Department of Physiology
College of Medicine

# Physiology Practical

# For

# 2nd Year Medical Students

**(2018-2019)**

# Contents

# List of Abbreviations

| | |
|---|---|
| APB | Abductor pollicis brevis |
| CMAP | Compound motor action potential |
| EMG | Electromyography |
| MNCS | Motor nerve conduction study |
| MNCV | Motor nerve conduction velocity |
| ms | Millisecond |
| MUP | Motor unit potential |
| mV | millivolt |
| NCS | Nerve conduction study |

# List of Figures

# Introduction

Welcome to your second year in medical school. This manual has been prepared as a reference to help medical students navigate their way through 2nd year physiology practical sessions. The physiology practical sessions are part of the physiology curriculum that is ingrained in the block system of the first two years of medical school. Its aim is to provide a practical aspect to some of the physiological concepts learned during mainstream lectures allowing students to have hands on experience that will strengthen their understanding of the physiological concepts. Practical sessions will also help them apply the knowledge learned in the classroom in a safe environment.

This manual is meant to be a guide for students providing the structure and topics covered in physiology practical sessions. However, students are encouraged to look for information and broaden their knowledge using other resources.

To make the best of the practical sessions, students are advised to attend the sessions on time and prepare by reading related lecture material prior to the practical sessions. During the sessions, students are encouraged to engage actively and take the opportunity to get hands on experience whenever it is feasible.

Wish you all the best!

Physiology Practical Team

# Overview of 2nd Year Medical Student Physiology Practical Sessions

Physiology practical sessions during the second year of medical school are confined to the Neuropsychiatry block and will include the sessions shown in the table below.

| Block name | Block duration | Number of sessions | Session title |
|---|---|---|---|
| Neuropsychiatry block | ≈ 8 weeks | 3 (2-hour-sessions) | EMG and nerve conduction |
| | | | Audiometry |
| | | | Color vision, light and accommodation reflex |

# Faculty and Staff Members Involved in Physiology Practical Teaching

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# Advice for Students

- Show up to physiology practical sessions on time.
- Read related lecture material prior to the laboratory session.
- Each laboratory session starts with a pre-lab lecture that serves to explain the objectives and procedure to be done in the lab. Listen attentively to these lectures.
- Engage actively in the laboratory activity and take every opportunity to get hands on experience whenever possible.
- Answer the practice questions provided at the end of each lesson.
- Do not depend solely of this guide for information.

# Chapter 1: Neuropsychiatry Block Physiology Practical

There are 3 practical physiology sessions during the neuropsychiatry block which are as follows;

1. EMG and nerve conduction.
2. Audiometry.
3. Color vision, light and accommodation reflex.

# Practical 1. EMG and Nerve Conduction

## 1.1. Objectives:

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

- 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.

## 1.2. Electromyography (EMG)

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

### 1.2.1. Principle:

In the clinical setting, 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.

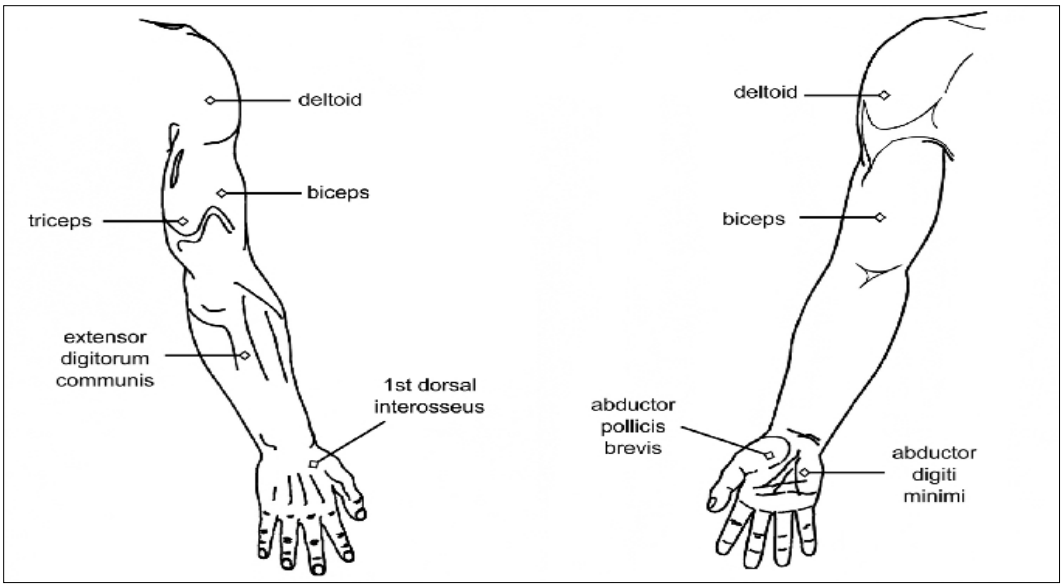



**Figure 1. Shows electrode placement sites for needle EMG.** Needle electrode positions for some commonly tested muscles. The electrodes are inserted perpendicularly to the skin.

- 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.

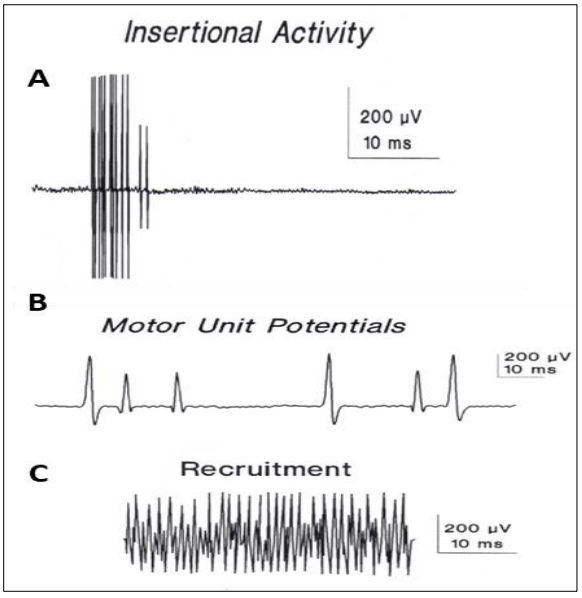



**Figure 2. Normal EMG activity.** Normal EMG patterns. (A) Insertional activity is a brief burst of potentials. Resting activity is absent. (B) Motor unit potentials (MUPs) are brief biphasic and triphasic potentials. (C) Recruitment with vigorous contraction results in activation of many MUPs at fast rates, obscuring the background.

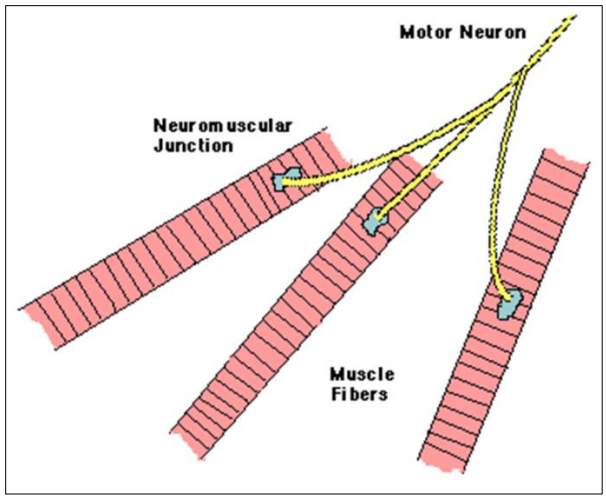



**Figure 3. Shows a single motor unit.** A single motor unit consist of one motor neuron and the muscle fibers it innervates.

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”.

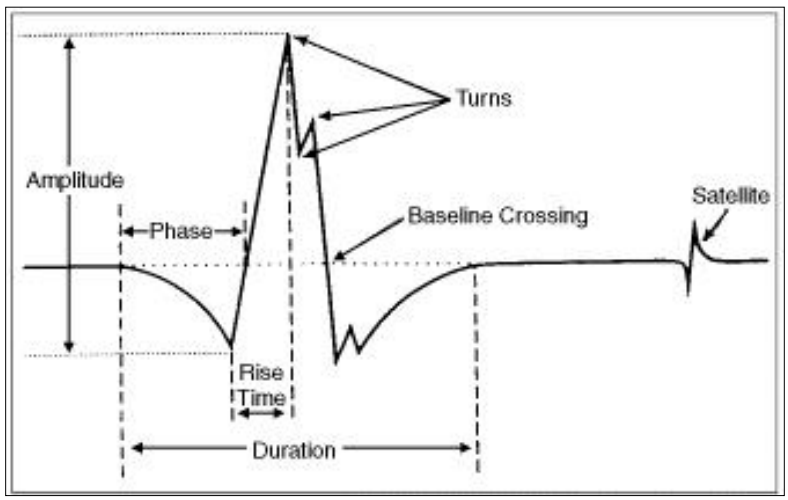



**Figure 4. A normal MUP.**

### 1.2.2. Procedure:

Recordings will be obtained from the abductor pollicis brevis (APB) muscle in the hand

1. Select a volunteer and explain the procedure to him/her.
2. Three surface electrodes need to be placed on the volunteer. An electrode jell should be applied to each electrode before placement;
    a. The ground is placed on the dorsum of the hand where the muscle will be tested.
    b. The recording electrode is placed on belly of the APB “midbelly”.
    c. The reference electrode is placed approximately 2-3 cm away from the recording and on a bony prominence.
3. Once the electrodes are in place, start recording;
    a. At the beginning, ask the subject to relax (not to contract the muscle), and record the muscle electrical activity during this period.
    b. Then, ask the subject to exert mild to moderate voluntary effort while you continue recording.
    c. Finally, ask the subject to do maximum contraction of the muscle and record the electrical activity during this period.

### 1.2.3. Indications for 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 a diagnosis.
- Grade the severity of the disease.
- Define evolution, stage, and prognosis.

### 1.2.4. EMG Abnormalities:

Abnormalities in EMG can be seen in any part of the study i.e. at rest and during muscle contraction.

At rest, Fig-5;

- Positive sharp waves.
- Fibrillation.
- Fasciculation.

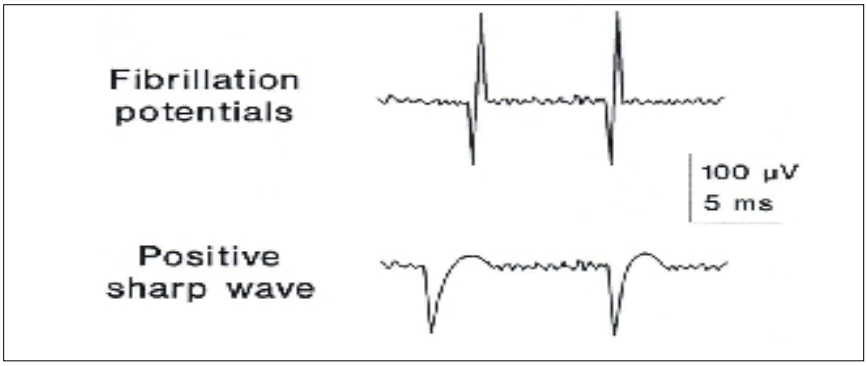



**Figure 5. Shows positive sharp waves and fibrillation potentials.**

During muscle contraction, abnormalities can be seen in the MUPs as well as the recruitment;

- Patterns of abnormal MUPs are shown in Fig-6.
- Patterns of abnormal recruitment are shown in Fig-7.

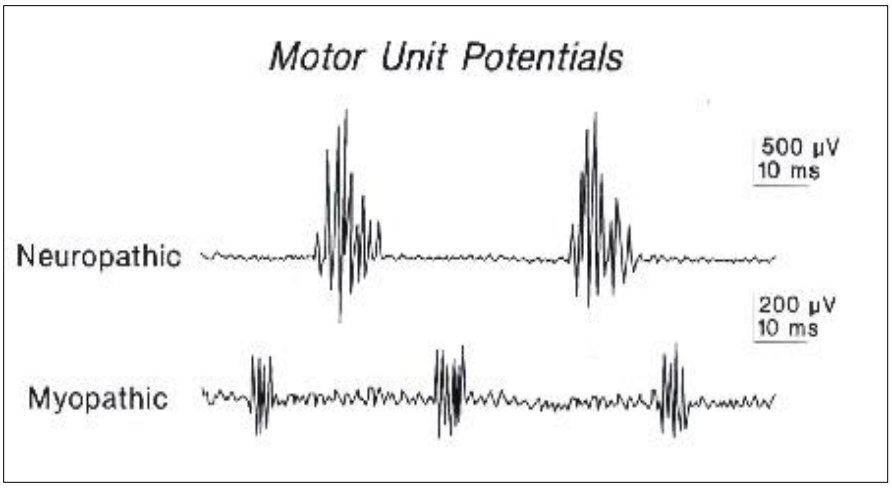



**Figure 6. Different abnormal patterns of MUPs.** Neuropathic MUPs are polyphasic, have a long duration, and of high amplitude (giant MUPs). Myopathic MUPs are polyphasic, have a short duration, and are of low amplitude.

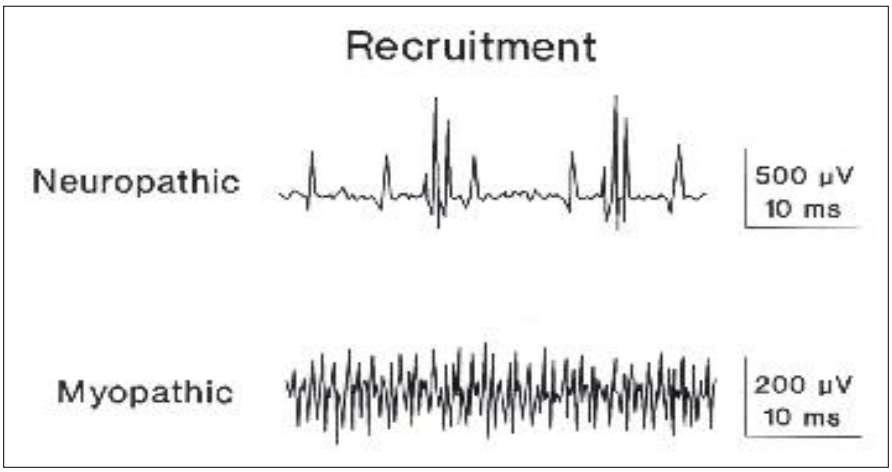



**Figure 7. Different paterns of abnormal recruitment.** In neuropathy there is reduced recruitment. While myopathy shows full interference (rapid recruitment) but with low amplitude.

A summary of normal and abnormal EMG findings are shown in the table-1 and Figure-8.

**Table 1. Summary of general normal and abnormal characteristics of MUPs.**

| MUP characteristics | Normal | Neuropathic | Myopathic |
|---|---|---|---|
| **Duration (ms)** | 3-15ms | Longer | Shorter |
| **Amplitude** | 300-5000µV | Larger | Smaller |
| **Phases** | Biphasic/triphasic | Polyphasic | May be polyphasic |
| **Resting activity** | Absent | Present | Present |
| **Interference pattern** | Full | Partial | Full with small amplitude MUPs |

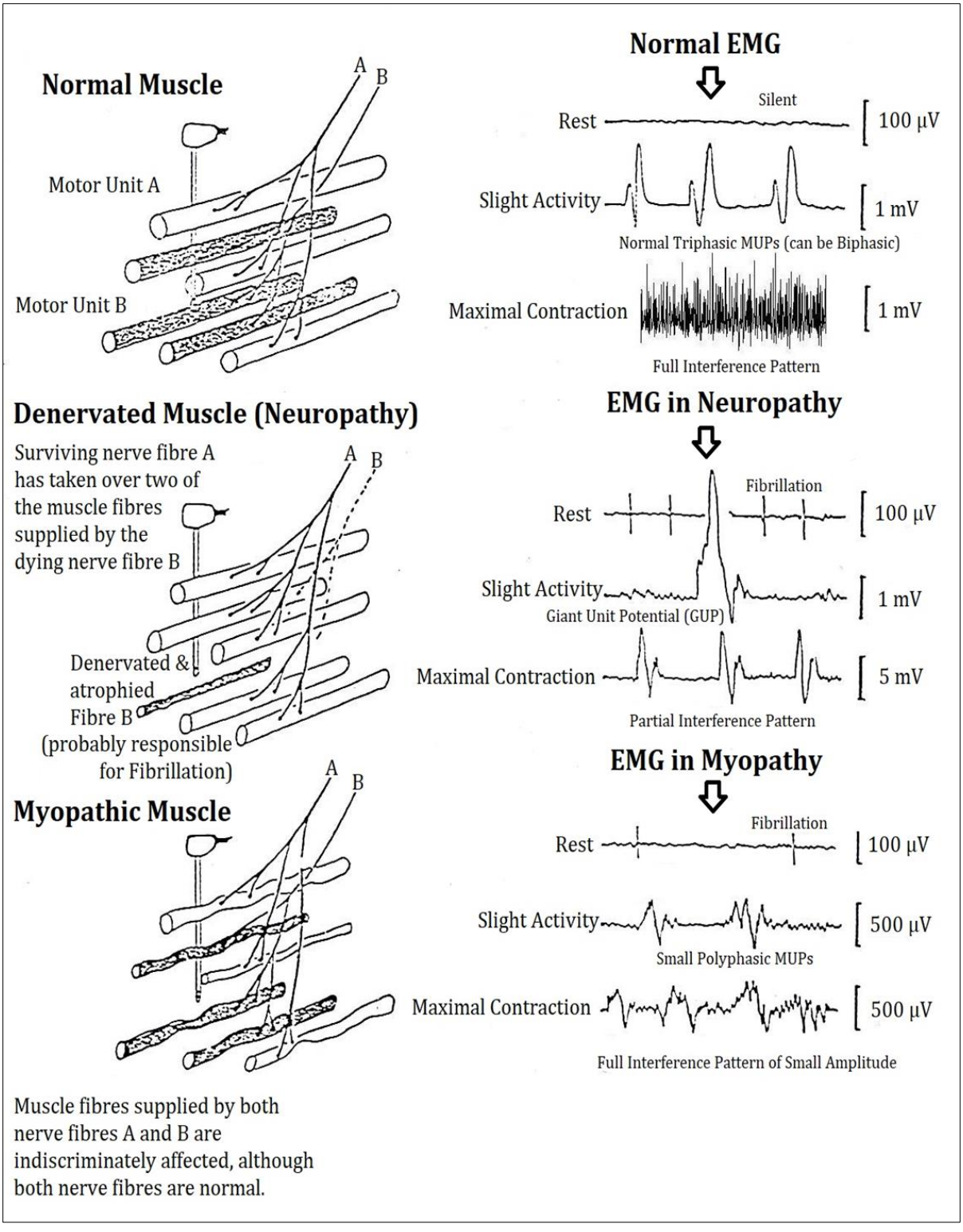



**Figure 8. Shows different EMG recording patterns under normal, neuropathic and myopathic conditions.**

## 1.2.5. Practice questions:

1. **What is meant by “the motor unit”?**

   _____

   _____

2. **What is meant by “motor unit potentials (MUPs)”?**

   _____

   _____

3. **What will a normal recording of a muscle show in each of the following states;**

   - Rest:_____
   - Mild muscle contraction:_____
   - Maximal muscle contraction:_____

## 1.3. Nerve Conduction Studies (NCS)

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. During the student physiology lab only motor NCS will be performed.

### 1.3.1. 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.

### 1.3.2. Procedure:

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

1. Select a volunteer and explain the procedure to him/her.
2. Clean the area of the skin where the electrodes will be placed to improve skin conductivity.
3. Surface electrodes are used for MNCS, after applying the electrode jell to each of the electrodes they will be placed as follows;

a. The recording electrodes are placed on the muscle supplied by the nerve under study (the APB for the median nerve) so that the cathode or negative (active) electrode is placed over the belly of the muscle, while the anode or positive (reference) electrode is placed over the distal tendon.
b. The grounding electrode should be placed between stimulating and recording electrode, preferably, over bone rather than muscle.
c. The stimulating electrodes are placed between the flexor carpii radialis tendon and the Palmaris longus tendon with the cathode electrode placed distally to the anode. This will stimulate the median nerve at the wrist. A recording of the compound muscle action potential (CMAP) is obtained and the latency is noted.
d. The median nerve is then stimulated at the elbow medial to the biceps tendon and over the pulse of the brachial artery (antecubital fossa). A recording of the CMAP is obtained and the latency is noted.
e. The distance between the two stimulating electrodes is measured. And the median nerve conduction velocity is calculated using the following formula;

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

MNCV= Motor nerve conduction velocity (m/sec)

Distance= distance between the two stimulating electrodes.

L1= latency at elbow.

L2=latency at wrist.

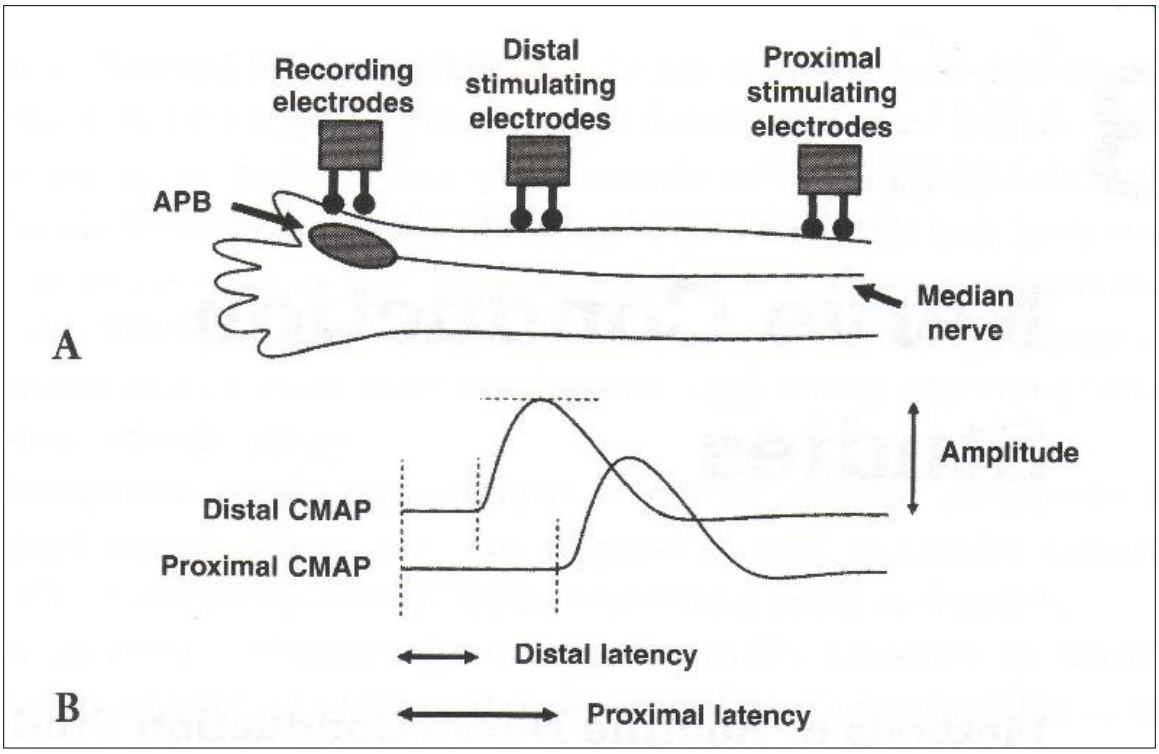



**Figure 9. MNCS.** (A) Diagram of the right forearm and representation of the electrode positions for median nerve conduction study. (B) Sample recording of median motor compound motor action potentials (CMAPs).

## 1.3.3. Practice questions

1. **What is the importance of NCS in clinical practice?**

   _____

   _____

2. **How can the conduction velocity of the ulnar nerve be calculated?**

   _____

3. **In general, what is the normal motor nerve conduction velocity in the upper limb?**

   _____

4. **What is meant by a slow conduction velocity in the median nerve? Name a few causes of such an abnormality?**

   _____

   _____

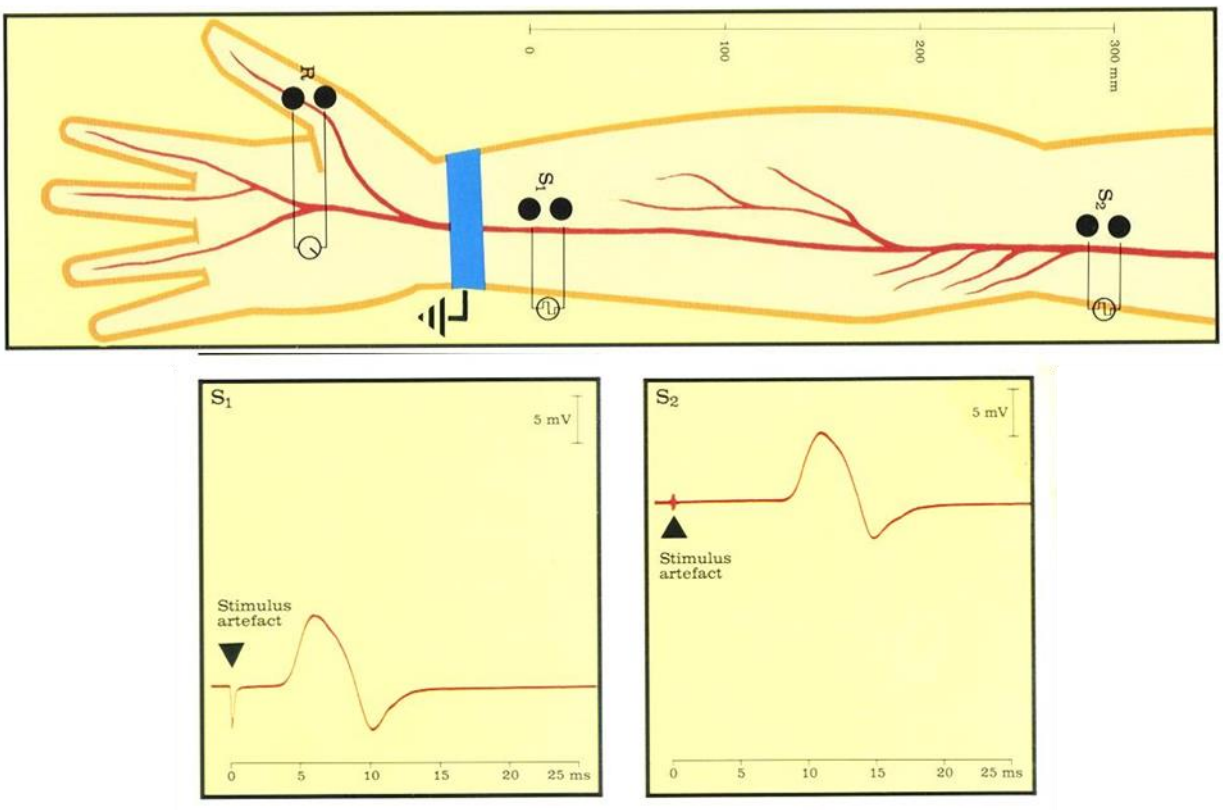



**Figure 10. A MNCS of the median nerve.**

5. **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.**

_____

_____

_____

_____

# Practical 2. Hearing Tests and Pure Tone Audiometry

## 2.1. Objectives:

At the end of the session, 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.

## 2.2. Important terminology related to this practical

### 2.2.1. 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.

### 2.2.2. 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.

### 2.2.3. 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 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.

### 2.2.4. Pure tone

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

### 2.2.5. 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, Fig-11.

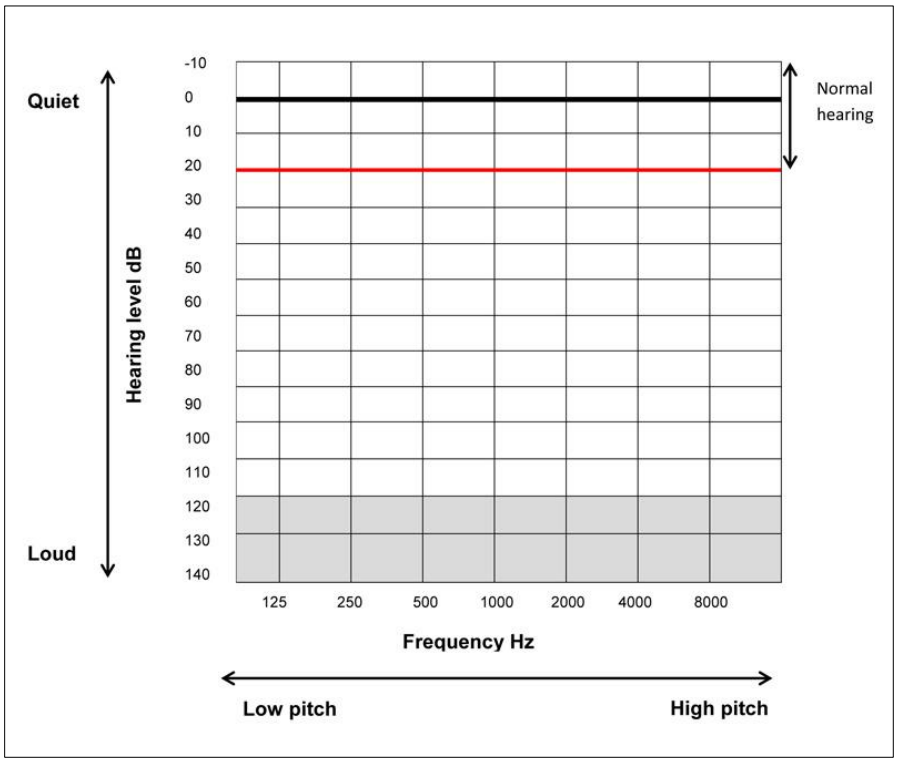



**Figure 11. An example of an audiogram chart.**

## 2.3. Tuning fork tests

### 2.3.1. Rinne's Test:

This test compares air conduction with bone conduction, Fig-12A.

#### 2.3.1.1. Procedure

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.

#### 2.3.1.2. 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.

### 2.3.2. Weber's Test:

This test distinguishes between conductive and sensorineural deafness, Fig-12B.

#### 2.3.2.1. Procedure

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.

#### 2.3.2.2. 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.

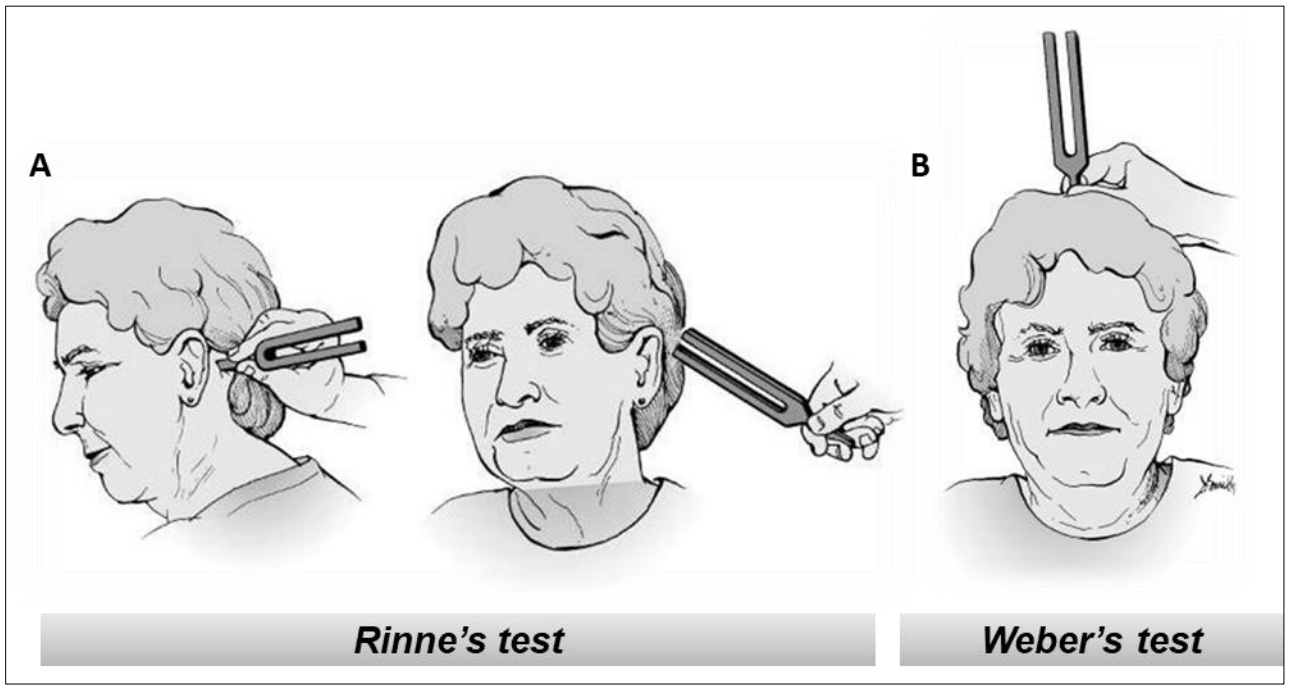



**Figure 12. Tuning fork hearing tests.** (A) Rinne's test, (B) Weber's test.

## 2.4. 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. Simply, it is an earphone connected to an electronic oscillator capable of emitting pure tones ranging from low to high frequencies. In addition to the earphone, an audiometer is equipped with an electronic (bone) vibrator. The earphone is to test air conduction while the electronic vibrator is for testing bone conduction from the mastoid process into the cochlea.

### 2.4.1. Procedure

1. The subject is seated comfortably in a sound proof room, Fig-13.
2. Color-coded earphones are applied (Red for right ear, Blue for left ear).
3. Each ear is tested at a time.
4. Masking sound is delivered to the non-test ear.
5. The ear being tested will be presented with pure tones of varying frequencies. Eight to10 frequencies covering the auditory spectrum are usually tested and the hearing loss is determined for each of these frequencies.
6. The examiner starts testing with a tone of 0 dB at 125 Hz. Then gradually increasing the frequency to 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, and 8000 Hz, however keeping the tone at 0 dB. If any of the frequencies was not heard we move to a louder tone and repeat the process again.
7. The responses are plotted on the audiogram.
8. This tests air conduction of the subject and the plotted marks are joined to produce the curve for air conduction.
9. The same steps are then repeated with the electronic (bone) vibrator on the mastoid process to test for bone conduction.
10. The responses are plotted on the audiogram as well using a different symbol.
11. The audiogram then will give a measure of the hearing threshold of the subject showing the presence of any hearing loss. It will also show the frequencies affected. Comparing air conduction with bone conduction, gives important clues as to the cause of hearing loss.
12. Normally air conduction is better than bone conduction.

## 2.5. Degrees of hearing loss

Hearing loss is variable and ranges in severity from mild to profound hearing loss. Figure-14 shows the ranges of hearing thresholds for a given frequency of sound that determine the severity of hearing loss in a subject tested by audiometry.

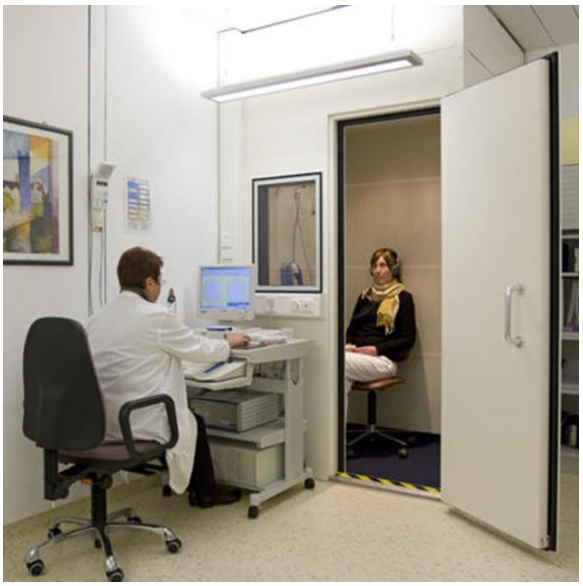


**Figure 13. Hearing assessment using and audiometer with the study subject sitting in a sound proof room.**

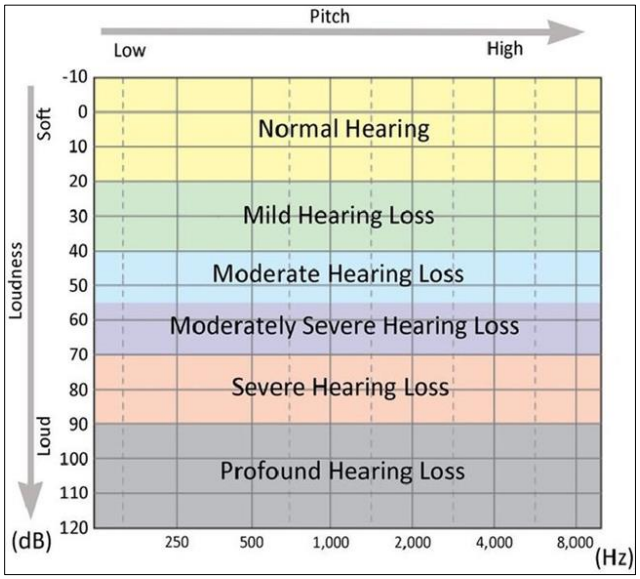



**Figure 14. Shows the degree of hearing loss and its corresponding hearing threshold range for each given frequency.**

## 2.6. Types of hearing loss (types of deafness)

Hearing loss can be divided into;

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

### 2.6.1. 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, Fig-15A.

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), Fig-16.

### 2.6.2. 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 if speech is loud enough to hear, it may sound unclear or muffled to a person with sensorineural hearing loss. The audiogram of a person with sensorineural neural hearing loss will show a decrease or a total loss of hearing for both air and bone conduction. This decreased or lost hearing may affect all frequencies or may be confined to certain frequencies, e.g. only with high frequencies or only with low frequencies, Fig-15B.

Causes of sensorineural hearing loss may be congenital or acquired. Acquired causes for sensorineural hearing loss my include, 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 and tumors such as acoustic neuroma.

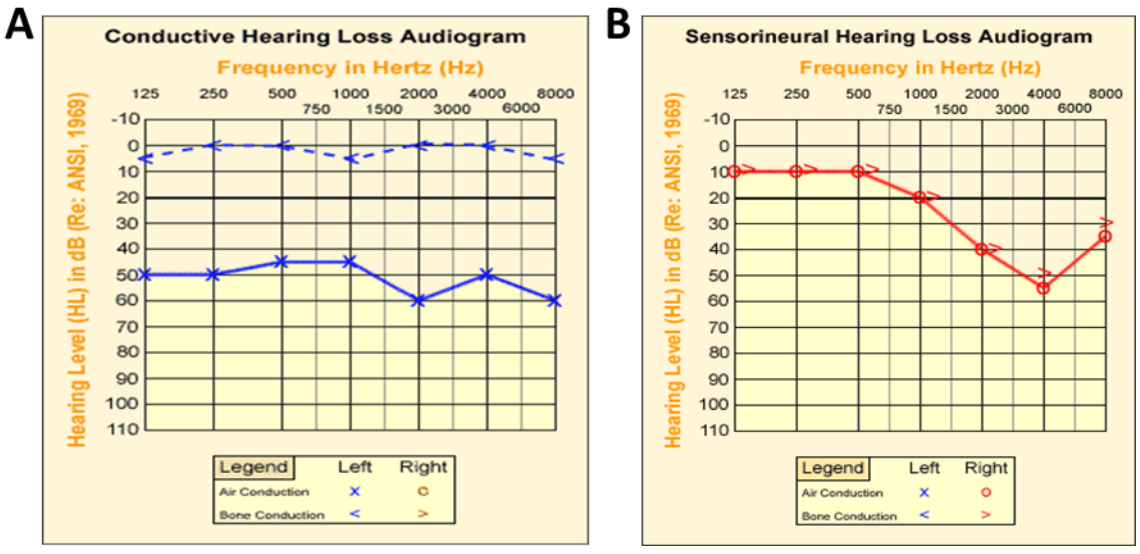



**Figure 15. Representative audiograms showing an example of conductive hearing loss in (A) and sensorineural hearing loss in (B).**

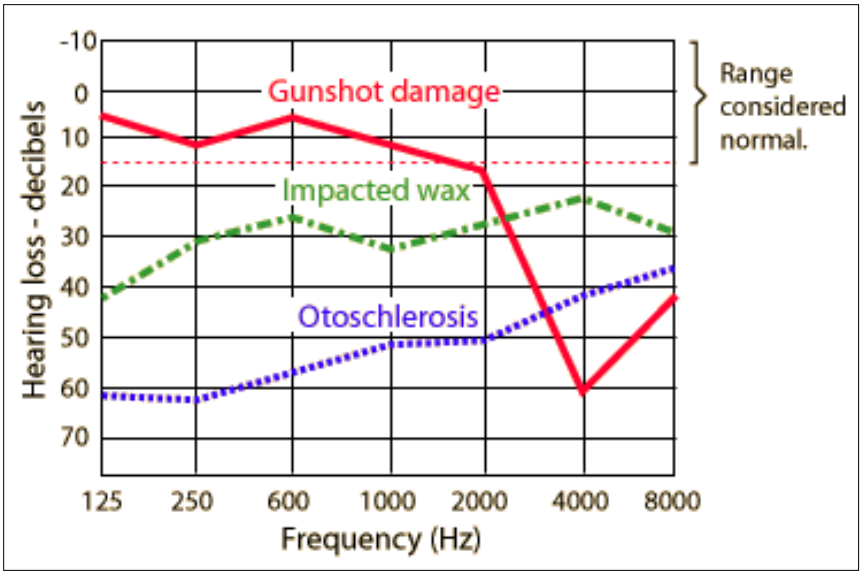



**Figure 16. Audiogram recordings showing various patterns of deafness**

### 2.6.3. 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. The audiogram shows a mixed picture of both patterns, Fig-13.

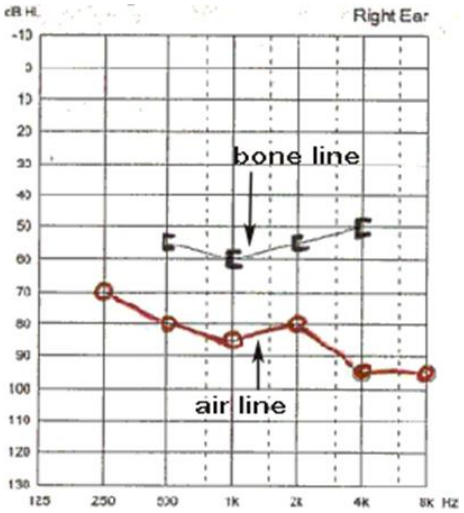
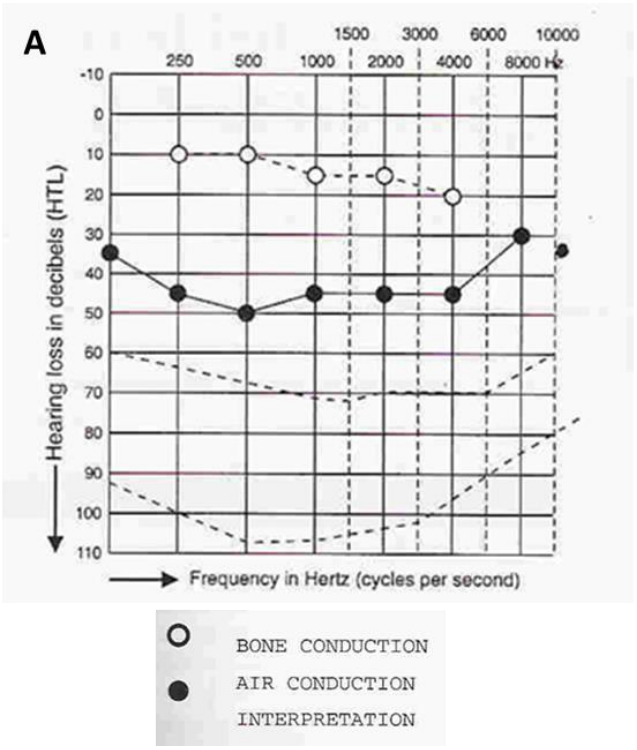
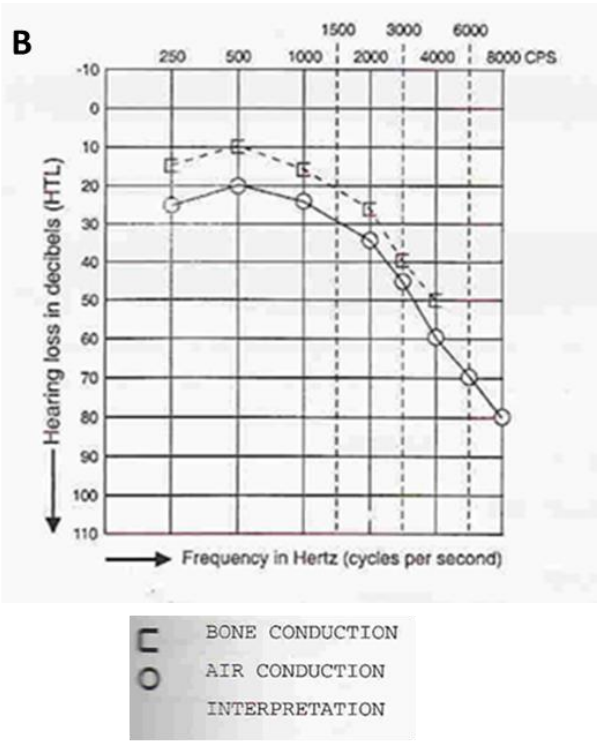



**Figure 17. Audiogram showing mixed sensoineural hearing loss.**

## 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** | | |
| **Interpretation** | | |
| **Possible causes** | | |

# Practical 3. Vision (Visual Acuity, Color Vision, Light and Accommodation Reflex)

**Visual Acuity** is defined as 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 and the density of the photoreceptors. Refractive ability refers to the ability of the eyes to bend parallel rays of light coming from infinity to focus on the retina.

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.

## 3.1. Testing far vision

### 3.1.1. Equipment

- Snellen's chart, Fig-18.

### 3.1.2. 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.

### 3.1.3. Interpretation

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

Where,

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:

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

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).

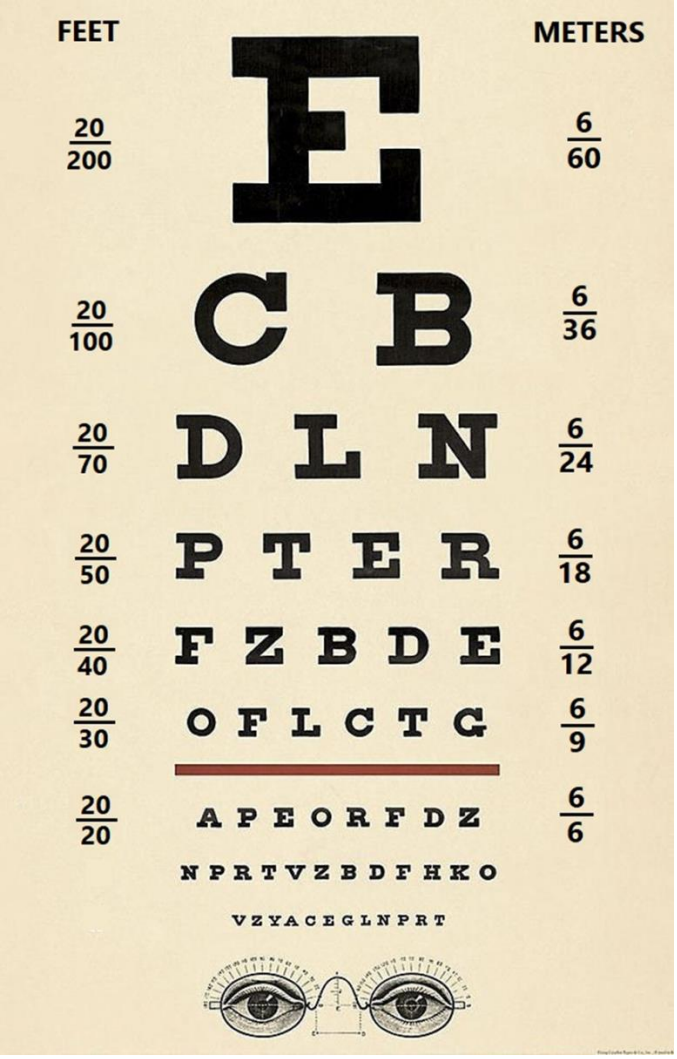



**Figure 18. Snellen's chart.**

## 3.1.4. Refractive Errors

### 3.1.4.1. 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.

### 3.1.4.2. 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.

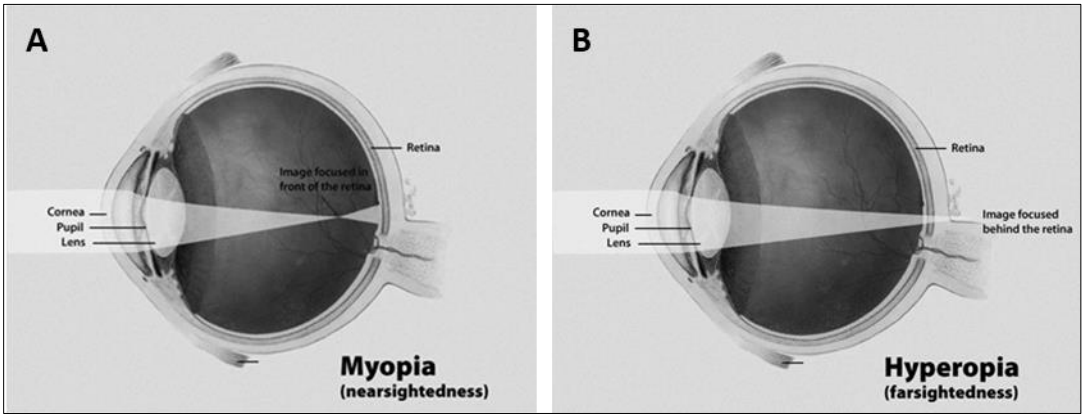



**Figure 19. Errors of refraction.** (A) A myopic eye with the image focusing in front of the retina. (B) A hyperopic eye with the image focusing behind the retina.

## 3.2. Testing near vision

The near vision test is measuring your ability to read and see objects within an arm's distance from the body. This 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.

### 3.2.1. Equipment

- Jaeger's chart.

### 3.2.2. Procedure

- Ask the subject to hold the Jaeger's chart at a distance of 14 inches (36 cm) 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.

### 3.2.3. 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.

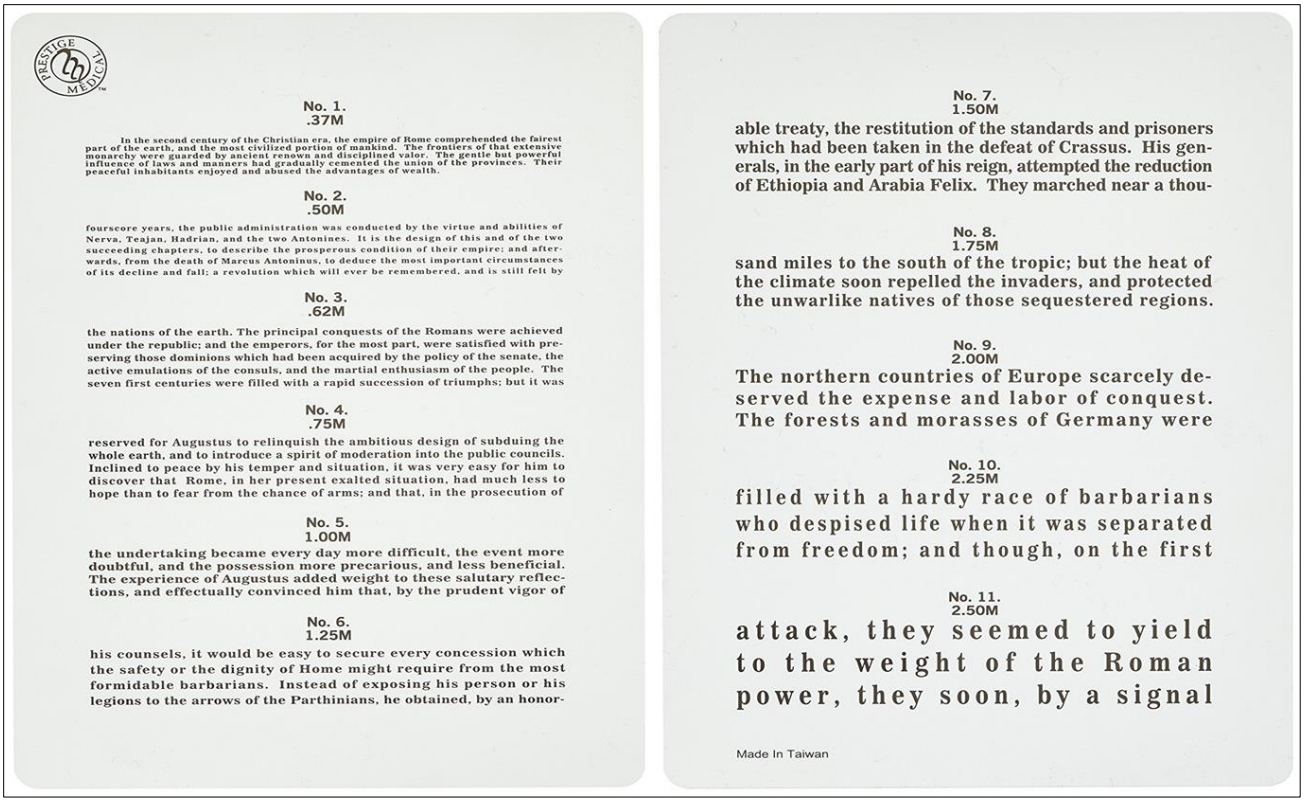



**Figure 20. Jaeger's chart.**

## 3.3. 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 the eye can also cause astigmatism. 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 and need to be treated by adding ***cylindrical lenses*** in eyeglasses that will correct the astigmatism by altering the way light enters your eyes.

### 3.3.1. Equipment

- Astigmatism chart.

### 3.3.2. 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.

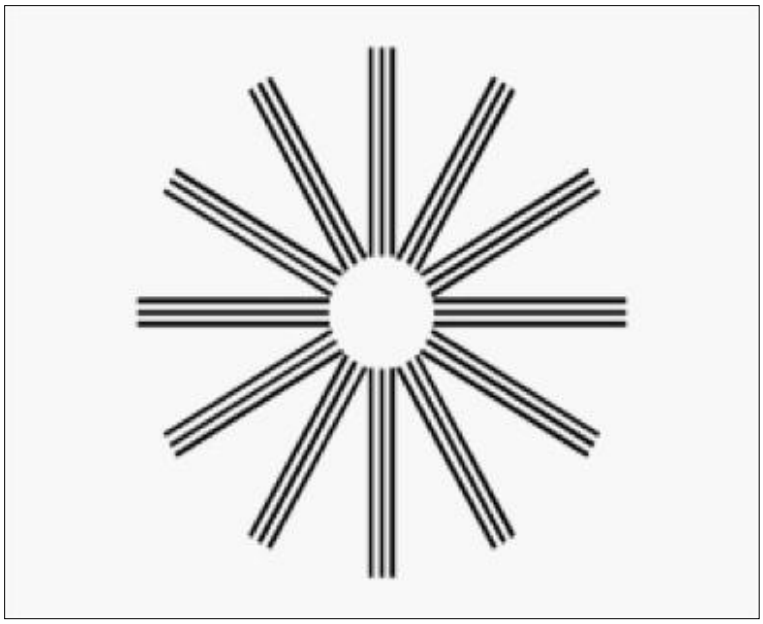


**Figure 21. Astigmatism chart.**

## 3.4. 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.

### 3.4.1. Equipment

- Blind spot card, Fig-22.

### 3.4.2. 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.

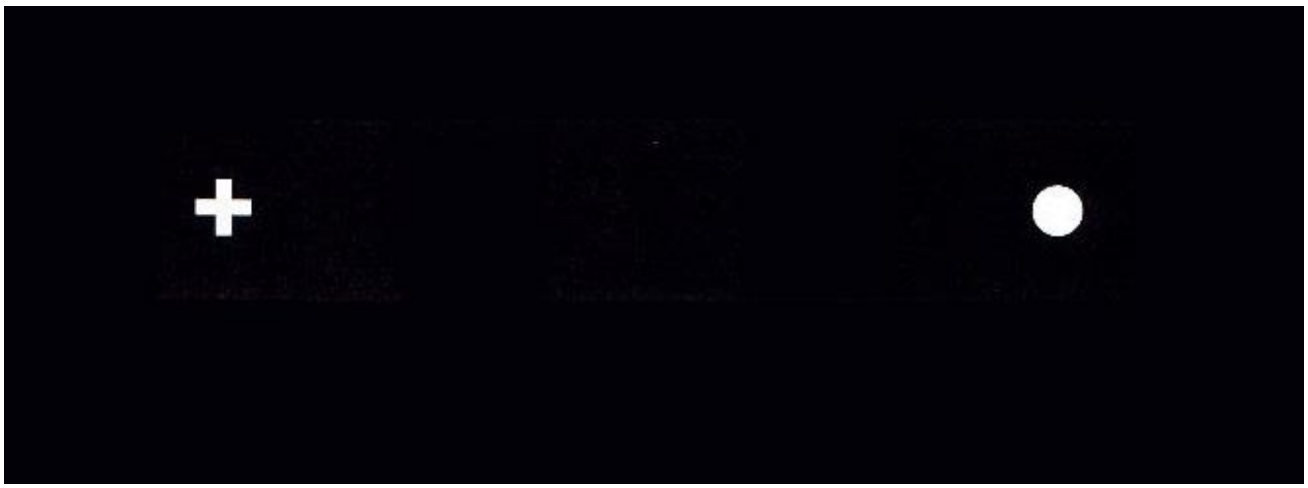


**Figure 22. Blind spot card.**

## 3.5. Determination of near point

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, table-2.

**Table 2. Changes in near point with age.**

| 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 |

### 3.5.1. Equipment

- Common pin.

### 3.5.2. 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.

## 3.6. Testing Accommodation

The process of accommodation can be tested by observing Purkinje-Sanson images in a dark room.

### 3.6.1. Purkinje-Samson images

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 than 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.

#### 3.6.1.1. Equipment

- A candle and a dark room.

#### 3.6.1.2. 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, Fig-23.

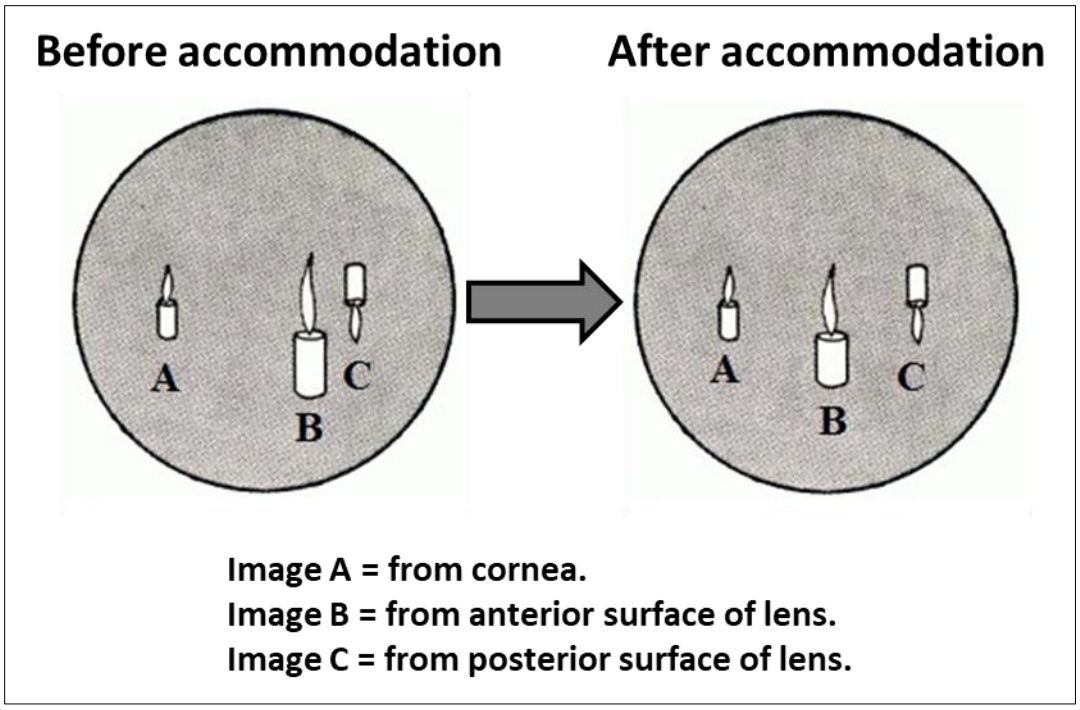



**Figure 23. Images reflected on the pupillary area using the candle light experiment in a dark room.**

## 3.7. 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.

### 3.7.1. Equipment

- Ishihara's colored plates, Fig-24.

### 3.7.2. 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.

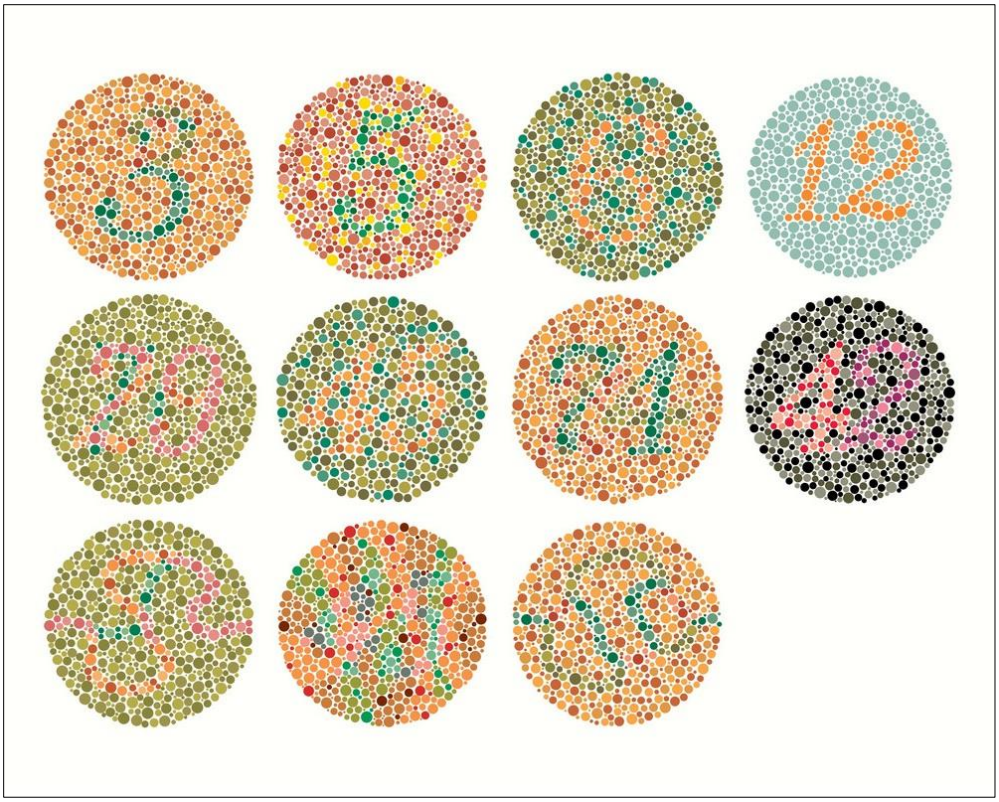



**Figure 24. Ishihara's color test plates.**

-End of physiology practical guide-