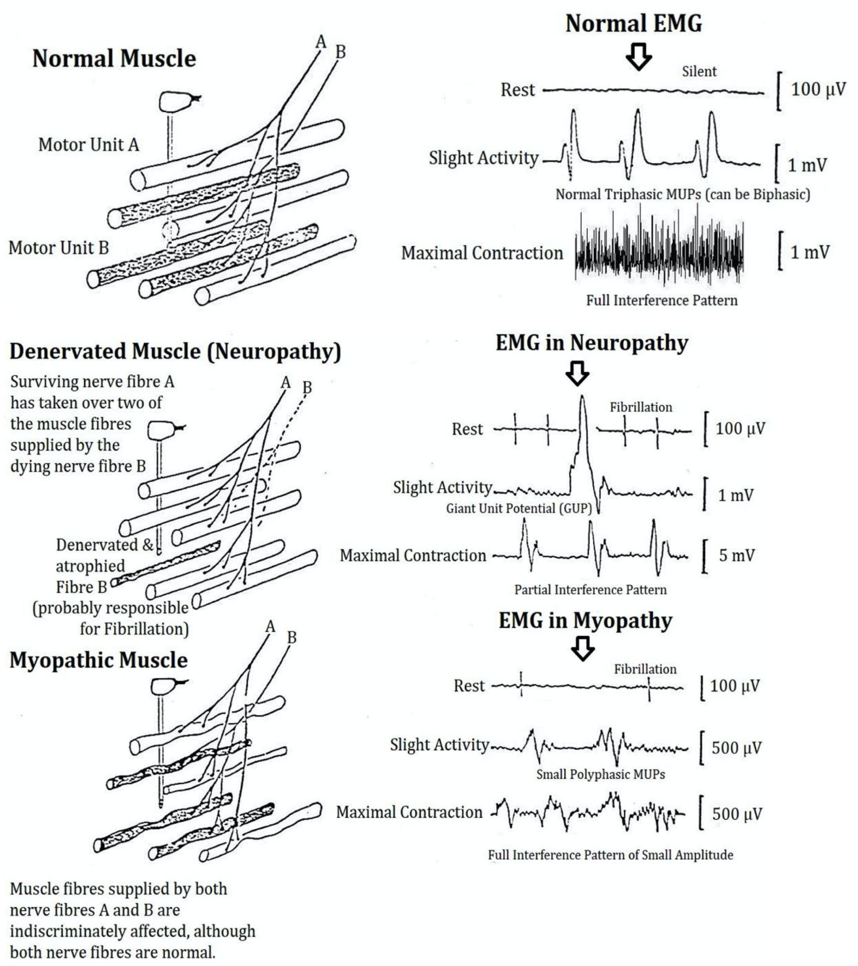
Myopathic: Full interference pattern, Low amp
You can't see the baseline(full pattern but with law amplitude and shorter duration)

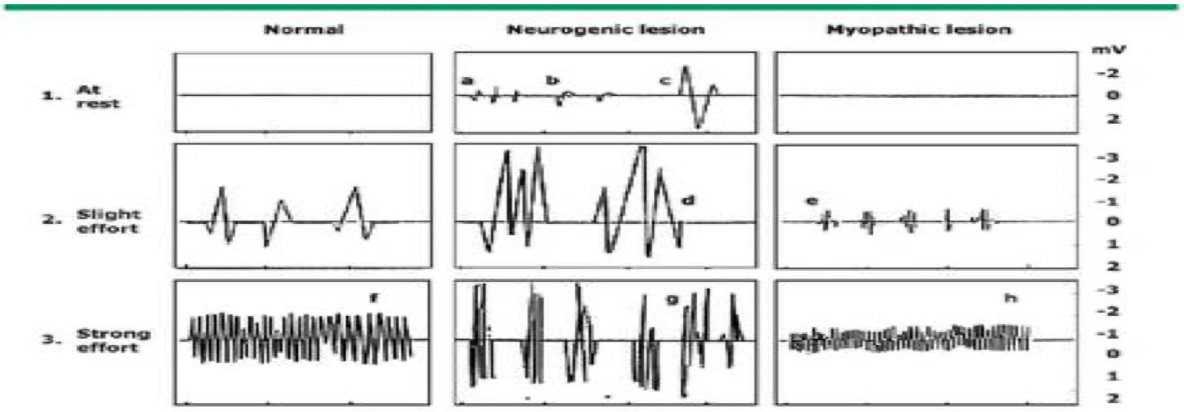


MUP			
	Normal	**Neurogenic**	**Myopathic**
Duration **msec**	3-15 ms	Longer	Shorter
Amplitude	300-5000 µV	Larger	Smaller
Resting activity	Absent	Present	May be Present
Interference pattern	Full	Partial	Full

Electromyography (EMG)

Helpful pictures





1. At rest (spontaneous activity): a. fibrilations, b. positive sharp waves, c. fasiculation.
2. Slight effort (motor unit potentials): d. giant polyphasic, e. BSAPS (brief-small-abundant polyphasic).
3. Strong effort (interference pattern): f. full, g. reduced units, h. reduced amplitude.
* (helpful in selecting denervated muscles [in radiculopathies (myotomal), mononeuropathies (distal to lesion), generalized neuropathies (distal muscles)] and myopathies)

Nerve Conduction Study (NCS)

You should Know the indications of NCV

Definition: A Nerve conduction study (NCS) is a test used to evaluate the function of peripheral nerves by measuring their conduction velocity and response latency. Motor and sensory nerve conductions are studied separately and require different techniques. The most common nerves tested in the upper limb are the median, ulnar, and radial nerves.

Principle:

- Motor NCS are performed by electrical stimulation of a peripheral nerve and recording from a muscle supplied by this nerve. A nerve potential is initiated at the stimulation electrode and is conducted along the nerve fibers to the muscle. When the muscle contracts, the compound muscle action potential is recorded and observed on the display screen. The **latency** of the response (the time it takes for the impulse to travel from the stimulating to the recording site) is **measured in milliseconds (ms)**. The **size** of the response (the **amplitude**) is also noted. The motor amplitudes are measured in **millivolts (mV)**.

- This is repeated by stimulating the motor nerve at a second site along its path. **The distance between the two stimulation points is measured** and the difference in latency times determined. By dividing the distance between stimulation points by the difference in latency times, the motor nerve conduction velocity can be calculated.

$$MNCV = \frac{Distance\ (mm)}{L1-L2\quad (msec)}$$

MNCV = Motor nerve conduction velocity **(m/sec)**
Distance= Between two stimulating electrodes **(mm)**
L1= Latency at elbow **(msec)**
L2= Latency at wrist **(msec)**

Normal values for conduction velocity:

- **In arm**
  - **50 - 70 m/sec**
- **In leg**
  - **40 - 60 m/sec:**

1-write the formula

2- make sure of all units (if you have the distance in cm you should convert it into mm by multiplying it in 10)

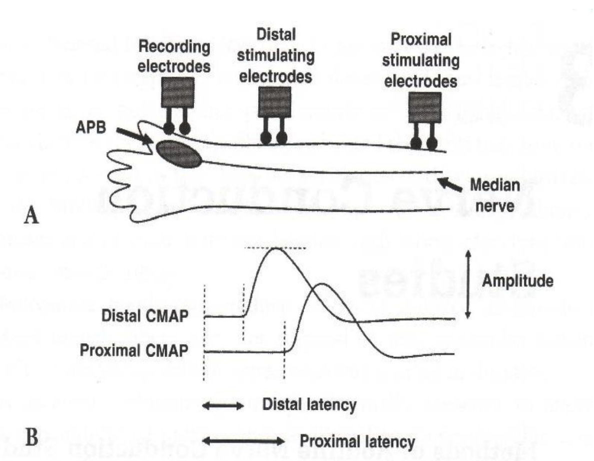
Ex: 23 cm —-[*10] = 230mm

Nerve Conduction Study (NCS)

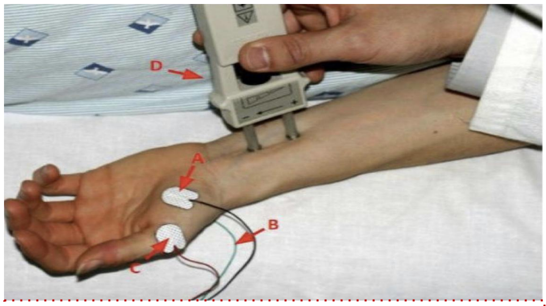
Procedure:

The motor nerve conduction study will be measured for the median nerve.

- Placement of electrodes as follows:
    - Recording electrode (Cathode or Negative) are placed on the muscle supplied by the nerve under study (*Abductor Pollicis Brevis*)
    - Reference (Anode or Positive) is placed over distal tendon
    - The grounding electrode is placed between stimulation and recording electrodes (dorsum of hand)
    - Stimulating electrodes are placed between *Flexor Carpi radialis* tendon and *Palmaris Longus* tendon **(Wrist stimulation)** with the cathode electrode placed distally to the anode
    - The median nerve is then stimulated at the **Elbow**
- The distance between the two simulations is measure and then nerve conduction velocity is calculated
- Compare to: Same limb (median vs ulnar), Left vs right limb, Upper vs Lower Limb, Previous results, Normal values



You should know the abnormalities



(A): recording electrode.
(B) : ground electrode.
(C): reference electrode.
(D): stimulating electrode.

Axonal degeneration neuropathy features	Demyelinating Neuropathy features
Low amplitudes	Normal amplitudes
Normal/ slight delay in latency	**Significant delay in latency**
Normal/ slightly low conduction velocity	**Significantly low conduction velocity**

NCS and EMG practice Qs

1- What is meant by "motor unit"

2- What is meant by "motor unit potentials (MUPs)"

3- What will a normal recording of muscle show in each of the following states

- **Rest:**
- **mild muscle contraction:**
- **Maximum muscle contraction**

4- What is the importance of NCS in clinical practice?

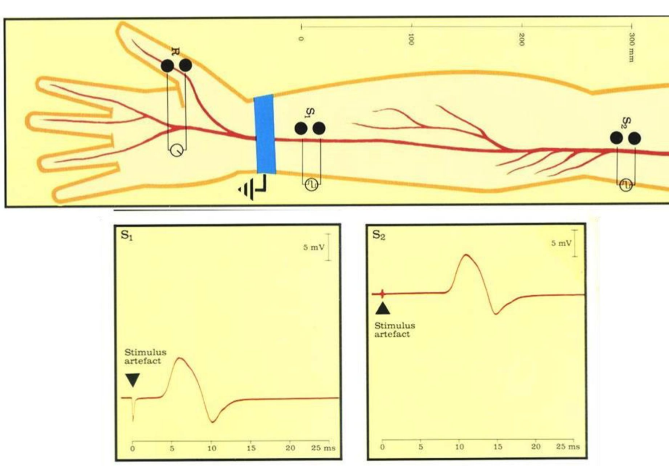
5- How can the conduction velocity of the ulnar nerve be calculated

6- In general, what is the normal motor nerve conduction velocity in the upper limb?

7- Name a few causes for slow conduction velocity in the median nerve?

8- A 29 yr woman did an EMG because of difficulty in walking. Her EMG reveals:
MUP amplitude reduced, Polyphasia present, Early recruitment, Fibrillation absent. Diagnosis?

9- A motor nerve conduction study was performed on the right median nerve of a patient. Two stimulating electrodes were placed, the first at the elbow while the second at the wrest. The recording electrode was placed on the belly of the APB, Fig-10. The CMAP recorded following stimulation at the wrest is shown as S1 in Fig-10, while CMAP recorded following stimulation at elbow is shown as S2. Calculate the conduction velocity of the median nerve



Elbow latency: 6.5ms
Wrist latency: 2.5 ms
Distance: 24cm

NCS and EMG practice Qs answers

1- One motor nerve fiber and all the muscle fibers it innervates

2- Compound potential generated by the muscle fibers of the motor unit during voluntary activity or during electrical stimulation of alpha-motor axons

3- What will a normal recording of muscle show in each of the following states

- **Rest:** No activity
- **Mild muscle contraction:** Normal Bi/Triphasic MUPs
- **Maximum muscle contraction:** Full interference pattern

4- Document focal or continuous abnormalities seen in mixed, motor or sensory nerve

5- By choosing two points along the course of the ulnar nerve and using this formula $MNCV = \frac{Distance\ (mm)}{L1-L2\ \ (msec)}$

6- 50 - 70 m/sec

7- Demyelinating Neuropathies like: Diabetes. Guillain barre

8- Myopathy

9- MNCV= (24 X 10) / (6.5-2.5) = 60 m/sec

Practical 2: Tests of hearing and pure tone audiometry

Objectives:

- ❖ 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.

❖ Definition,causes and graph are important

Tests of hearing and pure tone audiometry

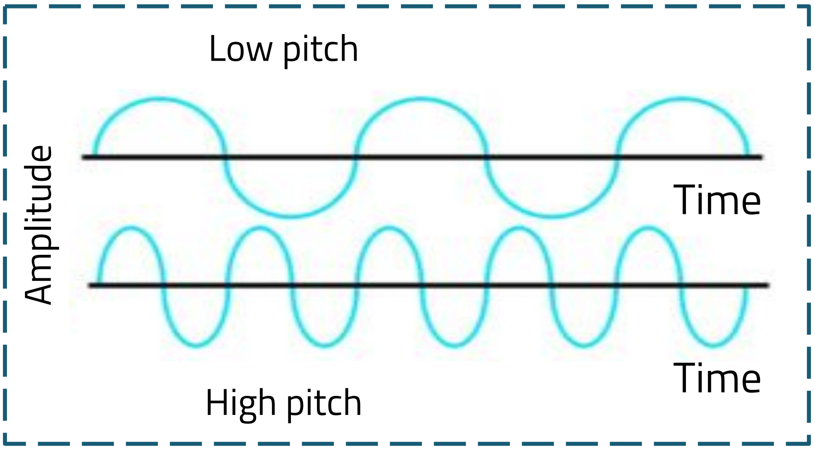
Terminology	Definition
Air conduction	❖ This test assesses sensitivity when the signal is transmitted through the outer, middle, and inner ear then through the brain to the cortex. ❖ Testing may be performed using headphones or insert earphones.
Bone conduction	❖ This technique assesses sensitivity when the signal is transmitted through the bones of the skull to the cochlea and then through the auditory pathways of the brain. ❖ This type of testing bypasses the outer and middle ear.
Masking sound	❖ Masking presents a constant noise to the non-test ear to prevent crossover from the test ear. ❖ The purpose of masking is to prevent the non-tested ear from detecting the signal (line busy), so only tested ear can respond.

Tests of hearing and pure tone audiometry

Pure tone

Know the definition

Pure tone is a single frequency tone with no harmonic content (no overtones). THis corresponds to a sine wave.



Audiogram

❖ The audiogram is a chart of hearing sensitivity with **frequency** charted on the X-axis and **intensity** on the Y-axis.

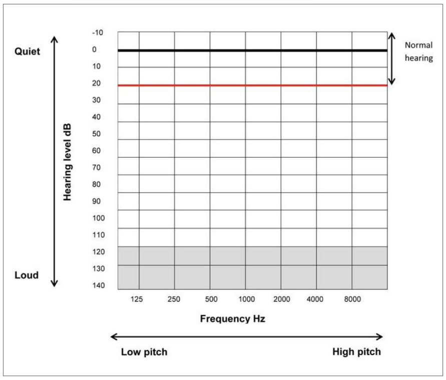
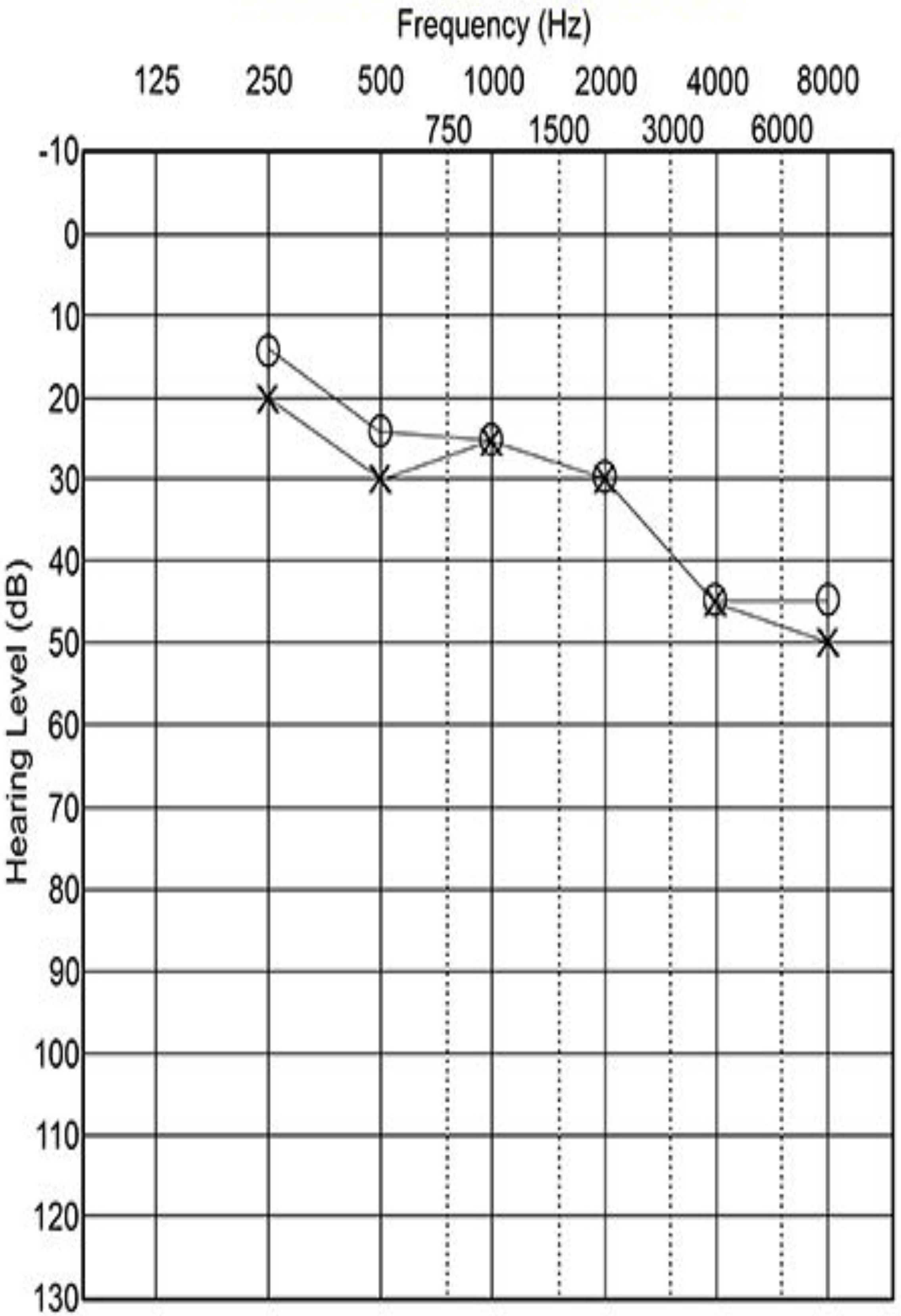


Figure 11. An example of an audiogram chart.

- ➢ Frequency is the pitch of the sound measured in Hertz (Hz)
- ➢ intensity is the volume of sound measured in Decibels (db).

Tests of hearing and pure tone audiometry

Name of chart
-What the X represent (frequency)
- What the Y represent (intensity)



Tests of hearing and pure tone audiometry

Tuning fork tests

Rinne's test:

- This test compares air conduction with bone conduction
  First: Bone conduction
  1-Vibrating tuning fork held on Mastoid process 2-patient covers opposite ear with hand
  3- patient signals when sound ceases
  4-move the vibrating tuning fork over the ear canal (Near, but not touching the ear)

  Next: Air conduction
  Patient indicates when the sound ceases.

- Normally air conduction is better than bone conduction.
  Air conduction usually persists twice as long as bone referred to as "positive test"

- Abnormally bone conduction better than air conduction.
  Suggests conductive hearing loss referred to as "Negative test"

  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.

Tests of hearing and pure tone audiometry

Tuning fork tests

conductive and sensorineural يفرق بين ال

- ❖ **<u>Weber test</u>**:
- ❖ This test distinguishes between conductive and sensorineural deafness Tuning fork places at midline forehead
- ❖ Normally sound radiates to both ears equally.
- ❖ Abnormally sound lateralizes to one ear.
- ❖ Ipsilateral conductive hearing loss OR Contralateral Sensorineural hearing loss.

Interpretation

- If hearing is **normal**, the sound will be 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.

Figure 12. Tuning fork hearing tests. (A) Rinne's test, (B) Weber's test.

Tests of hearing and pure tone audiometry

Pure tone audiometry

❖ Audiometry is the measurement of hearing using an audiometer.
An audiometer is an electronic device that produces acoustic stimuli of known frequency and intensity for the measurement of hearing.
–Earphone (red and blue) used to test air conduction
- Vibrator (bone) is for testing bone conduction

❖ In a sound proof room person is seated comfortably Earphones are applied which are color coded (Red -> Right) (Blue -> Left).

❖ Masking sound is delivered to the non-test ear.

❖ Start with a frequency of 125Hz & 0 db

❖ Gradually increase db till person hears the sound respond.

❖ Mark the threshold intensity on the audiogram paper.

❖ Find the threshold of hearing from 125 hz to 8000 hz and mark on the audiogram paper.

❖ Join the points to make air conduction audiogram.

❖ Place the bone vibrator over the mastoid process.

❖ Deliver the sound through the vibrator and find out the threshold of hearing for different frequencies of sound as used during the testing or air conduction.

❖ Use different sign to mark the bone conduction audiogram.
❖ Select the other ear and repeat the whole procedure.

Tests of hearing and pure tone audiometry

Conductive Hearing loss (deafness)

Conductive deafness reduces the effective transmission of sound through air conduction, but it **does not** affect bone conduction.
Conductive deafness is due to impaired sound transmission in the external or middle ear.
Patients with conductive deafness show **better bone conduction compared to air conduction due to loss of sound amplification.**

The abnormality reduces the effective intensity of the air-conducted signal reaching the cochlea, but it does not affect the bone-conducted signal that does not pass through the outer or middle ear.

Causes of conductive deafness include

- Wax in the ear canal
- Ruptured tympanic membrane,
- Fluid in the middle ear system (otitis media)
- Fixation of the footplate of stapes to the oval window (Otosclerosis)

Pure-tone air-conduction thresholds are poorer than bone-conduction thresholds by more than 10 db

Sensorineural Hearing loss (deafness)

This type of hearing loss is secondary to **cochlear** abnormality and/or abnormality of the **auditory nerve** or **central auditory pathways.**

Causes:

- Degenerative diseases such as presbycusis
- Trauma such as noise and head injury
- Idiopathic e.g. Meniere's disease
- Ototoxicity secondary to drugs like aminoglycosides and salicylates.
- Tumors such as acoustic neuroma.

Because the outer ear and middle ear do not reduce the signal intensity of the air conductedsignal ,both air- and bone-conducted signals are effective in stimulating the cochlea.

Pure-tone air- and bone-conduction thresholds are within 10 dB.

Mixed Hearing loss

Both are affected but the bone conduction is better

This type of hearing loss has **Sensorineural and conductive components**.
there may be damage in the outer or middle ear and in the inner ear (cochlea) or auditory nerve.

Pure-tone air-conduction thresholds are poorer than bone-conduction thresholds by more than 10 dB, and bone-conduction thresholds are less than 25 dB(less the normal range)

Tests of hearing and pure tone audiometry

DEGREES OF HEARING LOSS

- ❖ 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)

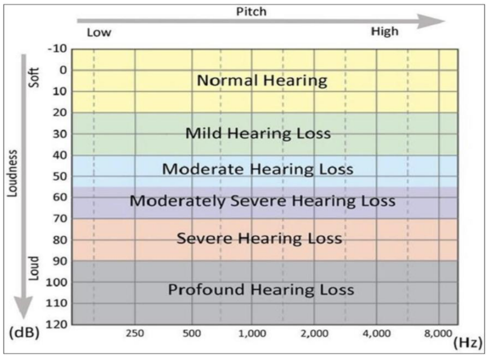


Figure 14. Shows the degree of hearing loss and its corresponding hearing threshold range for each given frequency.

COMMON AUDITORY DISORDERS

- ❖ Presbycusis (age related hearing loss)
- ❖ Otitis media:This condition is marked by fluid in the middle ear space usually secondary to an infection.
- ❖ Noise-induced hearing loss.
- ❖ Otosclerosis:The condition is caused by stapedial fixation in the oval window, stiffening the middle ear system.
- ❖ Ménière disease

Common examples

- ❖ Conductive hearing loss: Otitis media and Otosclerosis
- ❖ Sensorineural hearing loss: Presbycusis and Noise induced hearing loss

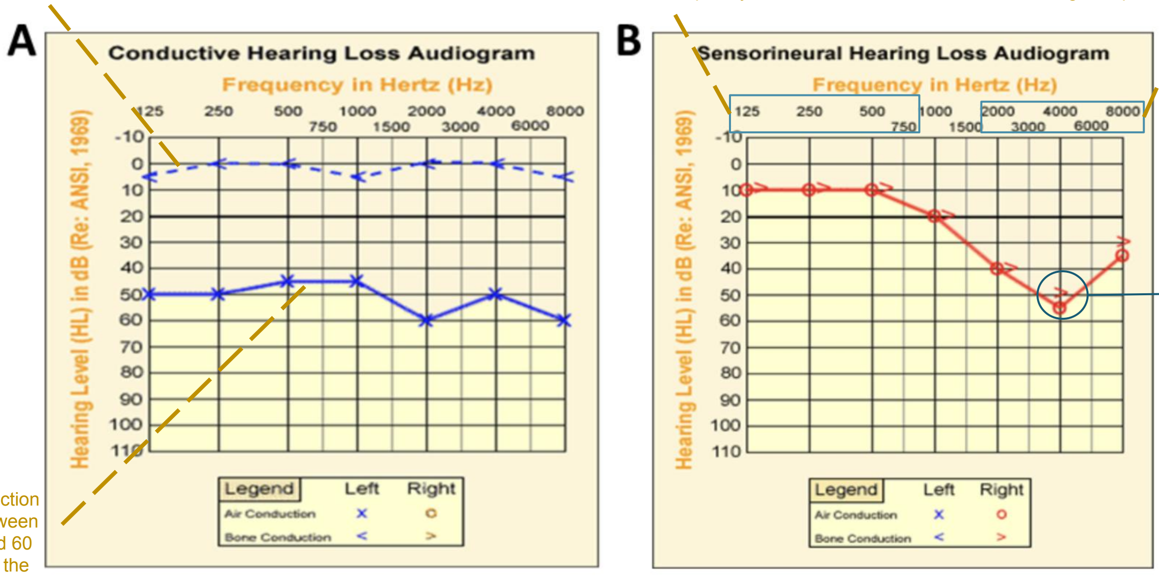
Tests of hearing and pure tone audiometry

1-comment in the bone & air conduction
2-if it's abnormal (degree of loss 'mild or moderate..')
3- the differential diagnoses(causes)
4-the type of hearing loss

Bone conduction is normal

In low frequency > normal

Defects In high frequency sounds

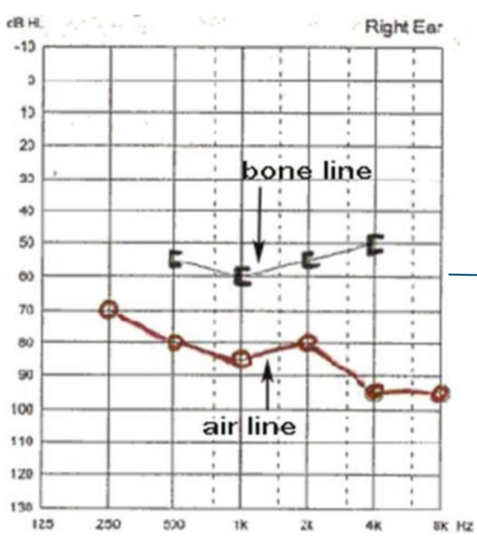


Air conduction is between 45 and 60 below the normal

The difference between Air and bone conduction is less than 10 = sensorineural Hearing loss

Figure 15. Representative audiograms showing an example of conductive hearing loss in (A) and sensorineural hearing loss in (B).

Cases of conductive hearing loss:
Diseases affect external or middle ear like:
Wax
OM
Rupture of tympanic membrane



Both are affected but
Bone conduction is better than air conduction
And the difference between them is more than 10 = Mixed hearing loss
Cause :
(defect in external ear and inner ear or middle ear and the auditory nerve)

Figure 17. Audiogram showing mixed sensoineural hearing loss.

Tests of hearing and pure tone audiometry

Found in Dr.Tajj's slides

Conductive deafness

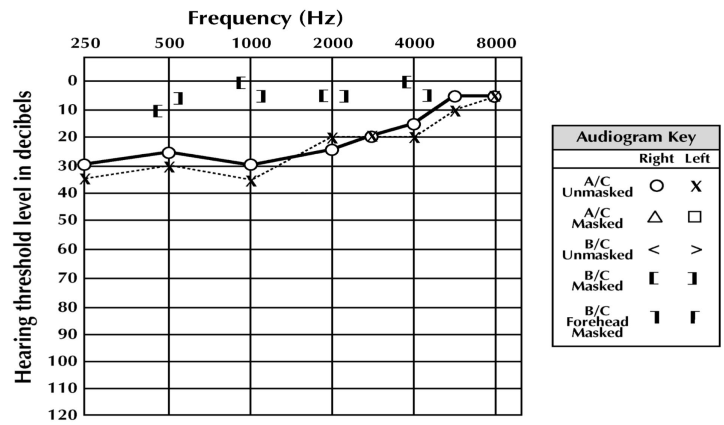
#Med435

Which type of hearing loss the chart represents?
Conductive hearing loss

What cause the hearing loss in this case and mention an example?
Obstruction or blockage of the outer or middle ear.**Ex**:Otitis media

Describe the BC and AC in this type of hearing loss.

➢ AC: Decrease in hearing sensitivity.
➢ BC: normal sensitivity. **BC>AC.**



SPEECH TESTS

TESTS		R	L
Sp. Reception Threshold (SRT)		30 dB	30 dB
Sp. Discrim. Scores	35 dB SL	98%	98%

Sensorineural deafness

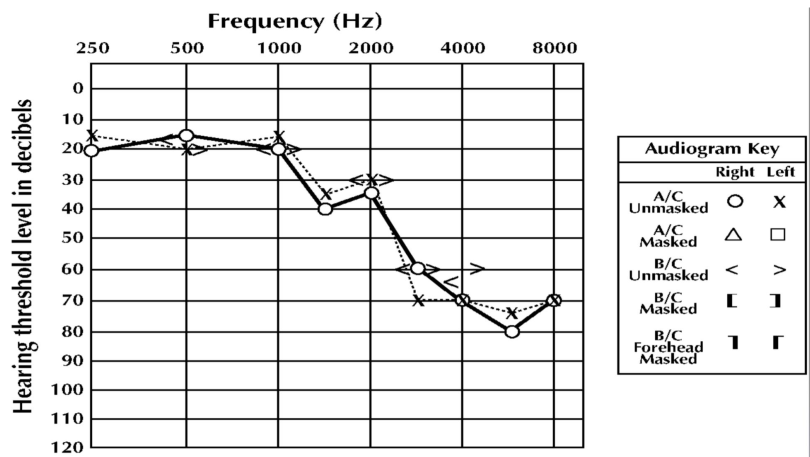
#Med435

Which type of hearing loss the chart represents?
Sensorineural deafness

What is the cause for this hearing loss, and what is the condition that this chart represents?

➢ Damage to cochlea (inner ear),auditory nerve.
➢ presbyacousis

Describe the BC and AC in this?
AC and BC thresholds are both decreased in sensitivity but **AC > BC**
They have approximately the same (±10dB) at all frequencies.



SPEECH TESTS

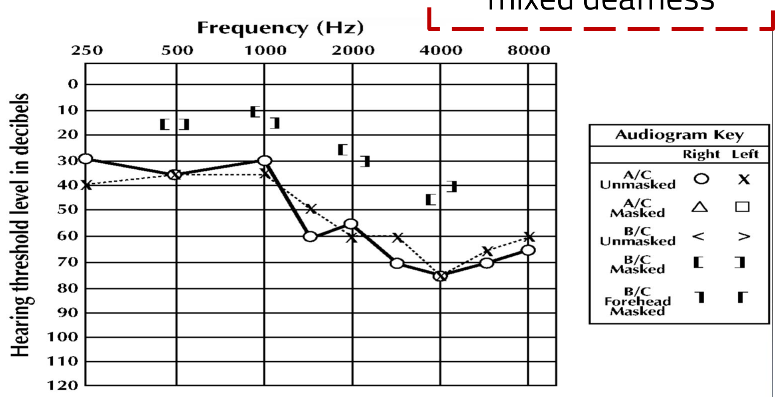
TESTS		R	L
Sp. Reception Threshold (SRT)		25 dB	25 dB
Sp. Discrim. Scores	35 dB SL	72%	76%

mixed deafness

#Med435

Which type of hearing loss this chart represents?
Mixed hearing loss

Describe the BC and AC?
Both AC thresholds and BC thresholds are reduced in sensitivity,but BC yields better results than AC.**(there is a gap between them).**



SPEECH TESTS

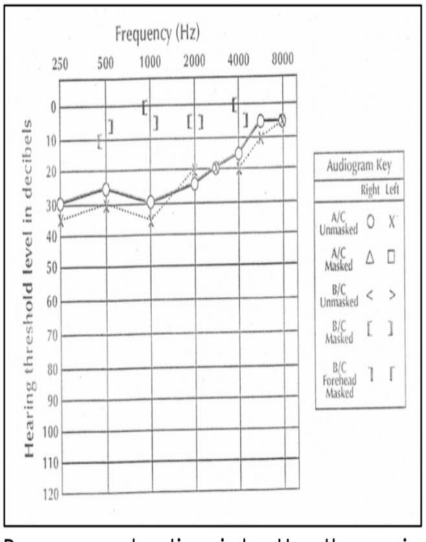
TESTS		R	L
Sp. Reception Threshold (SRT)		40 dB	40 dB
Sp. Discrim. Scores	35 dB SL	84%	86%

#Med434

Key

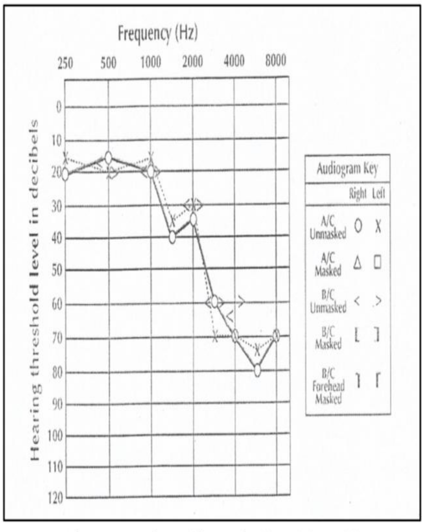
[ ] < > Bone conduction

× ○ △ □ Air conduction

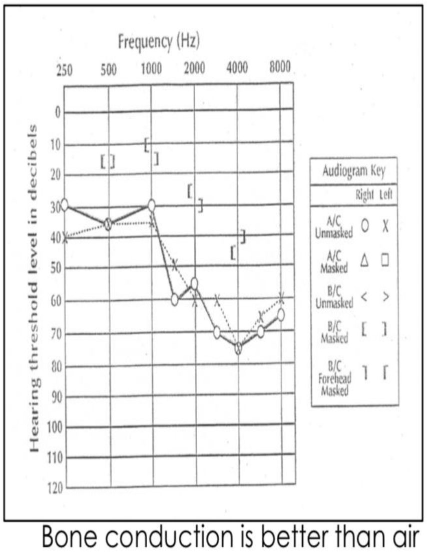


Bone conduction is better than air conduction, they are merging with each other at high f so it's

Conductive Deafness



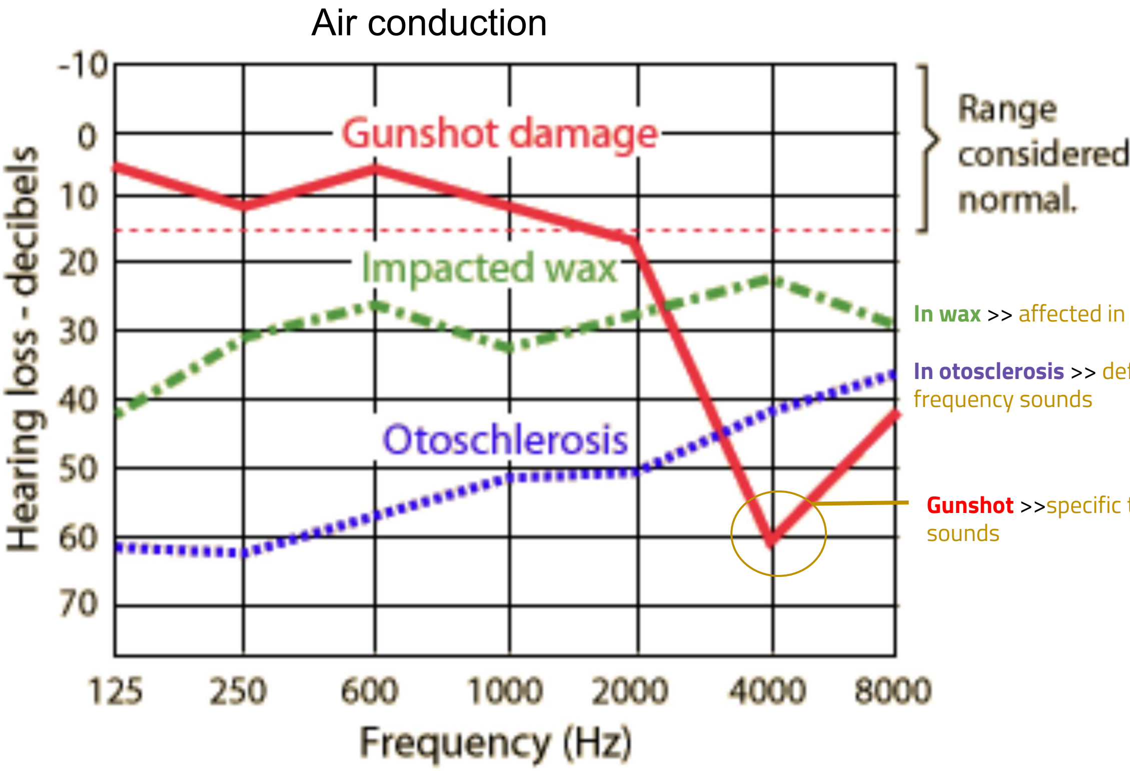
Air conduction is better than bone conduction, hearing threshold is more than 25-30db at higher f. so it's **Sensorineural Deafness**



Bone conduction is better than air conduction and the dif, between them is more than 10db in all f also the hearing threshold of air conduction in most f is more than 25db so it's

Mixed Hearing Loss

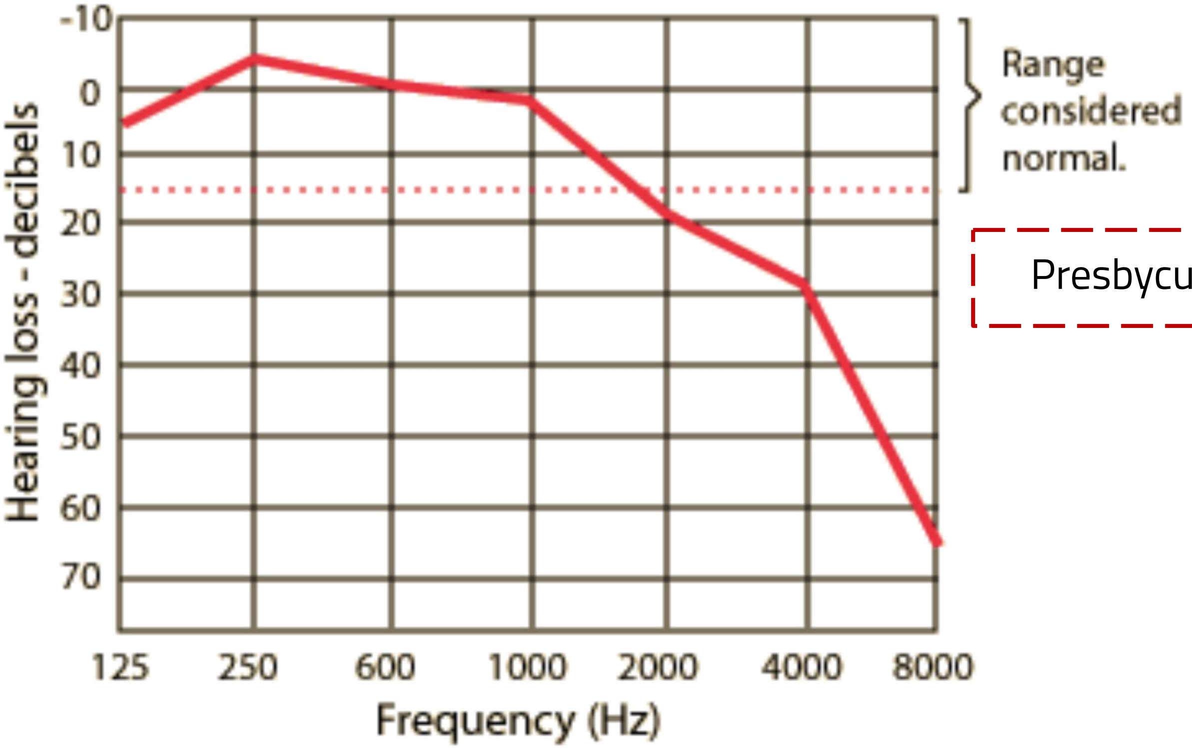
Tests of hearing and pure tone audiometry



In wax >> affected in all frequency

In otosclerosis >> defects is low in high frequency sounds

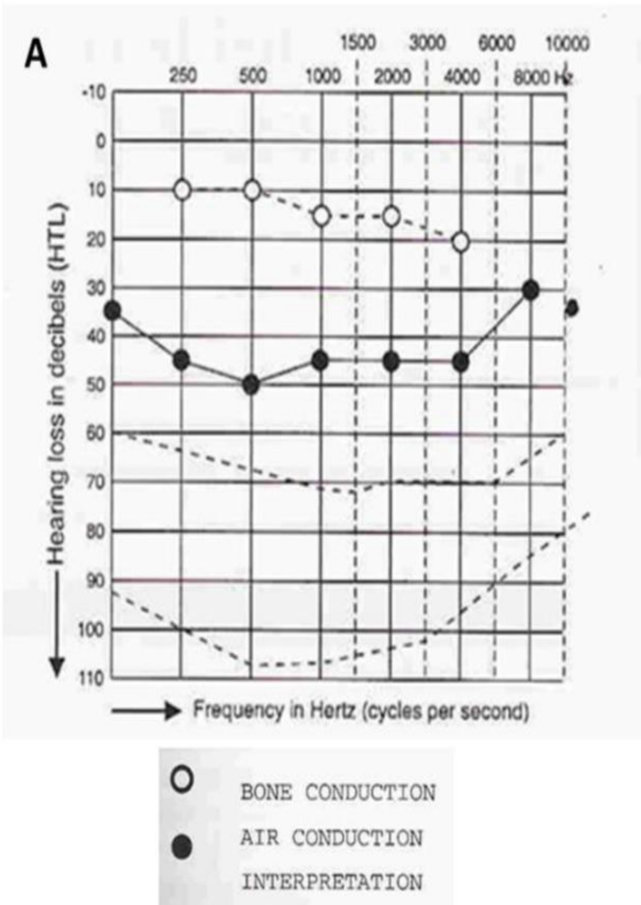
Gunshot >>specific to high frequency sounds

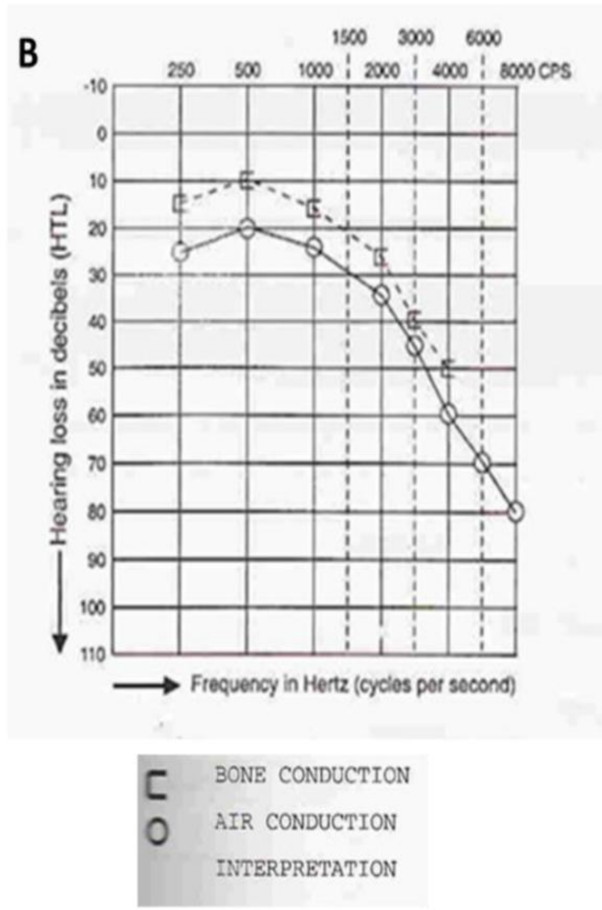


Presbycusis

2.7. Practice questions

1. **The audiograms shown below were recorded from right ear of two different subjects, subject (A) and (B). Describe the findings observed for each graph and identify the most likely type of hearing loss that each represents**





	Subject A	**Subject B**
Findings	Conductive deafness	Presbycusis
Interpretation		
Possible causes	Otosclerosis	Old age hearing loss

Practical 3:

Vision

(Visual Acuity, Color Vision, Light and Accommodation Reflex)

You must know
Definition
Equipment
Difference between myopia and hyperopia

- (chart name) and used To test what (type of analysis) ?
- Reed the analysis (ex 'd/D ')
- Errors and the correction

Vision

Visual Acuity:

The shortest distance by which two lines can be separated and still perceived as two lines.

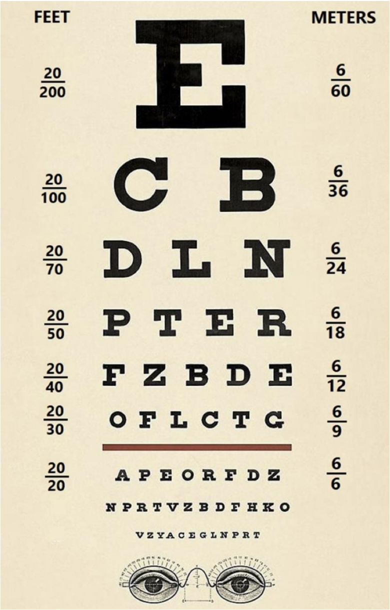
It depends on:

- The refractive ability of the refractive media (cornea and lens) of the eye
- The density of the photoreceptors.

The **fovea centralis** is the place of greatest visual acuity during the **daylight** and the **mid-peripheral portion of the retina** is the place of greatest visual acuity in the **dim light.**

Testing far vision:

Equipment: Snellen's chart.



Procedure:

- Ask the subject to stand about 6-meter (20-feet) away from the Snellen's chart. This distance is referred to as "d".
- Keep wearing eye glasses if they are for distant vision.
- Cover one of his eyes with an eye patch.
- Ask him to read the chart from the other eye and find out the smallest letters he could read.
- Note the distance written below the last line he is able to read fully. This distance is referred to as "D".
- Repeat the same procedure for the other eye.

Interpretation:

Visual Acuity (VA) = $\frac{d}{D}$

d = the distance from where the subject is reading the chart.

D = the distance from which a **normal** subject can read that line.

Suppose the smallest letter that can be read by the subject is in the line below which the distance is mentioned "9 meter", then the Visual Acuity of that eye is:

Visual Acuity (VA) = $\frac{6}{9}$

It means that the subject is able to read from 6 meters only which a normal person can read from 9 meters, so his visual acuity for the far vision is disturbed. Normal Visual Acuity for far vision is 6/6 (in meters) or 20/20 (in feet).

Refractive Errors very important

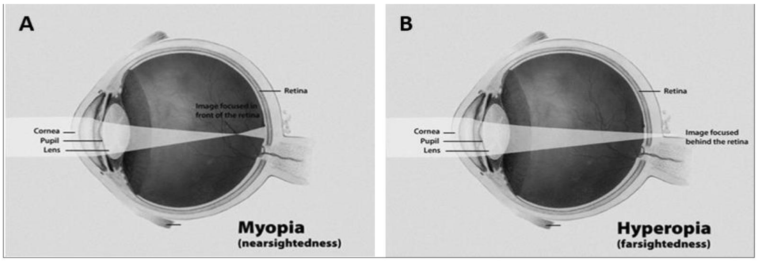
Myopia

Myopia is a refractive error in which **close objects are seen clearly**, but the **far objects appear blurred**, that is why this condition is also called nearsightedness. It occurs if the **eyeball is too long or the lens has too much curvature**. As a result, the light entering the eye from a distant object isn't focused exactly on the retina but **focuses in front of it**, so that distant object looks blurred, Fig-19A. This refractive error can be corrected by applying **concave** (minus) lenses in front of the eyes or performing surgery to flatten cornea that will decrease the refractive ability of the cornea and the light rays from a far object will focus on the retina.

Hyperopia

If the eyeball is smaller or the lens is weak, the image from a near object is focused **behind the retina**, making the object look blurred, Fig-19B. In these cases near vision is affected and the far vision remains intact, so this refractive error is known as farsightedness or in medical terms, hypermetropia. These patients need **convex** (plus) lenses in front of eye so that the light rays entering the eyes from any near object will focus exactly on the retina and the near objects can be seen clearly then.

Again...

Abnormality	Myopia(nearsightedness)	Hypermetropia (hyperopia = far-sightedness)
Definition	Myopia is a refractive error in which **close objects are seen clearly**, but the **far objects appear blurred**	these cases near vision is affected and the far vision remains intact
cause	**eyeball is too long or the lens has too much curvature**	**If the eyeball is smaller or the lens is weak**
leads to	**focus in front of retina**	**focus behind retina**
Correction by	Correction by **biconcave** lens	correction by **biconvex** lens.
Graph	 **Figure 19. Errors of refraction.** (A) A myopic eye with the image focusing in front of the retina. (B) A hyperopic eye with the image focusing behind the retina.	

Testing near vision

- The near vision test is measuring your ability to read and see objects within an arm's distance from the body.
- Jaeger notation test is important if you have **hypermetropia or presbyopia.**
- Most clinics record the near vision as a Snellen fraction (distance equivalent) or as a Jaeger notation such as J1, found on the side of reading cards adjacent to the line of print.
  In performing the near visual acuity assessment it is of great importance to note at what distance the chart is to be held from the patient. Some charts are calibrated for 12, 14, or 16 inch testing distances.
  Patients should be wearing their corrective lenses even if they are for distance viewing.
  If the patient wears specific reading glasses,they should be worn rather than the distance glasses.

Equipment:

Jaeger's chart.

Procedure

- Ask the subject to hold the Jaeger's chart at a distance of 14 inches (36cm) from his eyes.
- Keep wearing eye glasses if any.
- Cover one of his eyes with an eye patch.
- Ask him to read from the largest line to the smallest line that he can read easily or ask him to recognize the smallest size of the picture drawn in the chart and take note.
- Repeat the same procedure for the other eye.

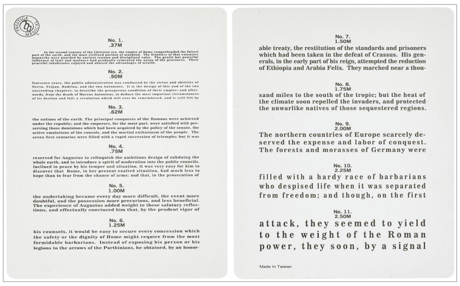
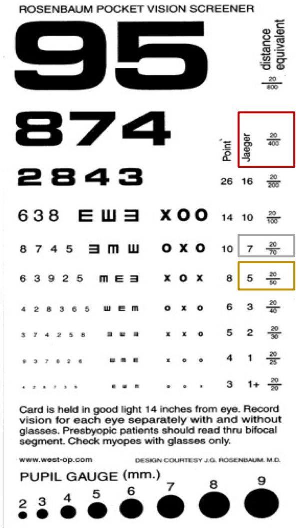


Figure 20. Jaeger's chart.

Interpretation:

- The Jaeger type scale ranges from J1+ to J16 with J1+ being the smallest type. J1+ is considered the equivalent of 20/20 distance visual acuity at the reading distance indicated on the card (14 inches from your eyes), **so a person with normal near vision should be able to read up to this line.**
- Suppose that the subject can read or recognize the picture up to the line marked J3, it means that he can read or recognize at 36 cm distance from his eye which can be read or recognized by a normal subject at 72 cm.



Patient 40 years old ....J no 5 $= \frac{20}{50}$

d = the distance from where the **patient** is reading the chart.

D = the distance from which a **normal** subject can read that line.

Testing for Astigmatism

Astigmatism Is a type of refractive error that causes blurred vision mainly **due to the irregular shape of the cornea** and sometimes uneven curvature of the lens inside. An irregular shaped cornea or lens prevents light from focusing properly on the retina. Astigmatism frequently occurs with other vision conditions like myopia and hypermetropia. Slight amounts of astigmatism usually don't affect vision and don't require treatment. However, larger amounts of astigmatism cause distorted or blurred vision, eye discomfort and headaches Astigmatism treated by adding **cylindrical lenses** in eyeglasses that will correct the astigmatism by altering the way light enters the eyes.

Equipment: Astigmatism chart.

Procedure:

- Ask the subject to stand at a 6-meter (20-feet) distance from an Astigmatism chart.
- Remove eye glasses if any.
- Cover one of his eyes with an eye patch.
- Ask him to see the chart from the other eye. This chart consists of a number of dark lines radiating from a central point, like spokes of a bicycle wheel.
- **If astigmatism is present, some of the spokes will appear sharp and dark, whereas the others will appear blurred and lighter** because they come to focus either in front of or behind the retina when they pass through uneven curvature of the cornea.
- Repeat the same procedure for the other eye.

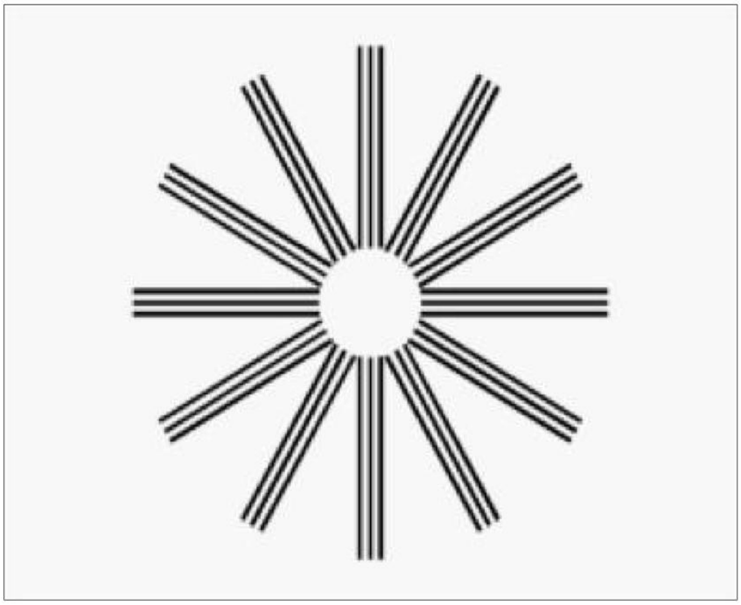


Figure 21. Astigmatism chart.

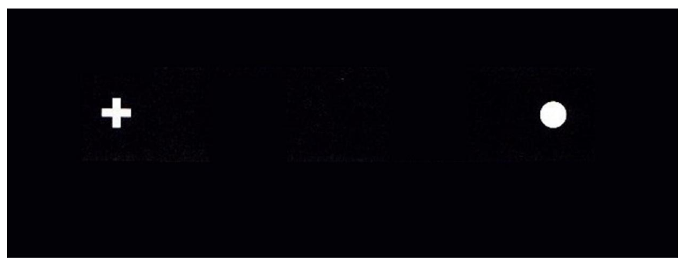
Demonstration of the blind spot

The blind spot is the area in the visual field where an object cannot be seen keeping one eye closed. It is due to the fact that light rays from that area of the visual field focus on the optic disc of the retina which lacks photoreceptors.

Equipment: Blind spot card

Procedure:

- Hold the blind spot card in your right hand and bring it in front of your face about 20 inches away from your right eye.
- Close your left eye.
- Focus on the "plus" sign which can be easily done if the "plus" sign is positioned in line with your right eye.
- Keeping your right eye focused on the "plus" sign, gradually bring the blind spot card closer to your face until the "circle" drawn on the blind spot card disappears. This is the blind spot of your right eye. If you move the blind spot card further close to your right eye, the circle will reappear.
- Repeat the same procedure for the left eye, but this time you will focus on the circle and the plus sign will disappear.



Determination of near point

Know the definition

Near point is the nearest possible distance at which the near object can be clearly seen. The near point of vision changes dramatically with age, averaging about 8cm at the age of 10 and about 100 cm at the age of 70.

Equipment: Common pin.

Procedure

- Ask the subject to sit comfortably.
- Select the test eye and close the other eye.
- Hold a common pin at an arm's length (about 10 inches) in front of his eye and ask him to look at the pin-head.
- Keeping the pin-head in focus, gradually bring the pin closer to his eye.
- Ask the subject to indicate when the pin-head first appears to be blurred or cannot be seen.
- Measure the distance with a ruler.
- Repeat the same procedure for the other eye.

Age	Near point
10 years	8 cm
20 years	10 cm
30 years	12.5 cm
40 years	18 cm
50 years	40 cm
60 years	83 cm
70 years	100 cm

Testing accommodation Purkinje-Sanson images

The process of accommodation can be tested by observing Purkinje-Sanson images in a dark room.
If a small bright light, usually a candle, is held in front of and a little to one side of the eye in a very dark room, three images are seen:

1. The first image comes from the cornea and it is small, bright and upright.
2. The second image comes from anterior surface of the lens. It is large, upright but less bright.
3. The third or last image comes from posterior surface of the lens and it is small,bright and inverted.

During accommodation, the second image comes closer to the first image and also becomes smaller when the eye was at rest. And since an image reflected from a convex surface is diminished in proportion to the convexity of that surface, it is obvious that the front of the lens became more convex when the eye adjusted itself for near vision and this is how we can observe the process of accommodation by using these images.

Equipment: **A candle and a dark room.**

Procedure:

- Make the subject comfortably seated in a dark room.
- Ask him to look at a distant object.
- Hold a candle light in front of and a little to the side of the subject's any one eye.
- Look into the subject's eye from the side opposite to the candle.
- Observe how many images of the candle light are reflected in the subject's papillary area and take note of the relative size, brightness and position of the images.
- Now ask the subject to look at a nearby object and observe carefully the changes that are produced in the size, brightness and position of the images.

You should know the 3 images before the accommodation and after +(why changed or not 'cause ')

Image	Before accommodation	After accommodation
First image	Bright,small and upright from cornea	image does not change (corneal curvature unchanged).
Second image	Dim,large and upright from anterior surface of lens	image becomes smaller, closer to the upright image (↑curvature of anterior surface of lens).
Third image	Small and inverted from posterior surface of lens	changes very little (the curvature of the posterior lens surface changes very little)

#438
Figure 23 Showing **purkinje images**, the reason for an inverted image is that one of the candles escaped a curvature within the eye.

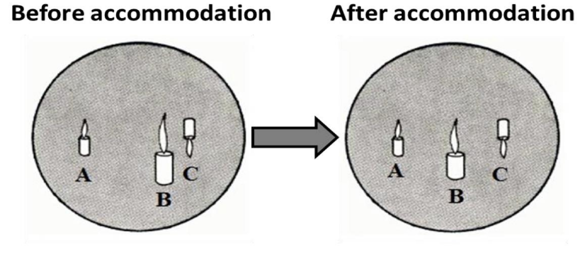


Image A = from cornea.
Image B = from anterior surface of lens.
Image C = from posterior surface of lens.

Figure 23. Images reflected on the pupillary area using the candle light experiment in a dark room.

Test for Color Vision

Color vision is the function of the **cones**.
There are three types of cones in our eyes; red, green and blue. Relative lack or deficiency of one, two or all of them will lead to a defect in color vision.

Equipment:

Ishihara's colored plates

Procedure

- Select the eye for testing and close or cover the other eye.
- Ask the subject to read the numbers showing in several colored Ishihara's plates or trace the zigzag pathway given in some plates.
- Note if the subject has difficulty or fails to read the number or trace the path correctly in a plate and then refer to the key given for that plate to decide which type of color blindness he is having.
- Repeat the same procedure for the other eye.

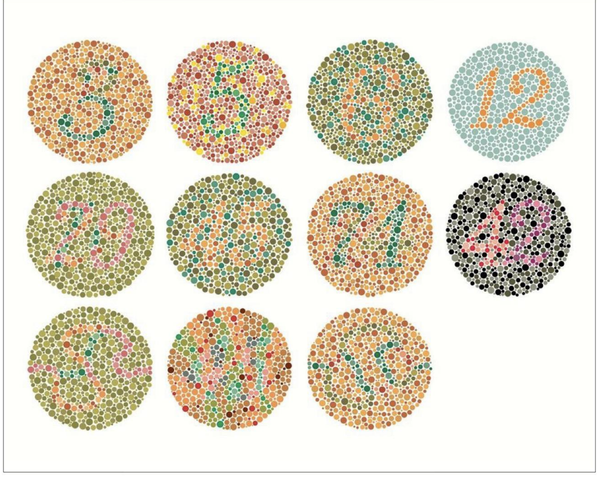


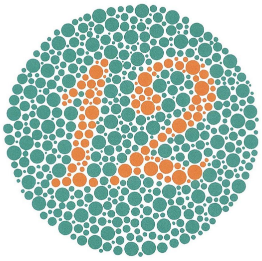
Figure 24. Ishihara's color test plates.

TYPE OF COLOR BLINDNESS	DEFINITION & PATHOLOGY imp
PROTANOPIA (RED BLINDNESS)	A form of colorblindness characterized by defective perception of red and confusion of red with green or bluish green due to the complete absence of red cones.
DEUTERANOPIA (GREEN BLINDNESS)	A form of colorblindness characterized by insensitivity to green, moderately affecting red–green hue discrimination due to the complete absence of green cones.
TRITANOPIA (BLUE BLINDNESS)	A very rare visual defect characterized by the inability to differentiate between blue and yellow due to the complete absence of blue cones.
PROTANOMALY	A type of **anomalous trichromatic vision** with defective perception of red due to less sensitivity of red cones.
DEUTERANOMALY	A type of **anomalous trichromatic vision** in which the green cones have decreased sensitivity,mildly affecting red–green hue discrimination.
TRITANOMALY	A rare type of **anomalous trichromatic vision** in which the blue cones have decreased sensitivity, affecting blue–yellow hue discrimination.

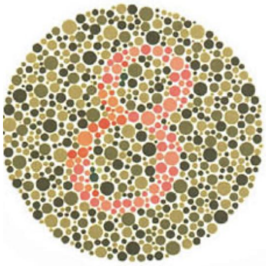
Nopia = blindness/total loss
Nomaly =weakness
Nomaly: يشوف الغامق بس ما يشوف الفاتح كويس

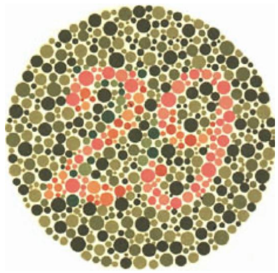
Male slides only

ما راح يجي بالاختبار

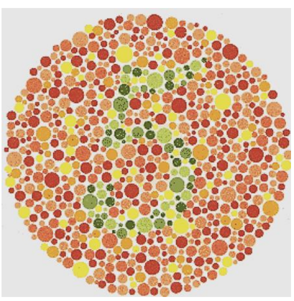


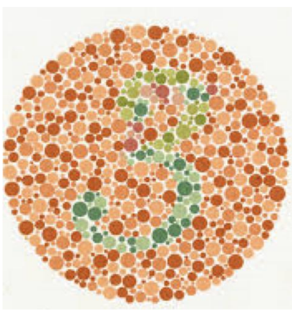
Both the normal and with all color deficiencies,read it as 12

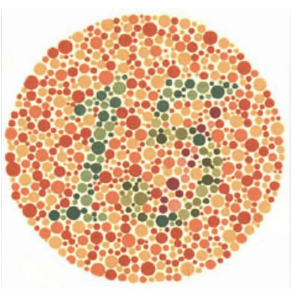


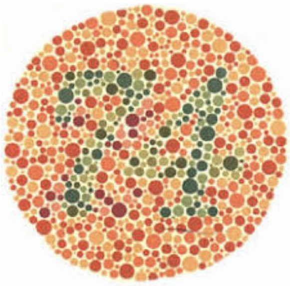


Normal People read them as 8 and 29
Those with red-green deficiencies read them as 3 and 70

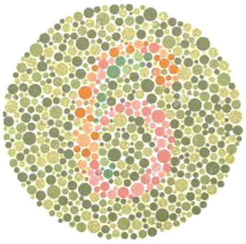


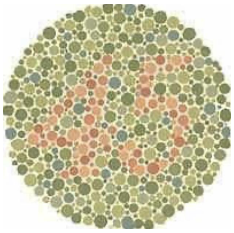




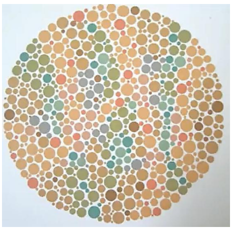


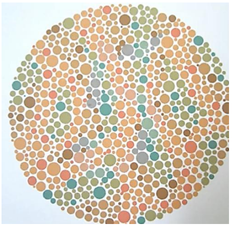
Normal People read them as 5,3,15 and 74
Those with red-green deficiencies read them as 2,5,17 and 21
Those with total color blindness cannot read any numerical.



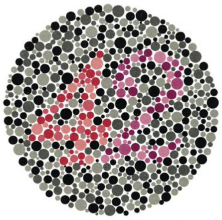


Normal People read them as 6 and 45
Majority of those with color vision deficiencies.
cannot read them at all or read them incorrectly.





Majority of those with red-green deficiencies read them as 5 and 45.



Normal People read them as 26 and 42
Those with protanopia and strong protanomalia read them as 6 and 2
Those with deuteranopia and strong deuteranomalia read them as 2 and 4