VISUAL ACUITY

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.

TEST FOR FAR VISION

Equipment:

Snellen's Chart

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).

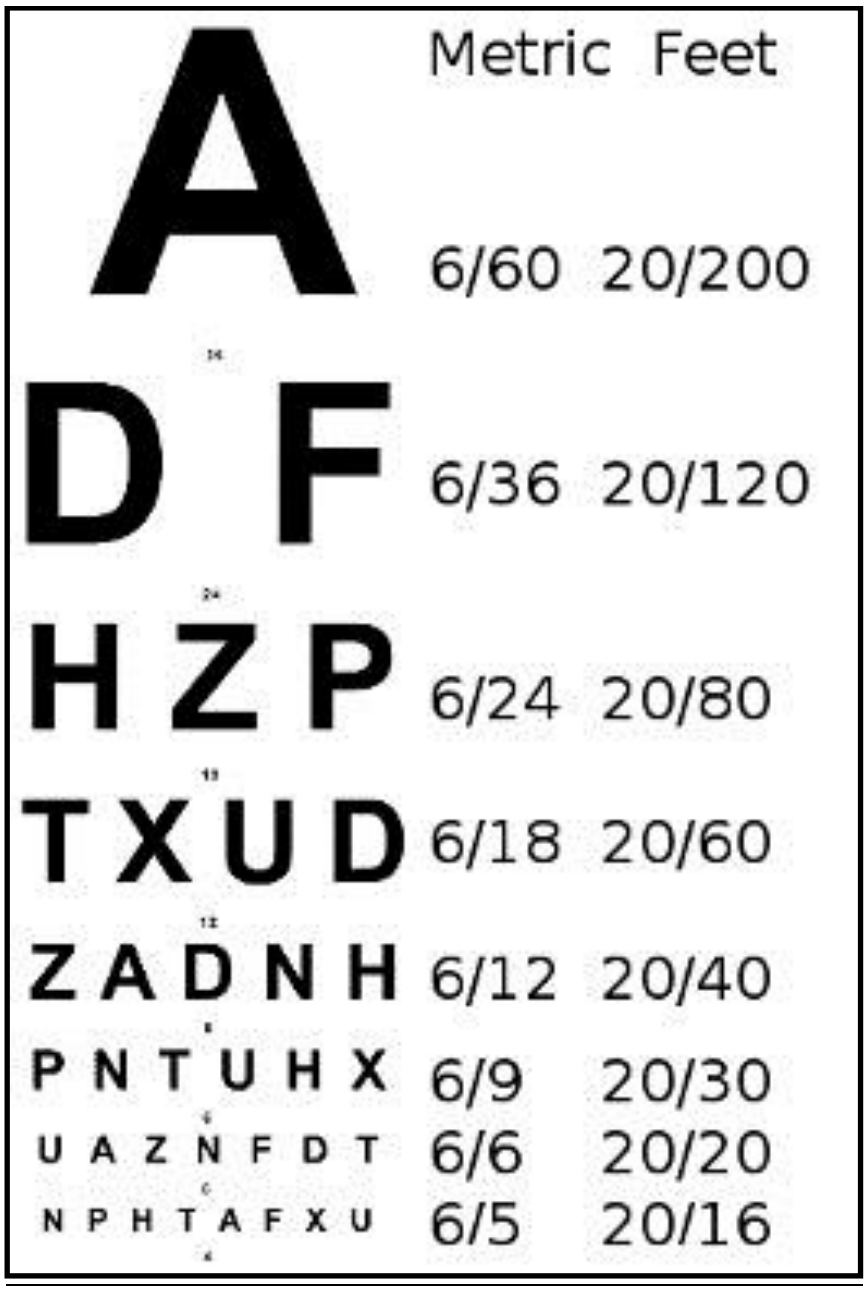
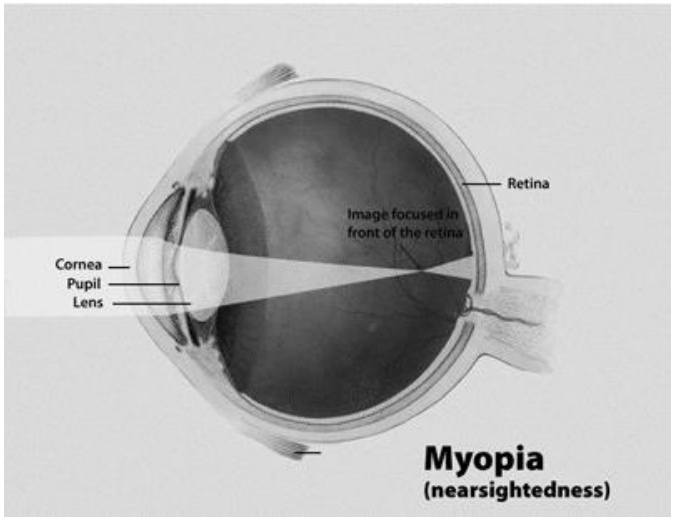


DIAGRAM OF SNELLEN'S CHART

REFRACTIVE ERRORS:

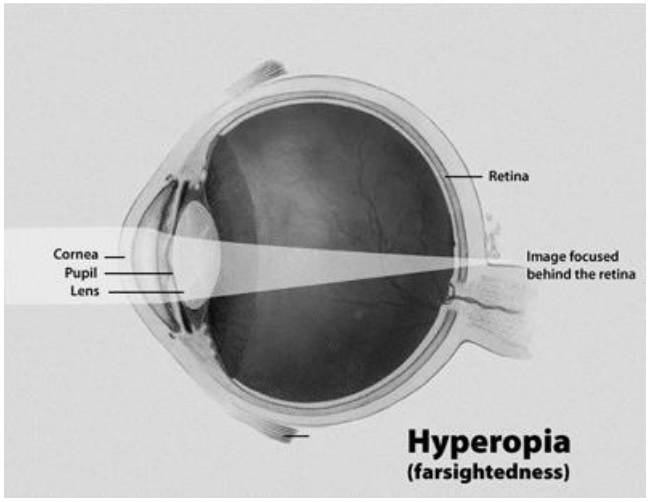
MYOPIA:

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. 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.



HYPERMETROPIA / 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. In these cases near vision is affected and the distance 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.

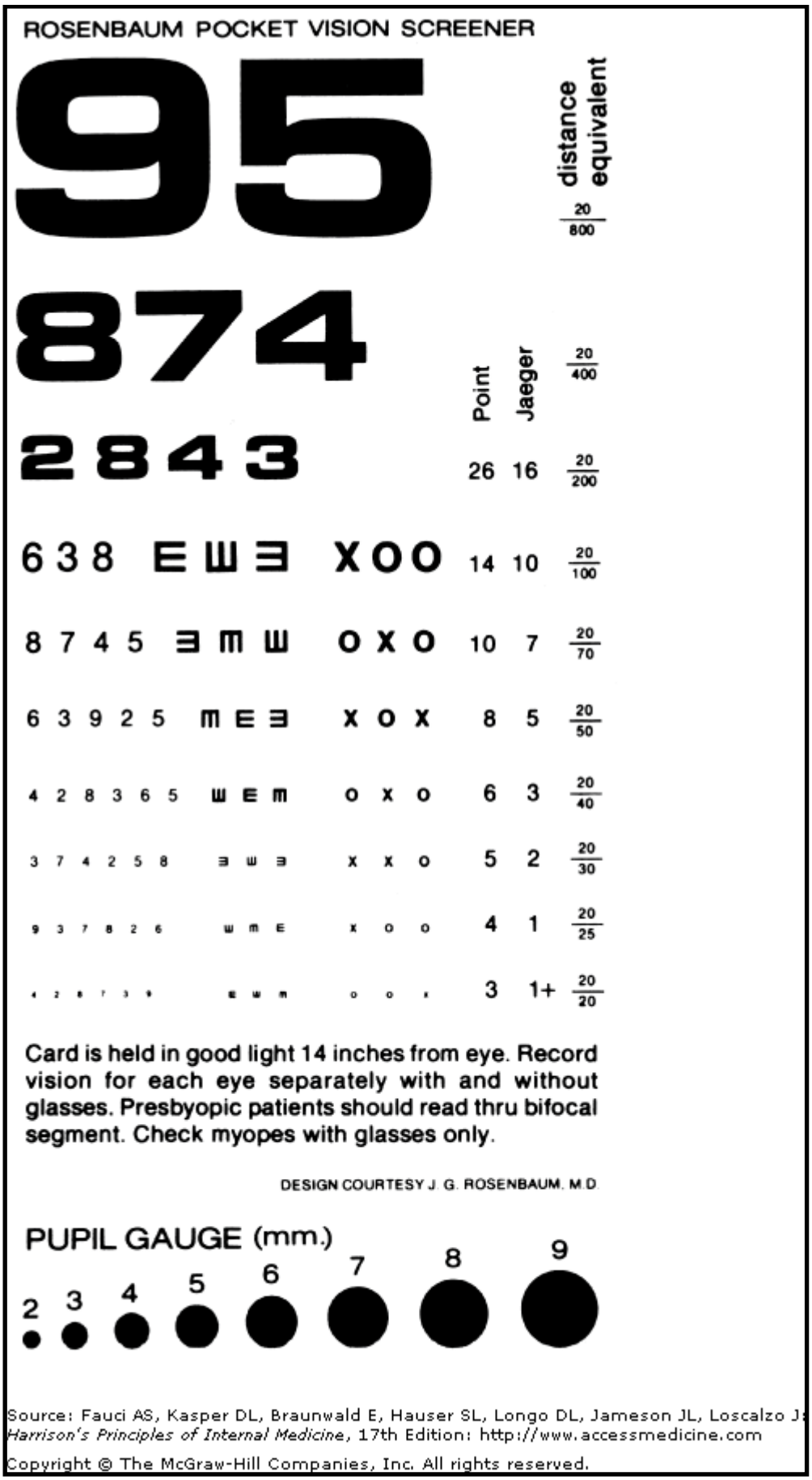


TEST FOR NEAR VISION

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.

Equipment:

Jaeger's Chart



Source: Fauci AS, Kasper DL, Braunwald E, Hauser SL, Longo DL, Jameson JL, Loscalzo J: *Harrison's Principles of Internal Medicine*, 17th Edition: http://www.accessmedicine.com

TEST 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. 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.

Equipment:

Astigmatism Chart

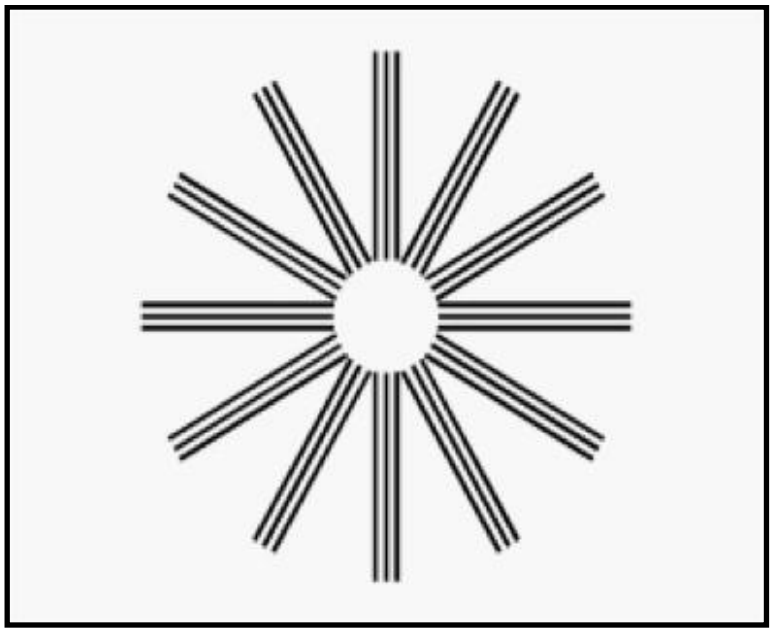


DIAGRAM OF ASTIGMATISM CHART

DEMONSTRATION OF BLIND SPOT

A blind spot, also known as a scotoma, is the place in the visual field where an object cannot be seen keeping one eye closed. This is due to the light rays from that part of the visual field focus on the optic disc of the retina which lacks the light-detecting photoreceptor cells. The optic disc of the retina is located medial to fovea centralis and is the part of retina through which the optic nerve and blood vessels pass. Since there are no photoreceptors to detect light on the optic disc, a part of the field of vision is not perceived. The brain fills in the blind spot with surrounding detail and there is also information from the other eye, so the blind spot is not normally perceived when both eyes are open.

Equipment:

Blind Spot Card

DIAGRAM OF A BLIND SPOT CARD

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.

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

Equipment:

Common Pin

TEST FOR ACCOMMODATION

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

PURKINJE-SANSON IMAGES:

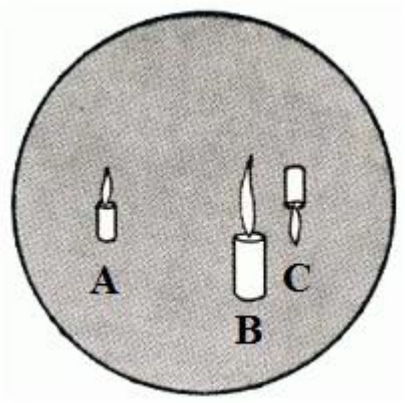
If a small bright light, usually a candle, is held in front of and a little to one side of the eye in a very dark room, three images are seen:

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.

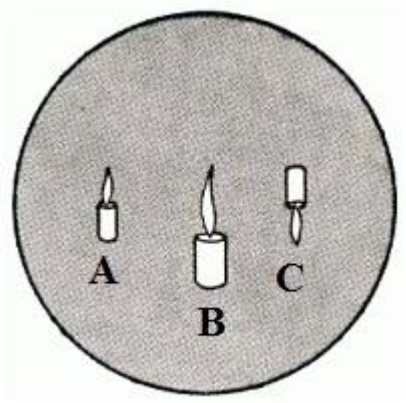
During accommodation, the second image comes closer to the first image and also becomes smaller than when the eye was at rest.

Equipment:

A candle and a dark room



Before Accommodation



After Accommodation

A = First image from Cornea

B = Second image from anterior surface of lens

C = Third image from posterior surface of lens

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.

TYPE OF COLOR BLINDNESS	DEFINITION & PATHOLOGY
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.**

Equipment:

Ishihara's Colored Plates

Hearing Tests and Pure Tone Audiometry

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.

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 any 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.

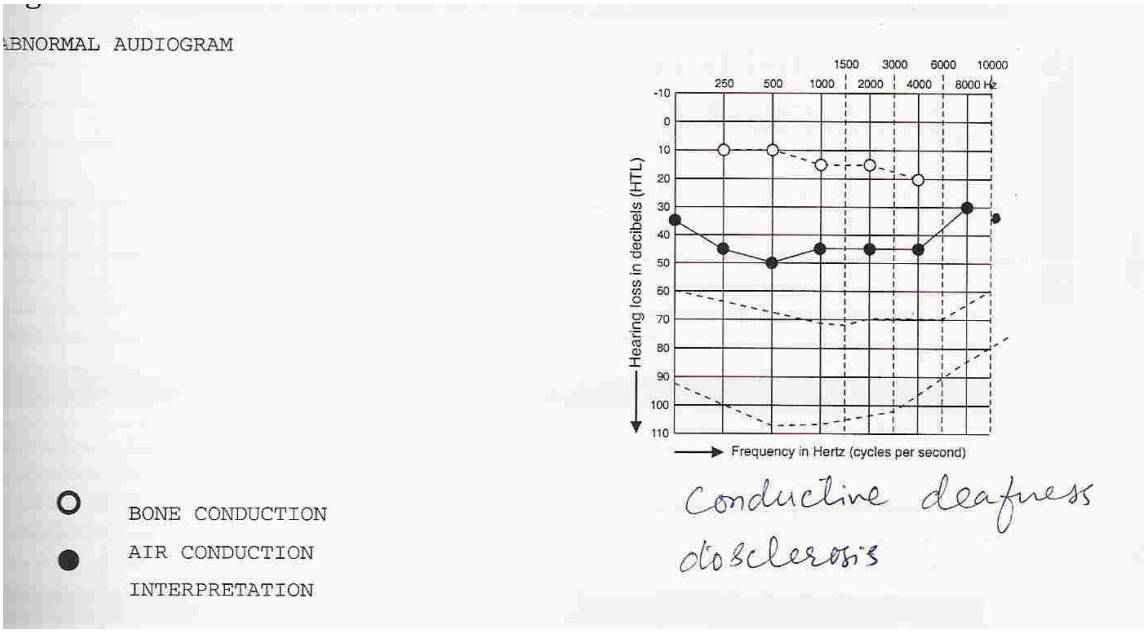
3] Ask the subject if the sound is heard better in one ear or the same in both ears.

2 Possible Results:

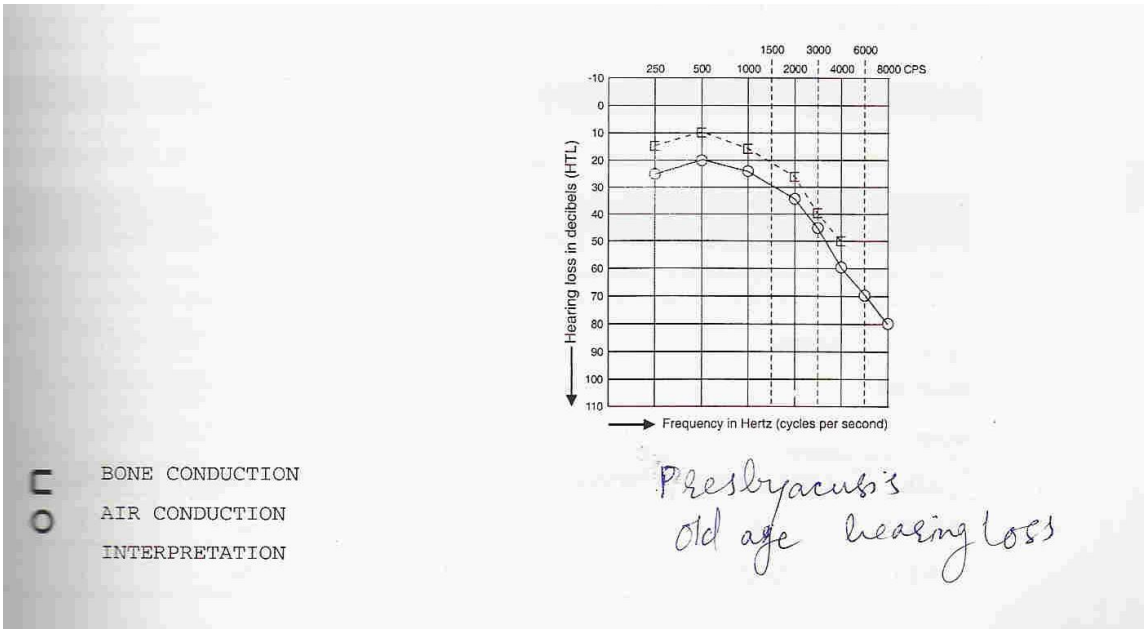
- If the hearing is normal, the sound is heard equally in both ears.
- The sound is heard more from one ear as compared to the other ear due to one of following 2 reasons:

1. 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.
2. 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.

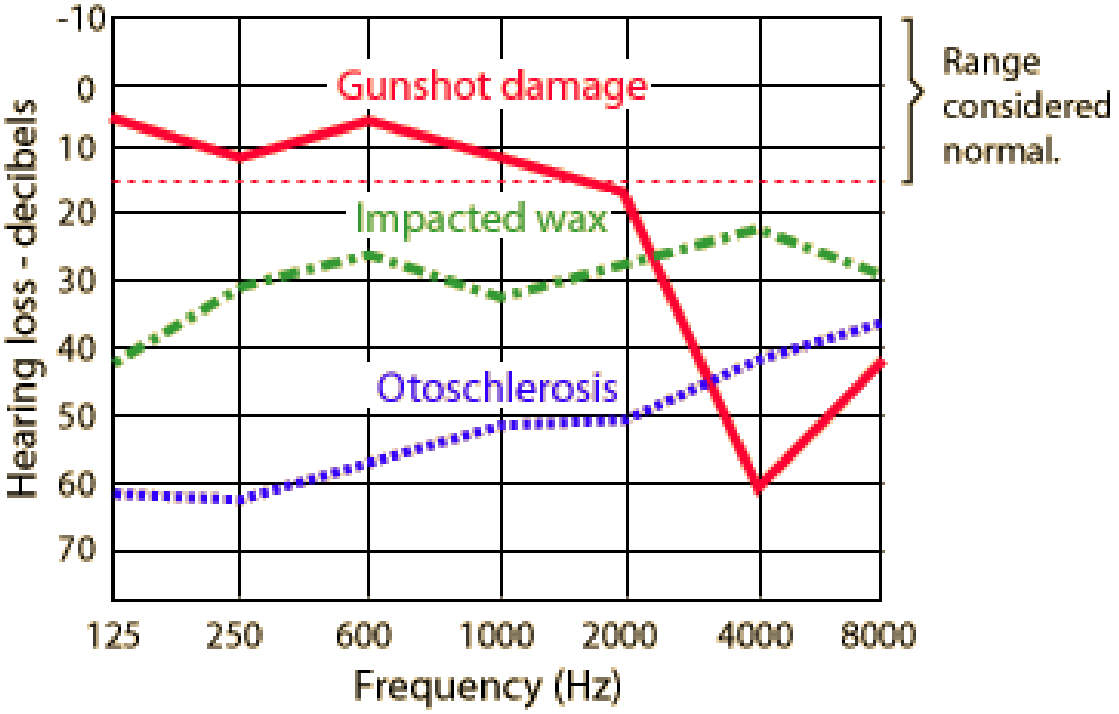
Pure tone Audiometry



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



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



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.

The problem is either in the outer or in the middle ear.

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).

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 30 db in one frequency of sound at least.

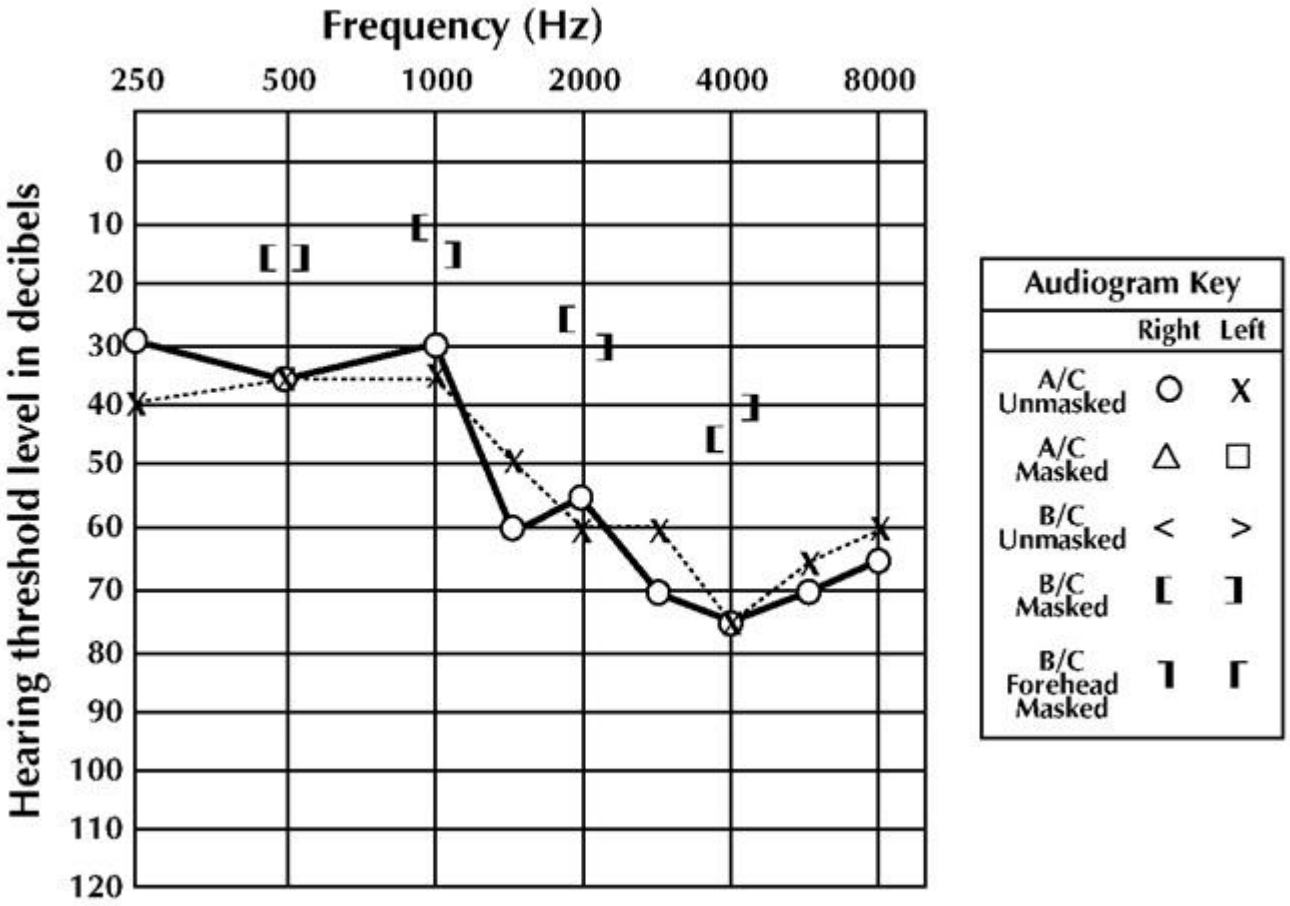
Some possible causes of Sensorineural hearing loss include:

- 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

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.**

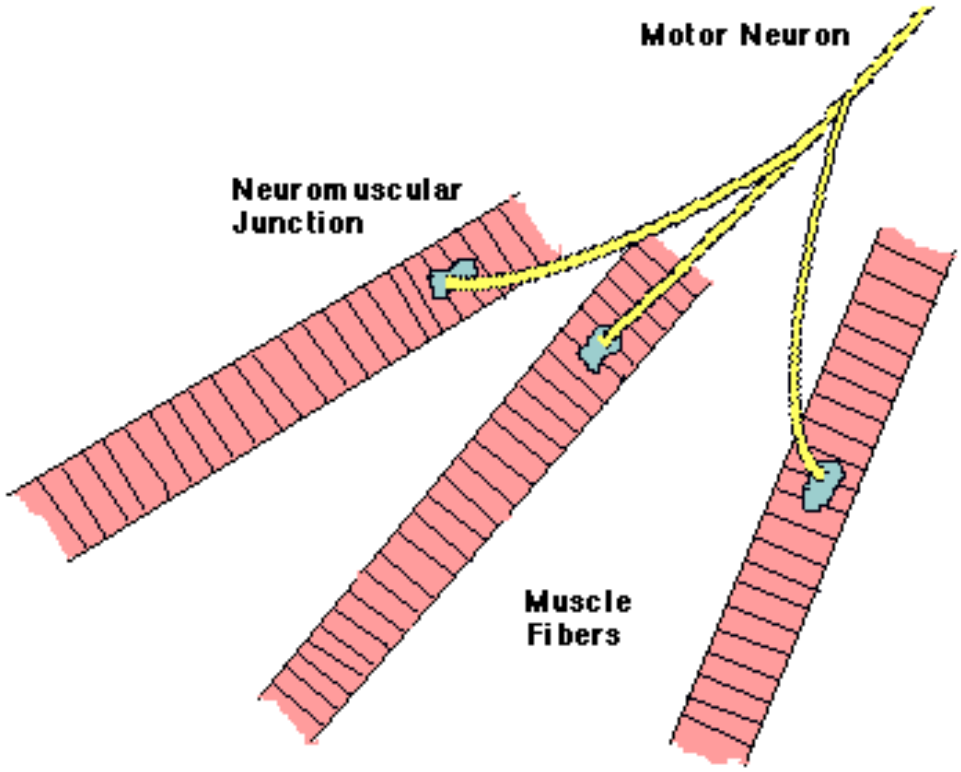
In these cases, bone conduction is better than air conduction and the difference between them is more than 10 db and the hearing thresholds for air conduction in most of the frequencies is more than 25 db.



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 30 db, so it is a clear case of mixed hearing loss.

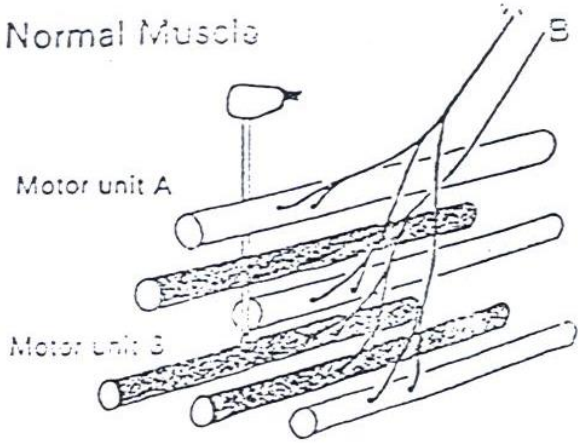
ELECTROMYOGRAPHY (EMG)

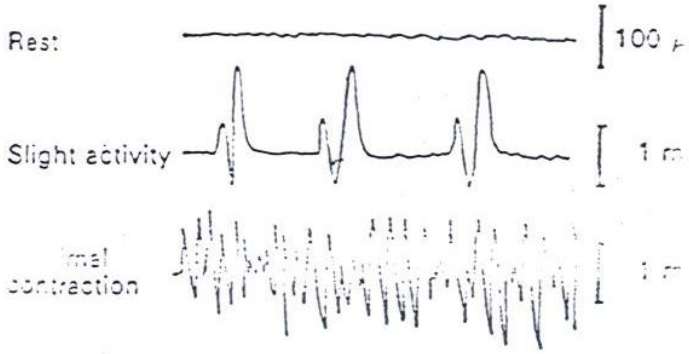
- It is a recording of electrical activity of the muscle by inserting needle electrode in the belly of the muscles or by applying the surface electrodes.
- The potentials recorded on volitional effort are derived from motor units of the muscle, hence known as motor unit potentials (MUPs).
- A motor unit is defined as one motor neuron and all of the muscle fibers it innervates.



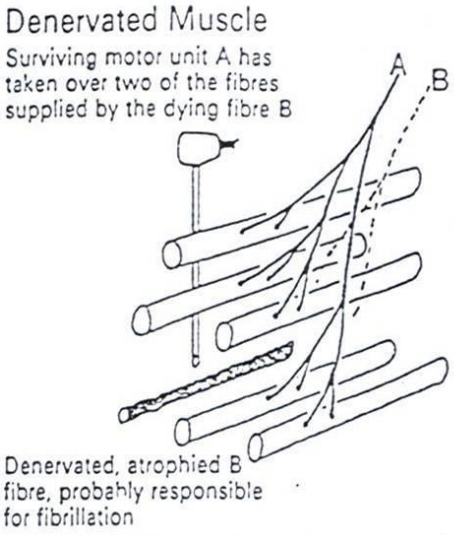
- In the patients of muscular weakness, muscle atrophy, traumatic or metabolic neuropathy, EMG along with motor nerve conduction velocity study is considered as an extension of the physical examination rather than a simple laboratory procedure.

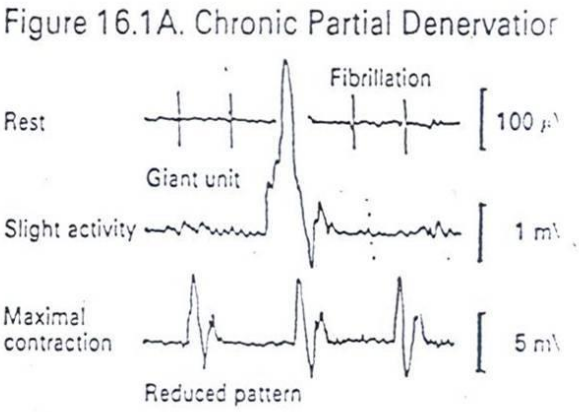
Normal EMG



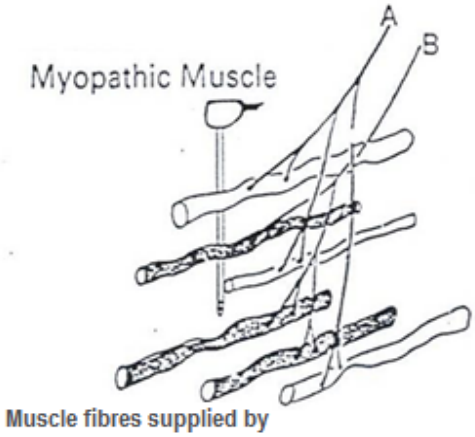


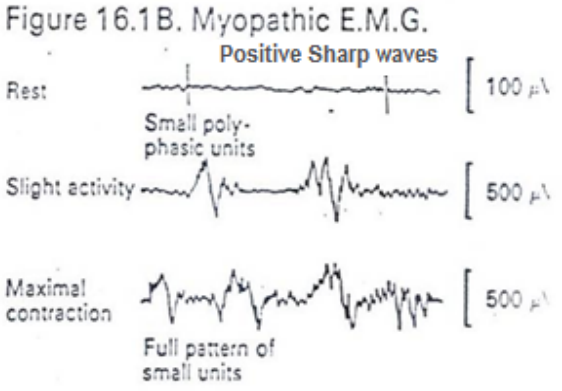
Neuropathic EMG changes





Myopathic EMG changes





ANALYSIS OF A MOTOR UNIT POTENTIAL (MUP)

MUP	NORMAL	NEUROGENIC	MYOPATHIC
Duration (msec)	3 – 15 msec	longer	Shorter
Amplitude	300 – 5000 μV	Larger	Smaller
Phases	Biphasic / triphasic	Polyphasic	May be polyphasic
Resting Activity	Absent	Present	Present
Interference pattern	full	partial	Full

SPONTANEOUS ACTIVITY AT REST

The skeletal muscle is silent at rest in normal people, hence spontaneous activity is absent, when we are not using a muscle and that muscle is at rest.

FIBRILLATION POTENTIALS

These occur at rest when the patient is not contracting his testing muscles.

These are randomly occurring small amplitude potentials.

These are seen in cases of neuropathy.

These potentials are generated from the single muscle fiber of a denervated muscle, possibly due to denervation hypersensitivity to acetylcholine.

NERVE CONDUCTION STUDIES

- A nerve conduction study (NCS) is a test commonly used to evaluate the function, especially the ability of electrical conduction, of the motor or sensory nerves of the human body.
- Motor Nerve conduction velocity (MNCV) is a common measurement made during this test.
- Based on the nature of conduction abnormalities two principal types of peripheral nerve lesions can be identified: ***Axonal degeneration and segmental demyelination.***

CALCULATION OF MNCV

It can also be calculated by formula

$$MNCV = \frac{Distance}{L1 - L2}$$

L_1 = latency at elbow.

L_2 = latency at wrist

It should be calculated in m/sec.

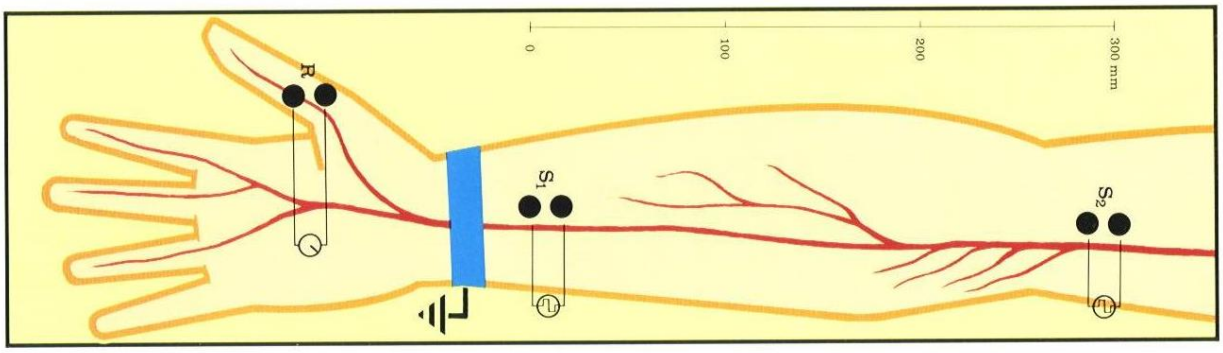
NORMAL VALUES FOR CONDUCTION VELOCITY

✓ In arm

50 – 70 m / sec.

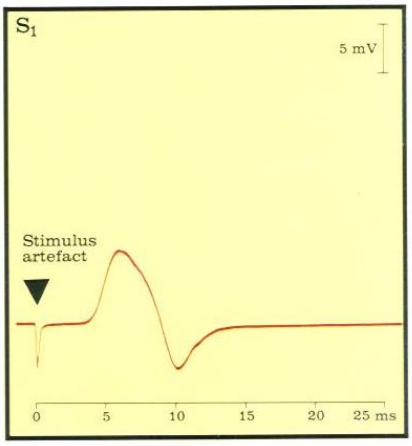
✓ In leg

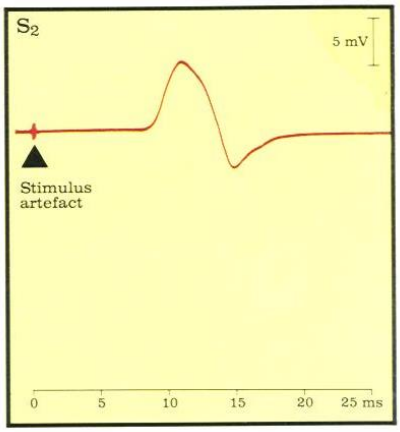
40 – 60 m / sec.



Distance

d = 285 mm





Latency At wrist

L2 = 3.5 ms

Latency At elbow

L1 = 8.5 ms

Hence, MNCV = 285 / 8.5 – 3.5 = 57 m/sec.