N.E.U.R.O.P.H.Y.S.I.O.L.O.G.Y

Practical Manual

Neurophysiology ...

On A Plate Of Silver

Done by: Physiology Team 426

Designed by: Abo Slo7

In the mane of ALLAH

Between your hands is a complete practical manual for the whole year , we wrote it out of many references (departments manual, last 2 year hand outs and the internet) we would like to thank all who helped us especially Dr.Mojeb sheikh who gave us a lot of his time . and our colleges psl424 team

Trust me ,60 pages is not a lot if u know its 10 practicals

we , psl tem 426 wish u all high marks in the coming exams

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EXAMINATION OF THE SENSORY SYSTEM

2 main sensory systems :

1) Dorsal column system : responsible for sensation of fine touch ,vibration,2 point discrimination , proprioception , steriognosis .

2) Spinpthalamic system : responsible for crude touch , pain , temperature , itching and sexual sensations .

Experiments :

1) Tactile localization :

- Ask the patient to close his eyes .
- Touch different parts of the body with a cotton wool .
- Ask him to tell whether he-she feels the touch . And ask him to locate the exact area touched .
- Note if there's hypoasthesia or hyperasthesia .

hypoasthesia : reduced sensations .

Hyperasthesia : touch is painful or irritating .

2) Tactile (2 point) discrimination :

- Ask the patient to close his eyes .
- With the caliper wide apart touch the skin .
- Ask the patient to tell whether he-she feels two points or one .
- Decrease the width of the caliper and do the same repeatedly until the patient feels the 2 points as one .
- Now measure the width of the caliper , and this is the **two-point threshold** .
- Do the same thing in different sites back of the hand , palm , face leg , finger tip ……

What factors influence the two-point threshold ?

- Number of the receptors .
- Number of the affernt nerves .
- Width of area representation in the brain .

3) **Recognition of size ,shape and forms (steriognosis):**

- Ask the patient to close his eyes .
- Give him common objects key , pen ….. And ask him to identify them .

The loss of this sensation is called (asteriognosis) can occur in many conditions …e.g. tabes dorsalis , diabetic neuropathy .

4) **Weight discrimination :**

- Place different weights on the patient's hand .
- See if he-she can identify the difference in weight .

What is the physiological basis of intensity or weight discrimination ?

A) Spatial summation : depends on the number of the receptors .

B) Temporal summation : depends on the frequency of APs .

5) **Vibration sense :**

- Done by using tunning fork .
- Strike the tunning fork and put it on different bony prominences of the body , clavicle , tip of the shoulder , elbow , dorsum of the hand , patella base of the big toe .....
- Notice if the patient feels the vibration in both sides of the body accurately .

6) Pain :

a) Superficial pain :

- It is usually acute pain ,localized ,fast , transmitted by Aδ fibers .
- Examined by pin prick .

b) Deep pain :

- It is usually chronic pain , poorly localized , slow , transmitted by C fibers
- Can be examined by strong pressure on deep structures like bone , muscle ….

7) Temperature sense :

- Can be examined by two test tubes one contains worm water and the other cold , touch the patients skin with these two tubes .

Cold receptors : 10 – 38 C
Warmth receptors : 30 – 45 C

Sensory Abnormalities :

1/Herpes Zoster :

- varicella virus which has lain dormant in posterior root ganglia following chickenpox infection earlier in life .
- small scars and anesthesia remain in the affected segment .

2/ Tabes Dorsalis :

- form of Neurosyphilis .
- characterized by damage to the dorsal root ganglia and dorsal columns . Consequently ,there will be :

  a) impairment or loss of proprioception (vibration , position senses) and two-point discrimunation sense .
  b) Absent tendon reflexes .

c) sensory ataxia (loss of coordinated muscular contractions required for the production of smooth movements)

Q: How do we ascertain the presence of sensory ataxia ?

By performing Romberg's Test .

A positive Romberg's Test (Sign) : means that →

keeping the feet together , the patient can stand steadily with the eyes open but when if he closes his eyes he become unsteady and tends to fall .

3) Brown –Sequard Syndrome :

unilateral lesion or hemisection of the spinal cord .

Effects :

A/ Ipsilaterally :

1) There is motor weakness .

2) at the level of the lesion : Loss of all sensations +/_ hyperesthesia.

3) Below the level of the lesion : loss of vibration , position and two-point discrimination .

B/ Contralaterally :

loss of pain and temperature sensibility .

4) Syringomyelia :

- presence of one or more cysts (fluid-filled cavities , called syrinx) near the central canal of the spinal cord.
- cysts damage second-order spinothalamic fibers which cross directly if front of the central canal , at first affecting temperaure fibers then affects pain fibers .
- There is no loss of touch and pressure senses as well as vibration and position sensations .
- This is called Dissociated sensory Loss or Dissiciated Anesthesia

EXAMINATION OF THE MOTOR SYSTEM

A complete motor examination is done in 7 steps:

1- bulk of muscles

2-tone of muscles

3- power of muscles

4-reflexs

5-coordination of movement

6-Gait

7- involuntary movement

1- Bulk of muscles:

- Examine for evidence of atrophy or hypertrophy

2-Tone of muscles:

- Muscle tone is a state of tension or partial contraction found in healthy muscles, the degree of tone is estimated by handling the limbs and moving them passively .

- **An increase in the tone is called hypertonia (clinically spasticity or rigidity)**

  A- spasticity :resistance determined by angle and direction of motion seen in upper motor neuron lesions and pyramidal tract disease

  B-Rigidity: resistance at all angle of motion seen in extrapyramidal lesions

- **A decrease in the tone called hypotonia (clinically flaccidity)**
  - Flaccidity : muscle remain relaxed seen in :
    - Lower motor neuron lesions
    - Peripheral nerve disorders
    - Cereballar disorders
  - Flex of following joints:
    - Elbow joint
    - Wrist joint
    - Knee joint
    - Neck joint

3- Power of muscles:

- Muscle power is tested against resistance

4- Reflexes:

Name of the reflex	Method	Afferent nerve	Center	Efferent nerve	effect
Corneal	Touching nerve with cotton	C.N V	Pons	C.N VII	Closure of eye lid
Light	Apply light to the eye	C.N II	Midbrain	C.N III	Contraction of both pupil
Palatal	Touch the side of the uvula with tongue depressed	C.N IX	Medulla	C. N X	The uvula is elevated
Upper abdomen	Scratching	T7-T10	Spinal segment T7-10	T7-10	Contraction of muscles
Lower abdomen	Scratching	T10-12	T10-T12	T10-12	Contraction of muscles
Planter	scratching	S1-2	S1-2	S1-2	Flexion of the big Toe
Deep reflexes					
Biceps	Hitting the tendon	C5-6	C5-6	C5-C6	Contraction
Triceps	Hitting the tendon	C7	C7	C7	Contraction
Knee jerk	Hitting the tendon	L2,3,4	L2,3,4	L2,3,4	Contraction of quadriceps
Ankle jerk	Hitting the tendon	S1	S1	S1	Contraction of foot muscles

Babinski sign :

- *It is the plantar extinction response*

A-Dorisflxtion of the great toe

B- Fanning of other toes

C- Indicates damage to the pyramidal motor tract (UMNL)

D- Babinski + neonates up to age of 1 year

5- Coordination of movement:

- REMMBER THE CERRBULLEM CORRDINATES MOVEMENT

FINGER –NOSE TEST	HEEL-KNEE TEST
ASK THE SUBJECT TO TOUCH HIS NOSE EITH HIS RIGHT THEN LEFT INDEX FINGER OBSERVE IF ALL MOVMENT IS SOMTH	Ask the subject to lift one leg high in the air and place the heel of the foot below the opposite knee and then to slide the heel down his shin towards the ankle observer if the movment progress smoothly

6- Gait:

- Note pattern of movement:
  - Spastic gait
  - Festinant gait (shuffling gait)
  - Reeling gait (Zig-Zag)
  - Wadling Gait (duck movement)

7- Involuntary movement:

A. **Tremors**: involuntary regular contraction of muscles:

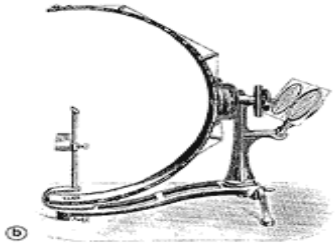
1. Resting tremors-at rest seen in (Parkinson's disease)
2. Intentional tremors-when reaching the target(cerebellar damage)

B. **Chorea** : spontaneous, uncontrolled flicking movement at the rest And increase during muscular activity and emotions

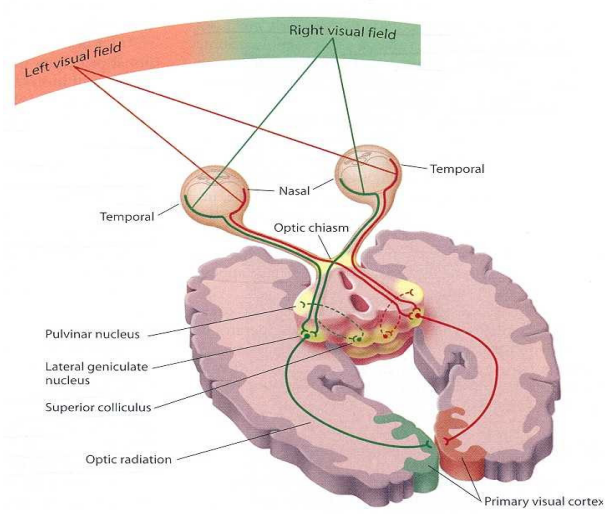
PERIMETRY

Perimetry : is a technique for determining the field of vision , with the help of an instrument called Perimeter .

- there are several types of perimeters , but the one we are using is a half circle of metal band marked in degrees .



The Field of vision : the portion of the external world that can be seen by one eye keeping the gaze fixed , and it is normally irregularly oval as it is limited medially by the nose and superiorly by the roof of the orbit .



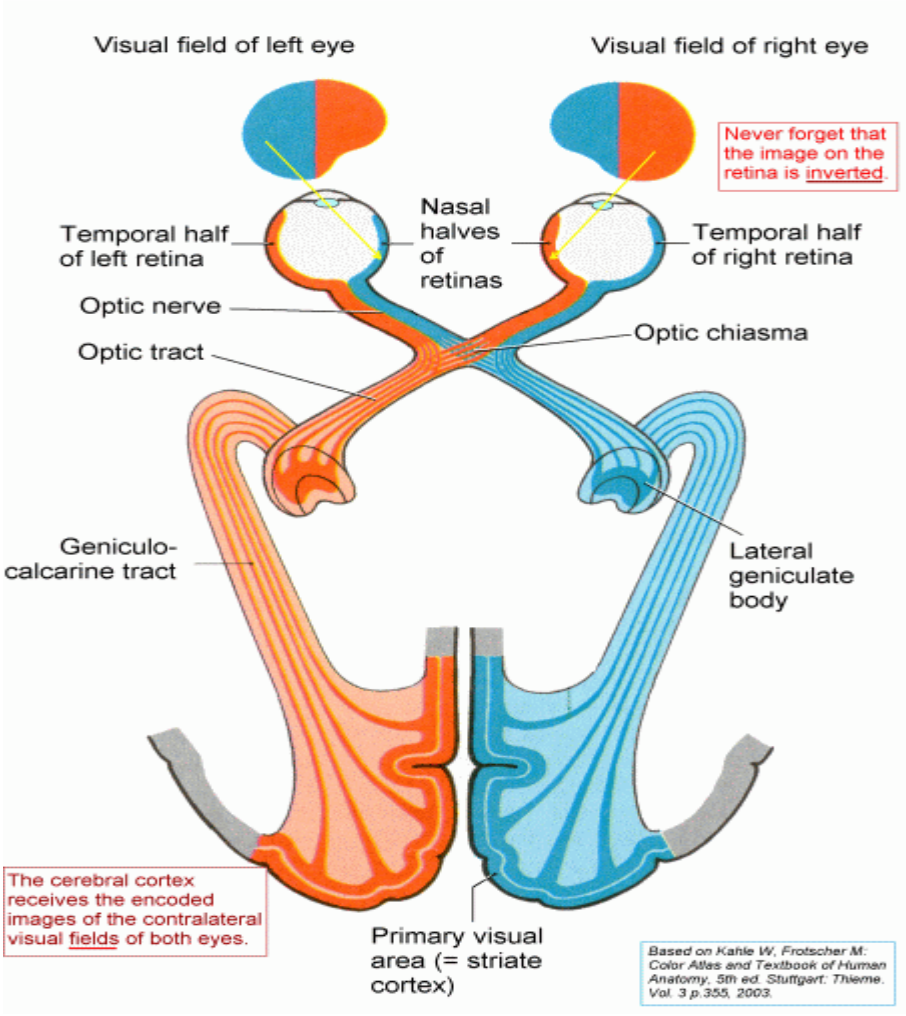
Procedure :

- Ask the subject to sit comfortably , and put his chin on stable chinrest .
- Ask him to look by the examined eye at the white spot in front , and cover the other eye
- Examiner should use the small stick with white disk at its end .
- Move it from the center going to the periphery , and ask the subject to indicate when the white disk disappears .
- Record the degree at which the disk was visible for the last time .
- Do the same thing for all four sides temporal , nasal , upward , downward and many different degrees between them (look at the chart on the next page) .
- Do it for the other eye .

Normal

Name .....
Datum .....
Diagnose .....
Arzt .....
L (S)
Beleuchtung .....
Objektgröße ..... mm²
Entfernung .....
Temp. 0
180 Nasal
OCULUS
Verbindung der Durchstichpunkte ergibt Gesichtsfeld vom Patienten aus gesehen.
By connecting points perforated the visual field is obtained as seen by the patient.
La liaison des points marqués au poinçon donne le schéma périmétrique, vu par le malade.
Bestell-No. 4470
Name .....
Datum .....
Diagnose .....
Arzt .....
R (D)
Beleuchtung .....
Objektgröße ..... mm²
Entfernung .....
Nasal 0
180 Temp.
blind spot
OCULUS
Verbindung der Durchstichpunkte ergibt Gesichtsfeld vom Patienten aus gesehen.
By connecting points perforated the visual field is obtained as seen by the patient.
La liaison des points marqués au poinçon donne le schéma périmétrique, vu par le malade.
Bestell-No. 4470

Lesions of the visual pathway : (very important)



- A lesion interrupting the whole of the optic nerve results in complete blindness in the corresponding eye .

- Beyond the optic nerve lesions may result in blindness in half of the field on each side , this is termed (**hemianopia**), when the same side is affected it is called homonymous hemianopia , when the opposite sides are affected it is called heteronymous hemianopia .

  ✓ The terms temporal and nasal , as well as right and left are also used .

1) heteronymous : it is usually caused by chiasmal lesions .

a) bitemporal : caused by lesion of the central part of the optic chiasma (e.g. pituitary tumor) which affect the nasal fibers of both retinae , so the **temporal** parts of the field is lost .

b) binasal : caused by lesion affecting the lateral parts of the chiasma .

2) homonymous : usually caused by retrochiasmal lesions (optic tract , Optic radiation Or occipital cortex) .

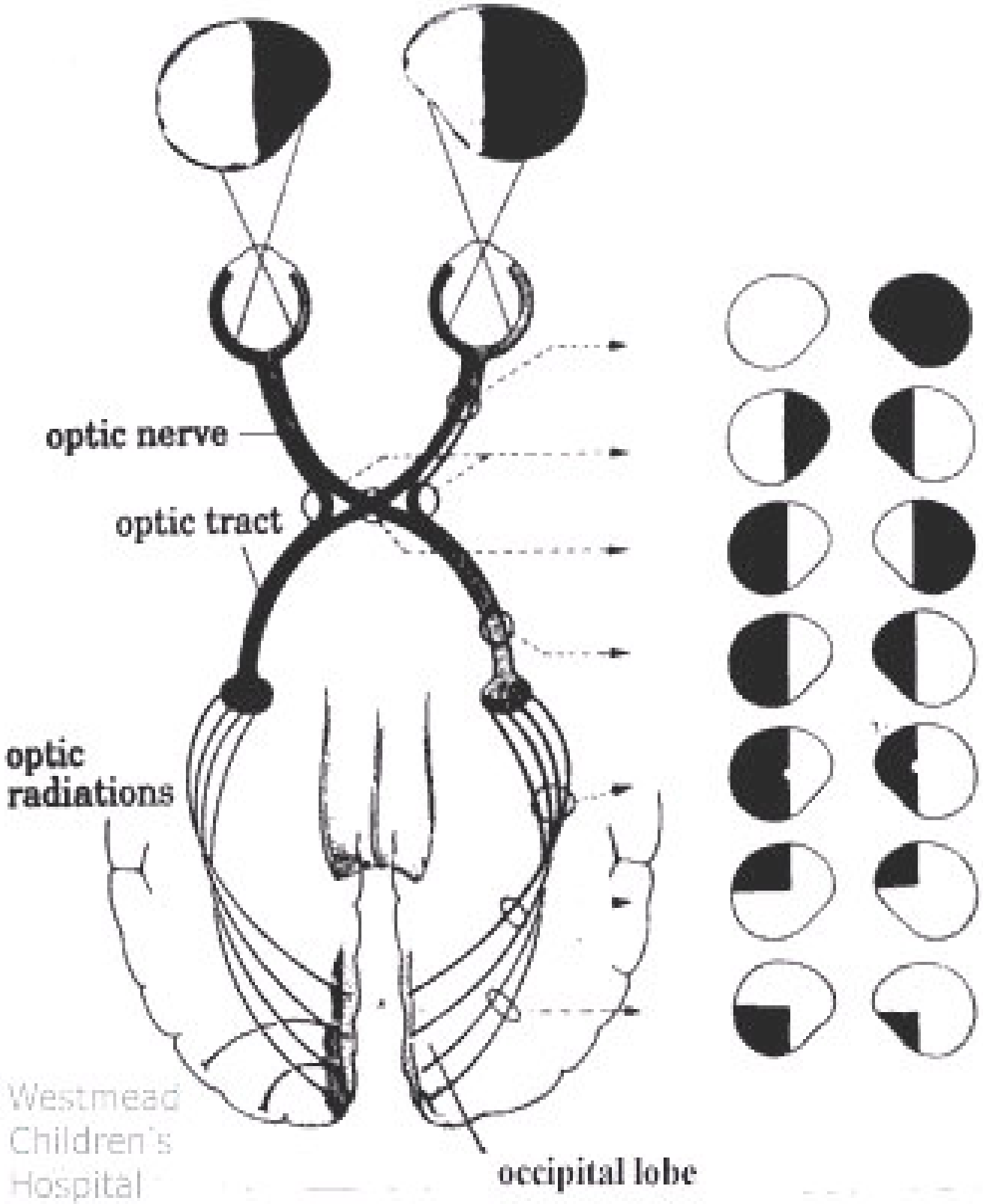
- e.g. lesion of the right optic tract will cause **left homonymous hemianopia** (loss of the left visual field of both eyes) , because the fibers of this tract are coming from the right parts of both retinae which receive image from left visual fields .

- Cortical lesions have some special characteristics : first , the macula is represented in much larger area than the periphery , so a lesion may not destroy all macular representation resulting in macular sparing . Second destruction of part of the occipital cortex may result in quadrantic loss of the visual field (only one quarter of the field of both eyes).

3) scotoma : patchy loss of field of vision .

- An important clue as to the location of the lesion , by using the light reflex

  ✓ If the light reflex is present it means that the visual pathway is intact up to the point where fibers take off from the optic tract just before lateral geniculate body , but if the light reflex is absent , it means the lesion may be in the optic nerve , chiasma , or tract before the fibers take off .



Lesion to the center of
optic chiasma
Bi-temporal heteronomous
hemianopia
L (S)
R (D)
Name
Datum
Diagnose
Arzt
Beleuchtung
Objektgröße
Entfernung
mm²
Temp.
180 Nasal
Nasal
180 Temp.
OCULUS SINISTER
OCULUS DEXTER
Verbindung der Durchstichpunkte ergibt Ges
By connecting points perforated the visual fie
La liaison des points marqués au poinçon donne
Gesichtsfeld vom Patienten aus gesehen.
he visual field is obtained as seen by the patient.
inçon donne le schéma périmétrique, vu par le malade.
Bestell-Nr. 4170

Lesion to the lateral sides
of optic chiasma
Bi-nasal heteronomous
hemianopia
L (S)
R (D)
Name
Datum
Diagnose
Arzt
Beleuchtung
Objektgröße
Entfernung
mm²
Temp.
Nasal
180 Nasal
180 Temp.
OCULUS SINISTER
OCULUS DEXTER
Verbindung der Durchstichpunkte ergibt Gesichtsfeld vo
By connecting points perforated the visual field is obtain
La liaison des points marqués au poinçon donne le schéma pé
Bestell-Nr. 4170
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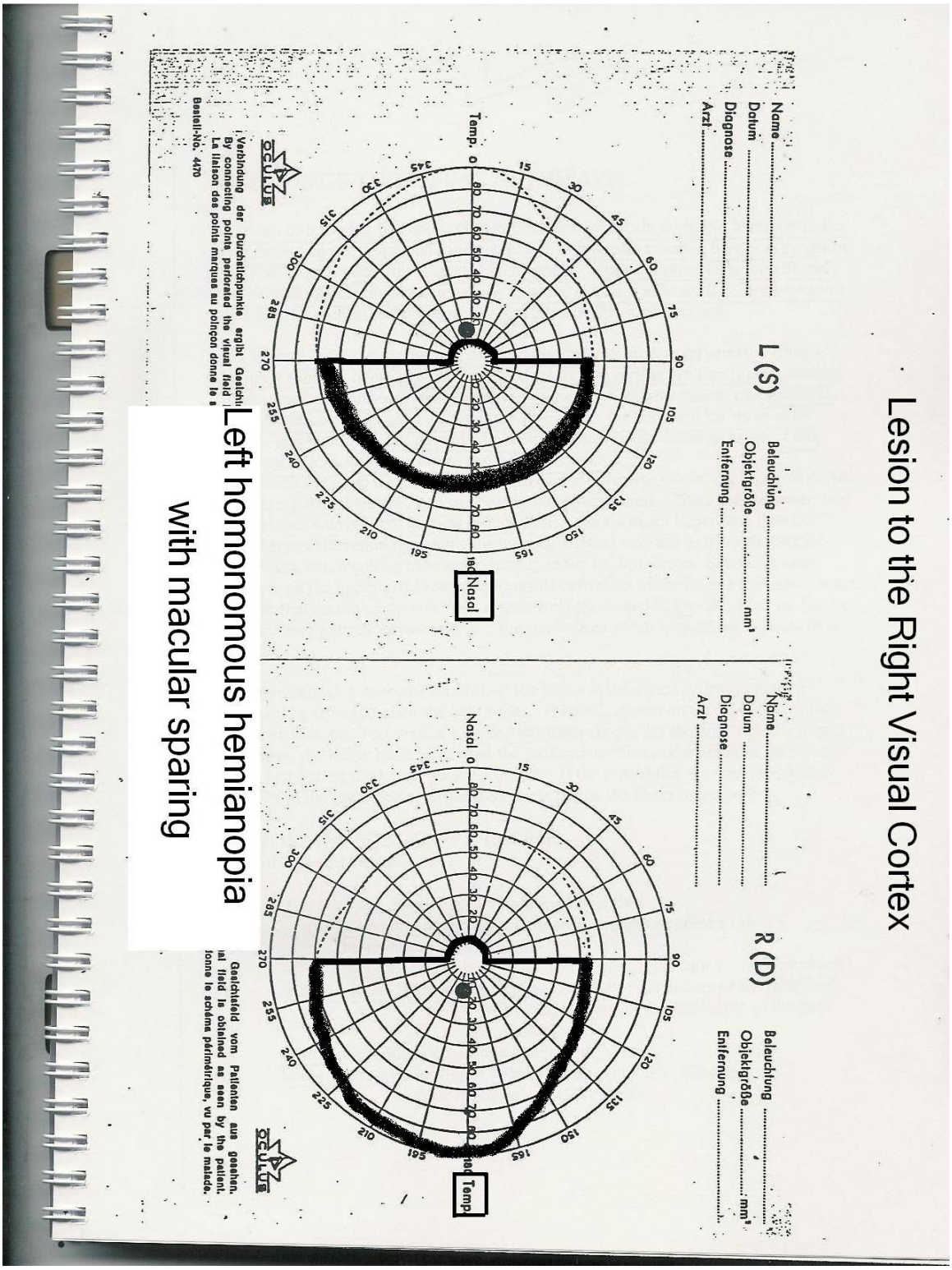
u poinçon donne le schéma périmétrique, vu par le malade.

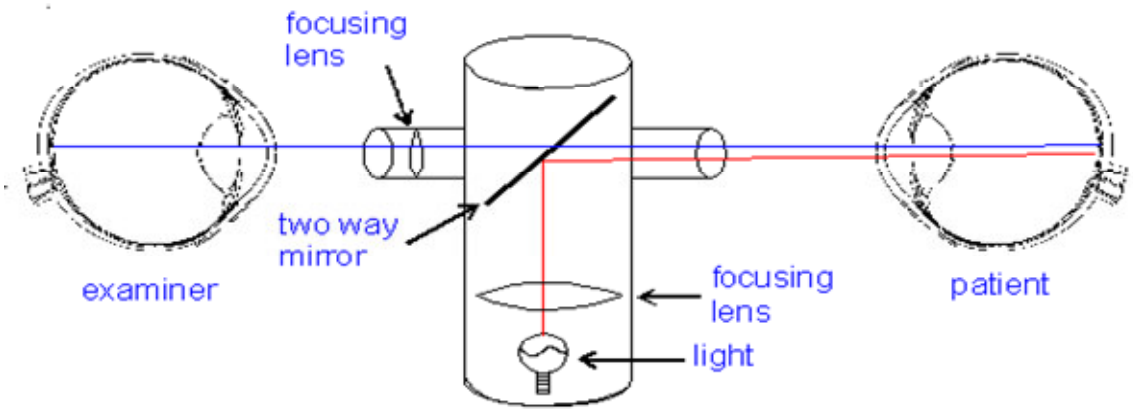

Lesion to the Right Visual Cortex
L (S)
R (D)
Name
Datum
Diagnose
Arzt
Beleuchtung
Objektgröße
Entfernung
mm²
Temp.
Nasal
Left homonomous hemianopia
with macular sparing

OPHTHALMOSCOPY

OBJECTIVES :

- To explain the general principles of ophthalmoscopy .
- Describe the normal appearance of the fundus.
- Describe the changes in the fundus that occur commonly in disease.
- Appreciate the importance of performing ophthalmoscopy as a part of the routine physical examination.

PRICIPLE OF OPHTHALMOSCOPE



METHOD :

- For a good view of fundus the pupil should be dilated by instilling few drops of short acting mydriatic drug (e.g. 1% cyclopentolate).
- The subject should be examined in sitting or lying down position.
- Examination room should be dark.
- keep the eye as still as possible.

Position of the examiner :

For examining right eye of the patient

- Examiner should stand on right side of the patient.
- Hold the instrument in his right hand.
- Use examiner's right eye.

If examining left eye, stand on left side, hold instrument in left hand use left eye.

- Viewing should begin about half meter away from the eye.

- First see the Red reflex (reddish-orange reflection from the eye's retina)

Initially the lens power in the instrument should be set to zero, or refractive error of patient or examiner :

- if the patient or examiner is myopic then set the (-ve)lens .
- if the examiner or patient is hypermetropic then set the lens to (+ve) lens.
- If both patient & examiner have refractive error then sum together their powers .

Examples :

- if examiner having +2, & pt. having +1 lens then adjust +3 lens in ophthalmoscope.
- If examiner have +2 diopters lens & pt. having -4 diopters lens then adjust (+2)+(-4) =(-2) lens in ophthalmoscope.

Changes of the retina :

1) Diabetic retinopathy :

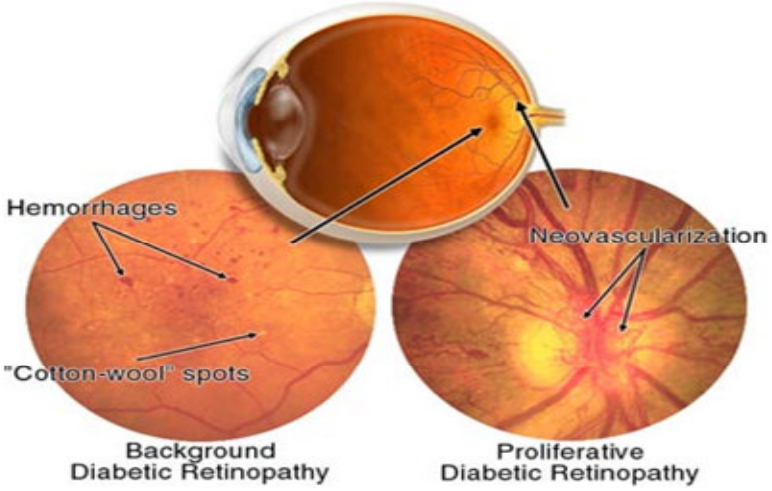
On examination we may find

A. Capillary micro-aneurysms are seen as tiny spots near the retinal vessels.

B. Retinal haemorrhages and exudate:

- ❑ Hemorrhage appear round
- ❑ Hard exudate (yellow with irregular margin)

C. New vessel formation



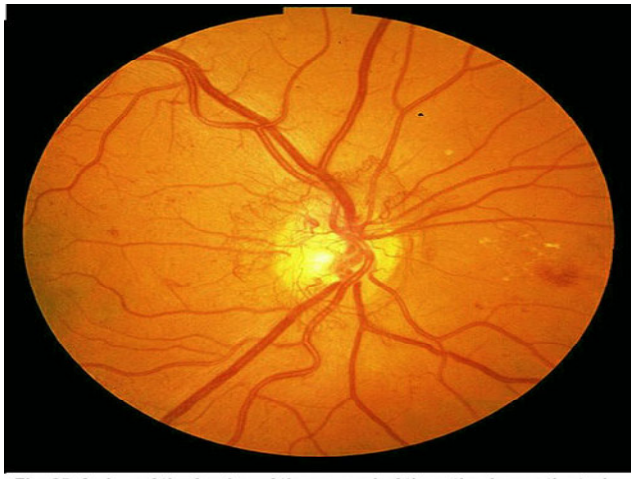


Fig. 25. A view of the fundus of the eye and of the retina in a patient who has advanced diabetic retinopathy.

2) Hypertensive retinopathy :

On examination we may find

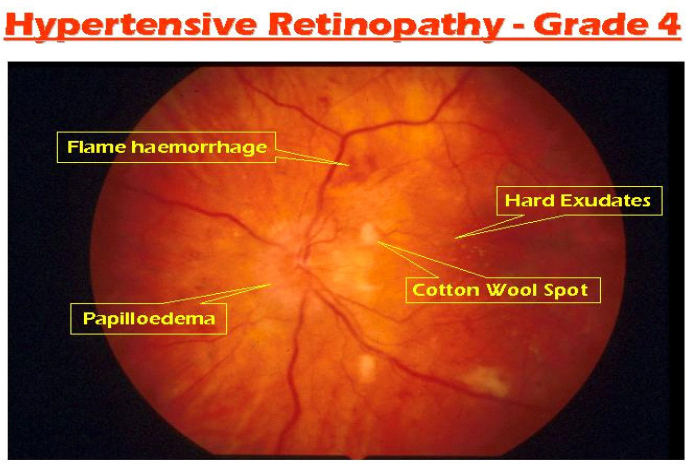
A. Generalized narrowing of retinal arteries.

B. Atrerio venous nipping i.e. indentation of the veins when they are crossed by the arteries.

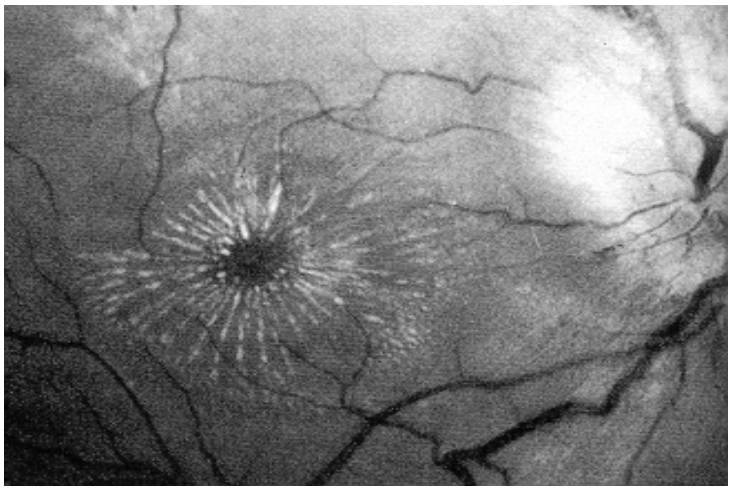
C. Retinal haemorrhages and exudate:

- Flame shaped hemorrhages
- Soft exudate (cotton wool)

C. Papilloedema (optic disc swelling)



In advanced cases, there will be a **macular star** (ring of exudates from the disc to the macula)



3) Papilloedema :

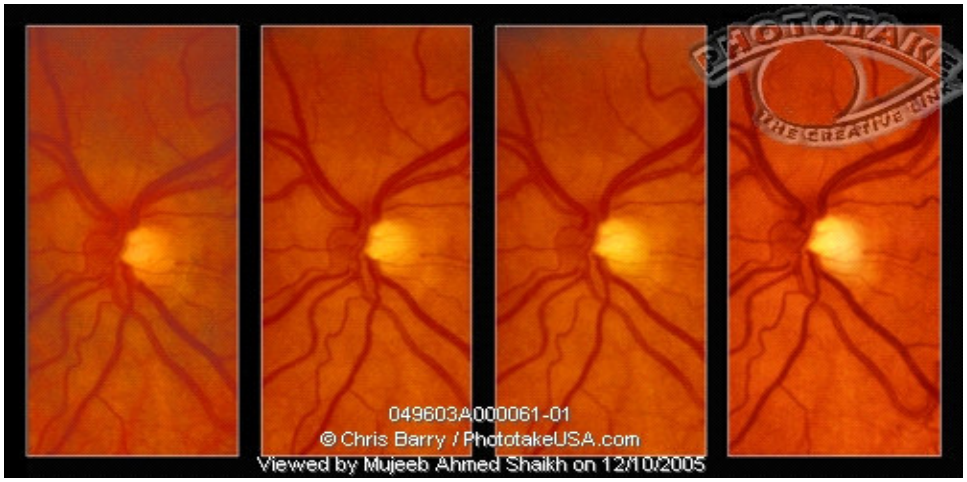
- Edema of optic disc, most commonly due to increased intracranial pressure. eg. Brain tumor or hypertension .

On examination of fundus we find;

- Increased redness of disc with blurring of its margins.
- Physiological cup disappears.
- Retinal vessels are distended.

4) GLAUCOMA :

- due to increased intraocular pressure glaucoma may cause optic nerve damage.



5) Myopic crescent :

- The Myopic Crescent is a crescent-shaped feature that sometimes develops in the retina of myopic eyes.

6) retinitis pigmentosa :

- inherited disorders in which abnormalities of the photoreceptors (rods and cones) or the retinal pigment epithelium (RPE) of the retina lead to tunnel vision and progressive visual loss.

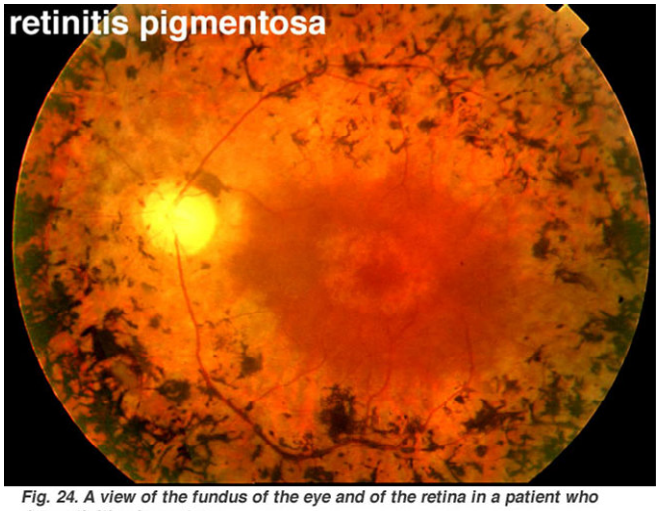
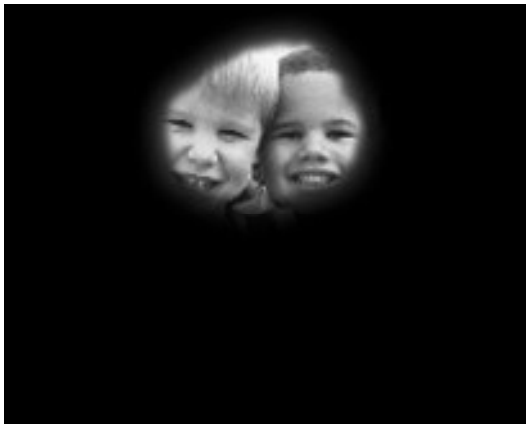


Fig. 24. A view of the fundus of the eye and of the retina in a patient who has retinitis pigmentosa.

tunnel vision



normal vision

N.B : there are some normal differences in the color of the retina for example :

The color of fundus is **brownish-red** in dark-brown-eyed Asians and **orange** in light blue-eyed Caucasians .

VISUAL EXPERIMENTS

Components :

1- Measurement of visual acuity.

2- color vision.

3- Accommodation.

Visual acuity :

- It is the accuracy of vision.
- we can check near or far vision .

1-Distant vision :

- For far vision we use (**snellen's chart**)→
- This chart composed of litters of many sizes .
- Below each letter there is a small number representing the distance which a normal person can see the litter clearly , because at this distance the letter will make an angle of 1 minute on the eye .@

Procedure :

- We make the patient sit at a distance of 6 meters from the chart .
- We ask the patient to take of his/her glasses (if present) and close one eye .
- We ask the patient to tell the letters , then we determine the smallest litter the patient can see clearly , then we see the number under that letter (suppose 25)
- This means the patient can see the letter only from 6 meters , where a normal person can see it from 25 meters .
- We apply this on the equilibrium :

V= d / D

V: vision acuity

d : distance from chart (always 6)

D : number under the litter .

- In this case :

V= 6 / 25

- This patient has short sightedness (**myopia**), usually caused by increase in the Anterioposterior diameter of eye . so the image is formed in front of the retina.
- This condition can be treated using a biconcave lenses .
- When we do it on a normal person, he/she will see the smallest letter on the chart (the number under it is 6)
- This means his/her vision is : V= 6 / 6

2-Near vision :

- We use for this test (**Jeagers chart**).
- This chart must be kept at 30 cm (normal reading distance).
- This chart contain either letters or pictures .
- Usually old patients can't see a near object because of there inability to accommodate because of lens stiffness. The image is formed behind the retina .
- Here the patient can see a far object normally .
- So it is called far sightedness (**hypermetropia**).
- For this case we use biconvex lenses for treatment .

Normal vision is called (emetropia)

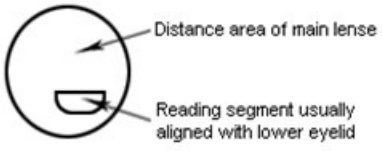
Other vision abnormalities

Astigmatism :

- It is due to irregular shape of the cornea .
- The image is not concentrated on one point of the retina , it will be dispersed on the retina .
- For this case we use cylindrical lenses for treatment .
- We test astigmatism by this picture →
- Patient with astigmatism will see some lines blurred

Presbyopia :

- Weakness of accommodation , due to stiffness of the lens.
- So there will be a problem in distant or near vision.
- Bifocal lens is used for treatment .



Color vision

- Color is detected by cones receptors .
- Person with color vision abnormalities can be :

1- color weak :

- Can't differentiate b/t different degrees of certain color .

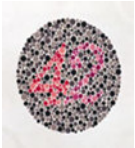
2-color blind :

- Can't differentiate b/t different 2 colors or more .

- This is an X-linked disease .
- We use 2 types of tests for testing color vision :

1- Ishihara's chart .

Numbers written in many colors on a background of different color to test the ability to observe the difference between colors .



2- yarn matching test .

Here we ask the patient to match similar colors of any objects (like pens) .

- Trichromate : presenting 3 colors Red ,Green and blue .
- If green is not seen → deuteranopia .
- If blue is not seen → tritenopia .
- If red is not seen → protonopia .
- But in case of only weakness in seeing one of these colors we replace the suffix (nopia) with (nomaly) .
- Like dentronomaly , tritenomaly and protonomaly .

Near point test :

- We usually use here a needle ,we put it in front of the eyes ,then we bring is closer and closer until it appears blurred then we measure the distance b/t the eyes and the needle .

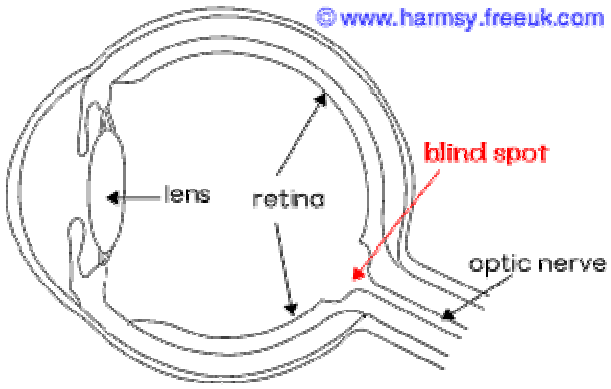
Sensory purkinje images :

- Here we use a candle , we put it in front and latrally to the patient eye in a dark room.
- And we ask the patient to concentrate on far object , we will see 3 images on the patient eye .
- Then we ask the patient to concentrate on near object , we will observe that the distance b/t 1st and 2nd images decreases and the distance b/t 2nd and 3rd increases .
- This is due to accommodation (bulging of anterior surface of the lens).

Blind spot :

- It is a simple experiment to know that there's a blind area at a certain distance from the eye (when we close one eye), normally it is not observed because this area is covered by the vision of the other eye .
- This area is present due to the lack of the receptors at the entry of the optic nerve in the eye .
- You can observe the blind spot by this test →
- When you put it at a certain distance you + ●

Will not see the black dot .



TEST OF HEARING AND PURE TONE AUDIOMETRY

Objectives :

▪ primary purpose of pure-tone tests is to determine the type, degree, and configuration of the hearing loss.

• To plot the frequency intensity recording and construct the audiograms .

• To interpret the audiograms .

Components :

• TUNNING FORK TESTS .

• AUDIOMETRY .

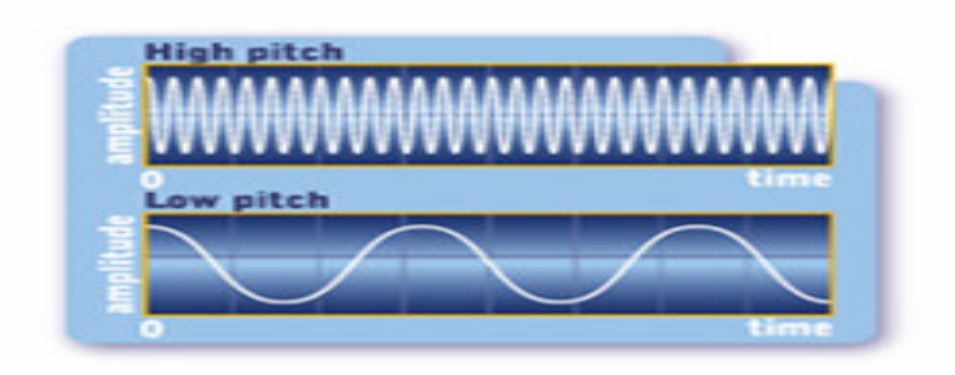
Some terminology :

• **Air conduction** : This test assesses sensitivity when the signal is transmitted through the outer, middle, and inner ear and then through the brain to the cortex. Testing may be performed using headphones, insert earphones .

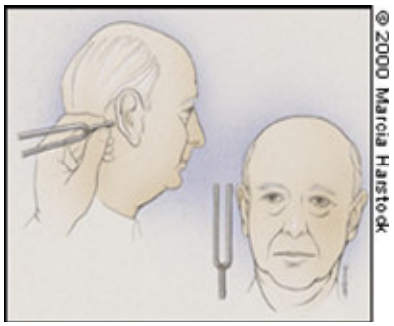
• **Bone conduction** : This technique assesses sensitivity when the signal is transmitted through the bones of the skull to the cochlea and then through the auditory pathways of the brain. This type of testing bypasses the outer and middle ear.

• **Masking** : constant noise to the non-test ear to prevent crossover from the test ear. The purpose of masking is to prevent the non-test ear from detecting the signal (line busy), so only the test ear can respond.

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



TUNING FORK TESTS



1) Rinne's Test

Technique : using a 512 tuning fork .

►First: Bone Conduction :

- Vibrating Tuning Fork held on Mastoid .
- Patient covers opposite ear with hand .
- Patient signals when sound stops .
- Move the vibrating tuning fork near the ear canal (not touching)

►Next: Air Conduction :

- Patient indicates when the sound ceases .

- **Normal:** Air Conduction is better than Bone Conduction
  - Air conduction usually persists twice as long as bone
  - Referred to as "positive test"
- **Abnormal:** Bone conduction better than air conduction
  - Suggests Conductive Hearing Loss.
  - Referred to as "negative test"

2) Weber Test

Technique : using a 512 tuning fork .

Tuning Fork placed at midline forehead

- **Normal:** Sound radiates to both ears equally
- **Abnormal**: Sound lateralizes to one ear , so the problem is either :
  - Ipsilateral (same side) Conductive Hearing Loss OR
  - Contralateral Sensorineural Hearing Loss.

Pure tone Audiometry

Technique :

- In a sound proof room person is seated comfortably.
- Ear phones are applied which are color coded. (Red for right ear, Blue for left ear.)
- Masking sound is delivered to the non-test ear.
- Start with a frequency of 125Hz. & 0 dB.
- Gradually increase the dB. till person hears the sound & respond.
- Mark the threshold intensity on the audiogram paper.
- Find the threshold of hearing from 125 Hz. to 8000Hz. & 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 & find out the threshold of hearing for different frequencies of sound.
- Use different sign to mark the bone conduction audiogram.
- Select the other ear and repeat the whole procedure.

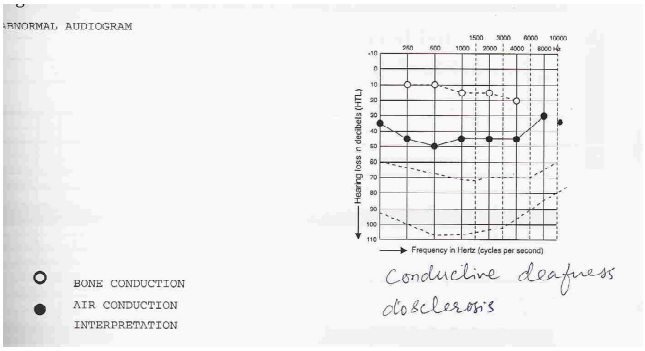
TYPES OF HEARING LOSS :

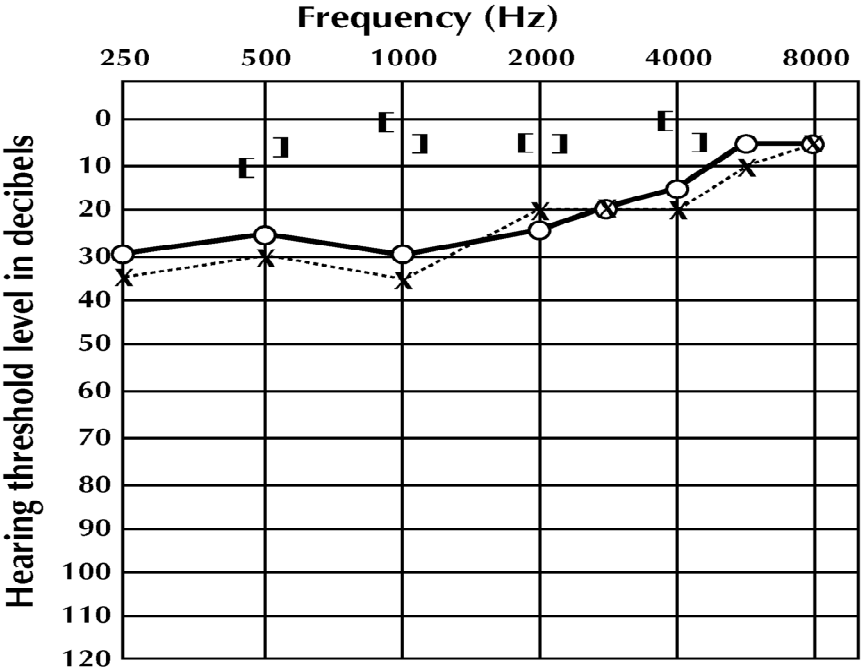
- **Conductive hearing loss .**
- **Sensorineural hearing loss .**
- **Mixed hearing loss .**

1) Conductive Hearing loss (deafness) :

- 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.

- Examples of abnormalities include perforated tympanic membranes, fluid in the middle ear system, or scarring of the tympanic membrane. Pure-tone air-conduction thresholds are poorer than bone-conduction thresholds by more than 10 dB .





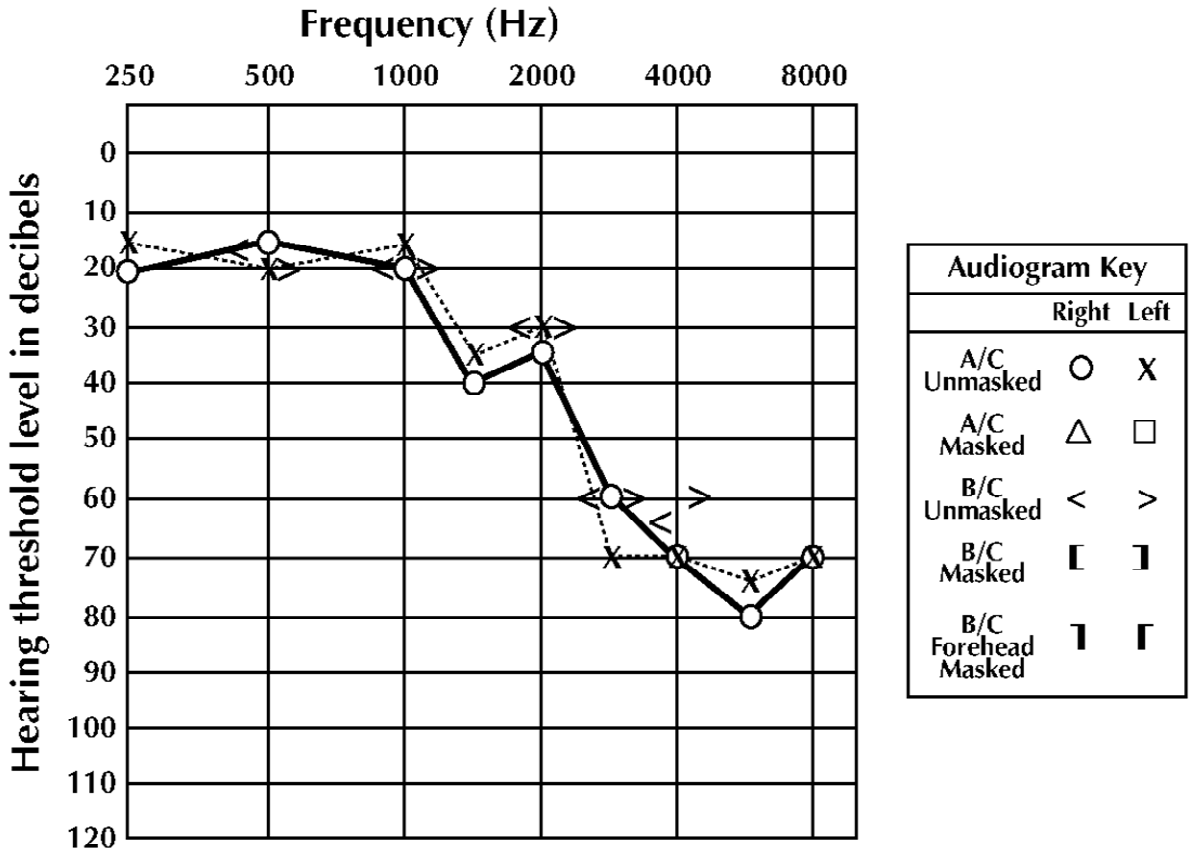
Audiogram Key		
	Right	Left
A/C Unmasked	O	X
A/C Masked	△	□
B/C Unmasked	<	>
B/C Masked	[	]
B/C Forehead Masked	⌉	⌈

SPEECH TESTS

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

2) 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.
- Because the outer ear and middle ear do not reduce the signal intensity of the air-conducted signal, both air- and bone-conducted signals are effective in stimulating the cochlea,but the problem is in or beyond the cochlea. Pure-tone air- and bone-conduction thresholds are within 10 dB



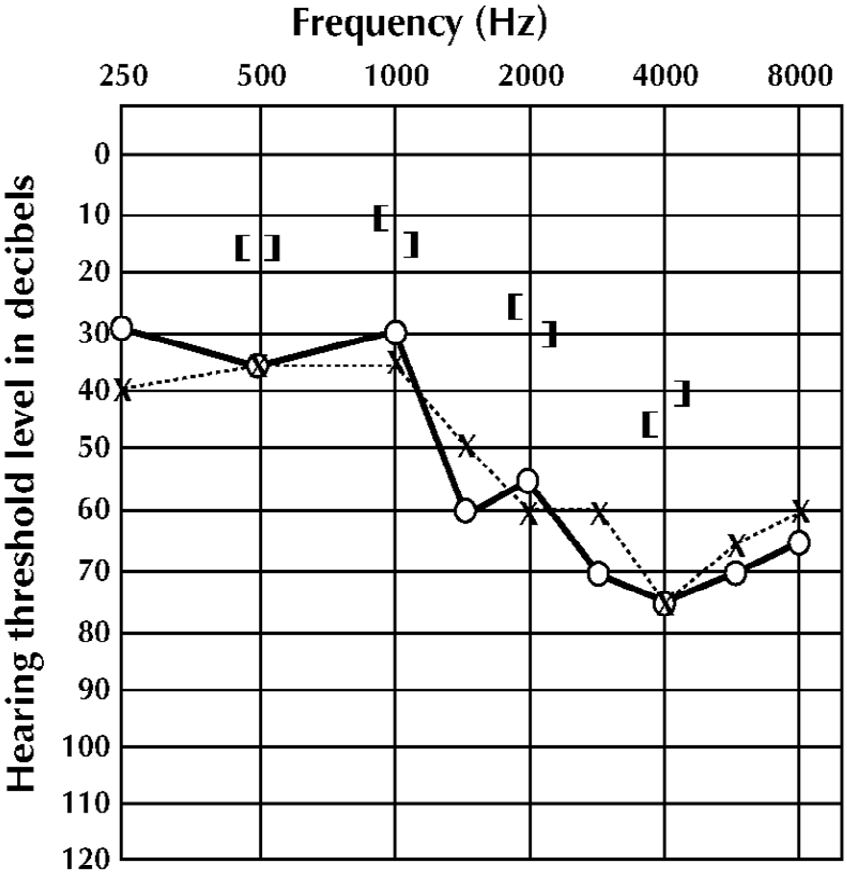
SPEECH TESTS

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

3) Mixed Hearing loss :

- This type of hearing loss has sensorineural and conductive components.
- 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 .



Audiogram Key		
	Right	Left
A/C Unmasked	O	X
A/C Masked	△	□
B/C Unmasked	<	>
B/C Masked	[	]
B/C Forehead Masked	]	[

SPEECH TESTS

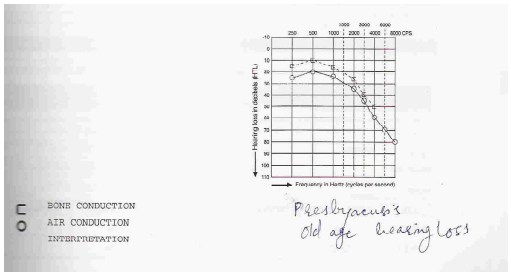
TESTS		R	L
Sp. Reception Threshold (SRT)		40 dB	40 dB
Sp. Discrim. Scores	35 dB SL	84%	86%

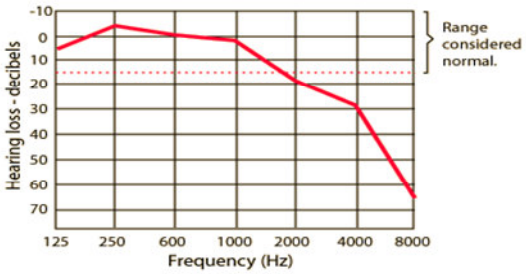
DEGREES OF HEARING LOSS :

- 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)

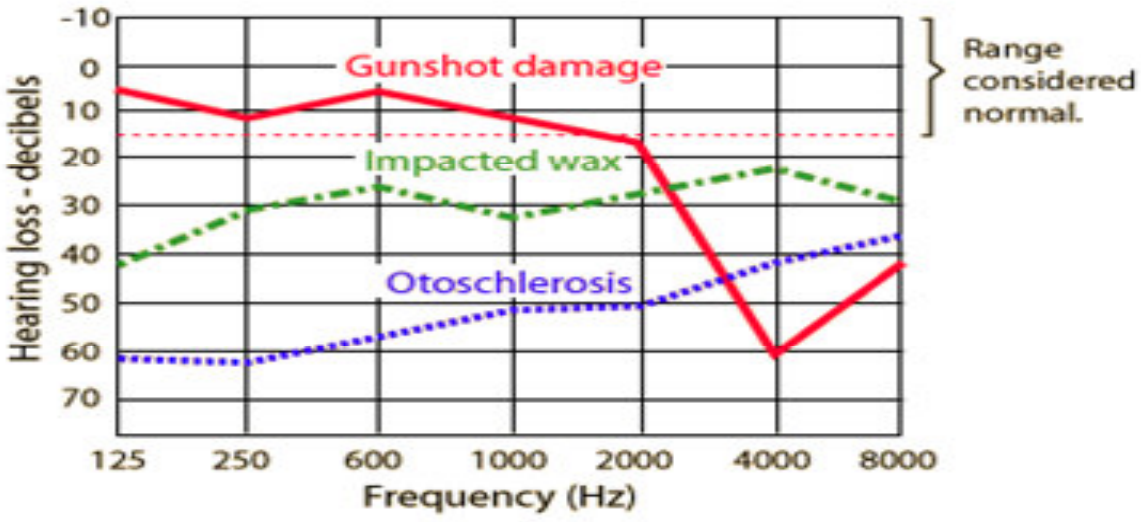
COMMON AUDITORY DISORDERS :

- **Presbyacusis** (age related hearing loss)





- **Otitis media**: This condition is marked by fluid in the middle ear space.
- **Noise-induced hearing loss** .
- **Otosclerosis**: The condition is caused by stapedial fixation in the oval window, stiffening the middle ear system.
- **Ménière disease**



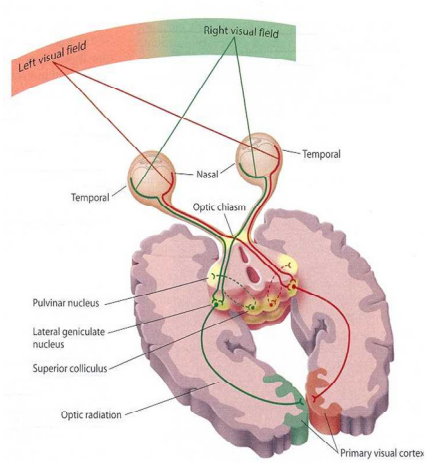
VISUAL EVOKED POTENTIAL (VEP)

Evoked potential : Electrical potentials that occur in the cortex after stimulation of a sense organ which can be recorded by surface electrodes .

Examples : (SEP) ►sensory evoked potential .
(VEP))► visual evoked potential .

• The VEP tests the function of the visual pathway from the retina to the occipital cortex.

• It assesses the integrity of the visual pathways from the optic nerve, optic chiasm, and optic radiations to the occipital cortex.



• The VEP is very useful in detecting an anterior visual conduction disturbance.

• VEPs are most useful in testing optic nerve function and less useful in postchiasmatic disorders.

•In retrochiasmatic lesions, the MRI (magnetic resonance imaging) is a more useful test.

• VEPs is not specific with regard to etiology.

For example a tumor compressing the optic nerve, an ischemic disturbance, or a demyelinating disease, all of them may cause the same change -delay in the P100- in VEP.

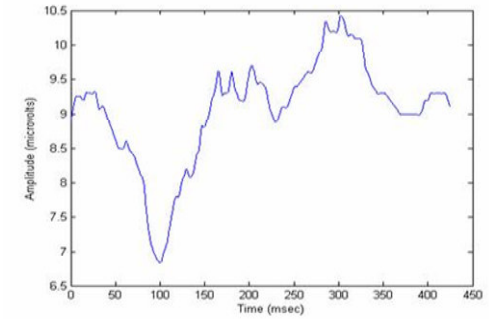
Comparison of VEP with MRI

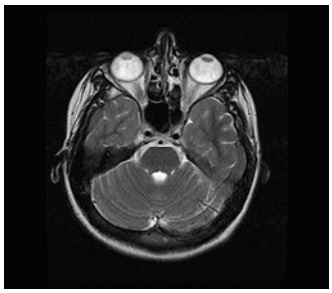
VEP

- The VEP explains the functionality of visual pathway.
- VEP gives us information about the physiology of a anatomical pathway with much less spatial or localizing information
- VEP is useful primarily in assessing optic nerve function in the anterior (prechiasmatic) portion.
- It is lateralizing but not localizing to the lesion.

MRI

- The MRI largely remains an imaging, structural, or anatomical test.
- The MRI scan gives more accurate information about structural problems
- MRI is a highly accurate localizing modality





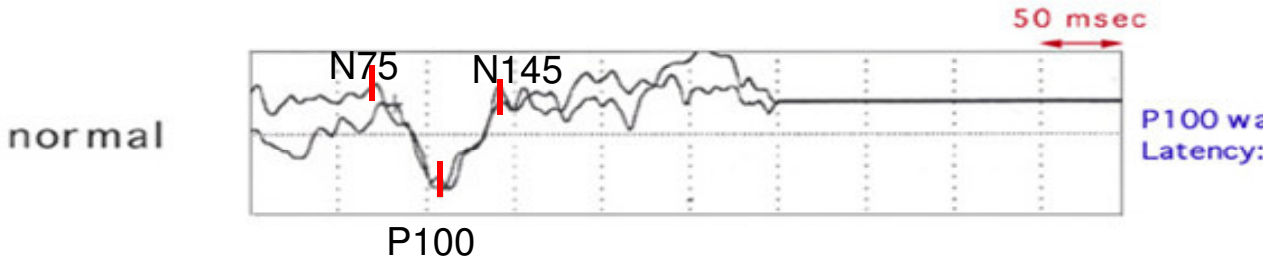
(Under given circumstances they may be complementary to each other)

Waveforms
(The NPN complex)

•The initial negative peak (N1 or N75)

•A large positive peak (P1 or P100)

•Negative peak (N2 or N145)



N.B. In this experiment (+)ve wave is down & (-)ve wave is up .

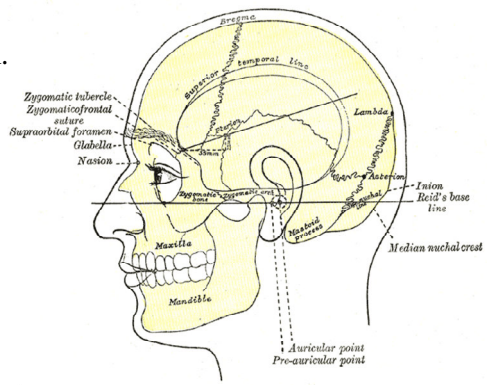
VEP generator site :

- Visual Cortex (occipital lobe)
  The generator site is believed to be the peristriate and striate occipital cortex .

Procedure :

- The room should be dark.
- Test mono-ocularly (one eye) with other eye covered.
- Stimulus:
  Checkerboard pattern (or less often, flash) is
  used as stimulation two reversal/sec.
- Stimulus rates of 1-2 Hz are recommended
- The recommended recording time window (ie, sweep length) is 250 ms.
- Seating distance: 70-100 cm from the monitor screen
- Fix the gaze at a colored dot in the center of the screen.
- Apply three scalp electrodes at;

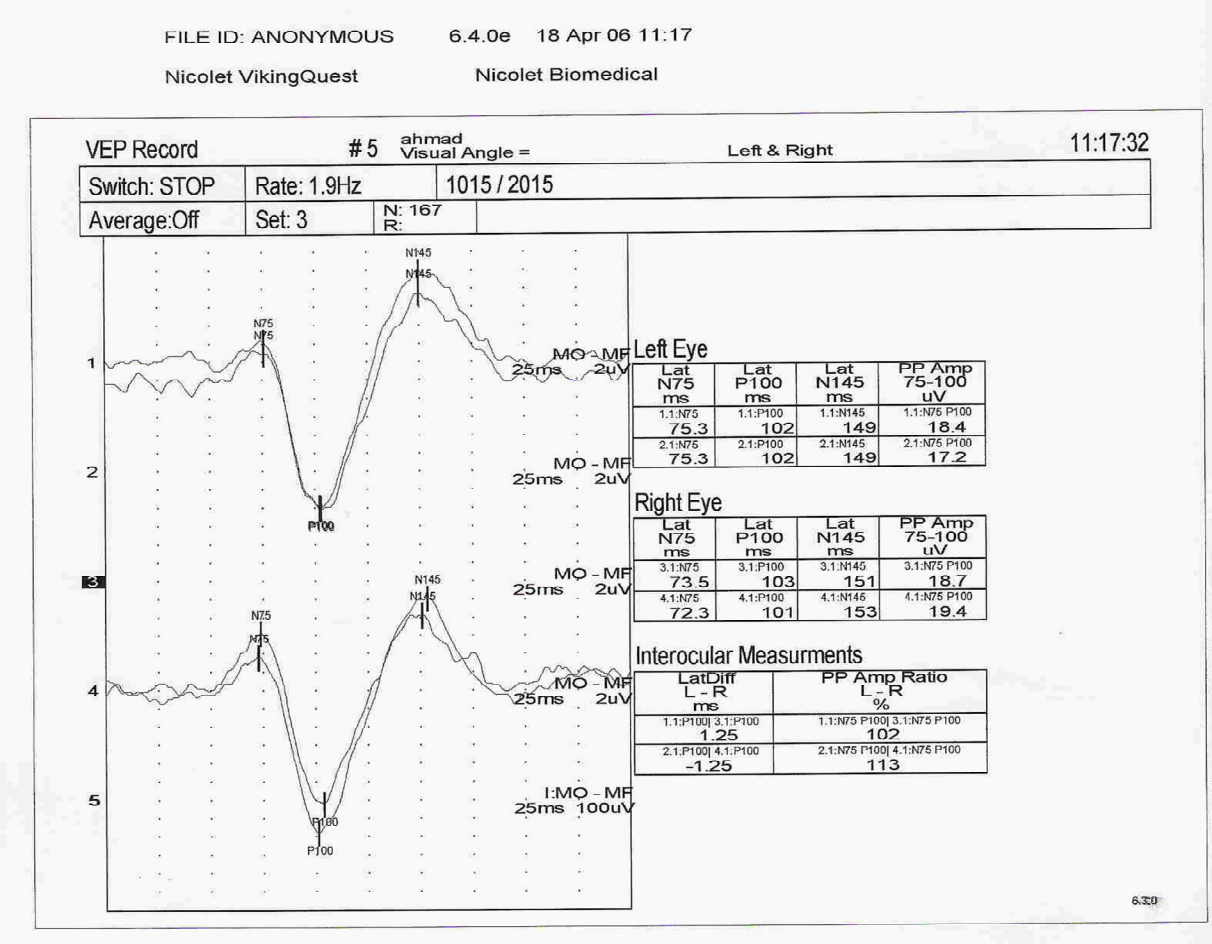
Oz : 2cms above the inion (RECORDING)
Cz : at vertex (REFERANCE)
Fz : on frontal bone (GROUND)



- Start averaging process.
- Continue averaging till 1000 stimulus repetition complete. It will stop automatically.
- Then you will get NPN complex .
- Identify the waves .
- Repeat the procedure & get another record to make sure the recording is correct (reproducibility of the test results)
- Then Repeat the procedure for other eye.

Analysis :

- Identify the waves (NPN complex)
- Determine the absolute peak latencies.
- Determine the amplitude of the waves.
- Determine the interocular latency difference.



- Negative components (N75) or (N145) of NPN complex may be absent even in normal subject.
- The only persistent wave is P100.
- P100 is 110 milliseconds (ms) in patients younger than 60 years
- it may rises to 120 ms thereafter in females and 125 ms in males as a Maximum value .
- There are lab-to-lab variability .
- Interocular P100 latency difference (b/t the tow eyes) is upto 5 – 6 ms.
- > 10ms is gross abnormality.

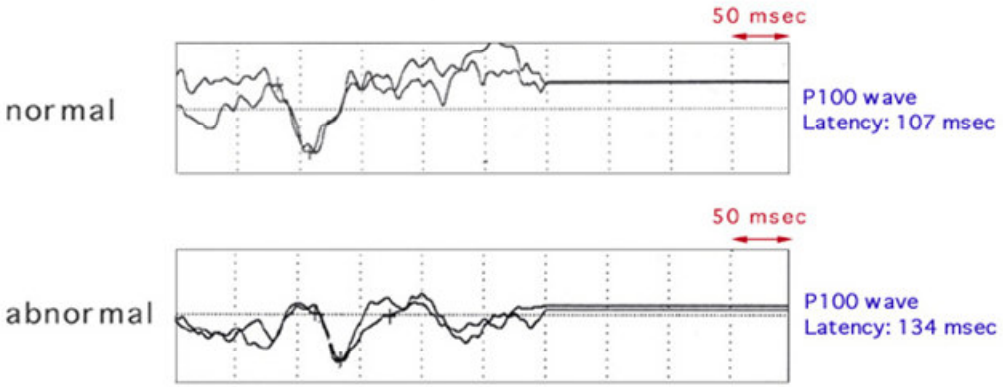
Factors influencing VEP :

- The size of the checks .
- Pupillary size.
- Gender (women have slightly shorter P100 latencies).
- Age: below 1 yr of age P100 may be 160ms (no myelination)& above 60 yrs also it get delayed.
- Sedation and anesthesia abolish the VEP.
- Visual acuity deterioration up to 20/200 does not alter the response significantly .
- Drugs.(eg. carbamazepine and sodium valproate prolong P100 latency) .

Abnormalities detection :

- Delayed P100 is due to,
  1. Demyelination of optic nerve.
  2. Axonal degeneration.
- Low voltage of P100 is due to,
  Problems of refrective medias of eye.
  eg. Corneal opacity, cataract , vitreous hemorrhage.
- Voltage should not be less than 5mv.

Visual Evoked Potentials



Differential diagnosis with abnormal (prolongP100 latency) VEP :

- Multiple sclerosis
- Optic neuropathy
- Optic neuritis
- Toxic amblyopia eg. Tobacco smoking, alcohol.
- Glaucoma
- Ischemic optic neuropathy
- Tumors compressing the optic nerve - Optic nerve gliomas, meningiomas, craniopharyngiomas, giant aneurysms, and pituitary tumors.

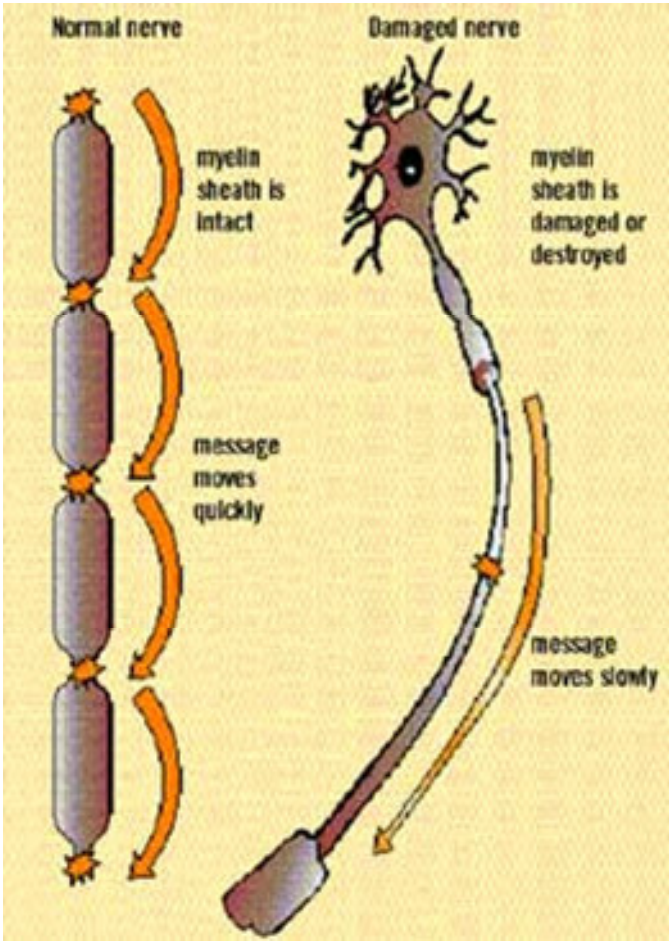
(Normal VEP virtually excludes an optic nerve or anterior chiasmatic lesion)

Clinical usefulness of VEPs :

- More sensitive than MRI or physical examination in prechiasmatic lesions
- Objective and reproducible test for optic nerve function
- Abnormality persists over long periods of time
- Inexpensive as compared with to MRI

Multiple Sclerosis (**MS**) :

- Its a chronic **demyelinating** disease of the central nervous system, which predominantly affects young adults during their most productive years. Viral and autoimmune etiologies are postulated. Genetic and environmental factors are known to contribute to MS, but a specific cause for this disease is not identified.



Auditory Brainstem Evoked Response

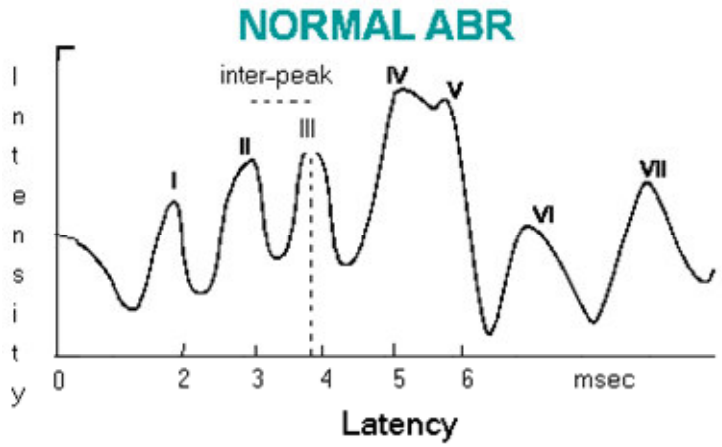
(ABR)

• **Definition :** It is the Evoked potentials recorded from the vertex after a brief auditory click.

•It is also called BAEPs (Brainstem Auditory Evoked Potentials) .

• It is a test needed to Examine the function of the auditory system , specially the cochlea-auditory nerve – brainstem pathway .

• ABR or BAEPs are set of seven positive waves recorded during the first 10 msec after a click .



• Waves of ABR :

Wave I ► cochlear nerve

Wave II ► Dorsal and ventral cochlear nucleus

Wave III ► Superior olivary complex

Wave IV► Nucleus of lateral lemniscus

Wave V ► Inferior colliculus

Wave VI ► Medial geniculate body

Wave VII►Auditory radiation/cortex

• ABR interpretation requires identification and measurement of the peak-absolute latencies of the waves I to V and interpeak latencies of (I-III) , (III-V) and (I-V) .

• It is very important to Identify the waves IV and V , they come together and go down to the base line .

Q : How do we find the latency of a wave ?

• we simply draw a vertical line from the peak of the wave to the base line .

- We can set the machine at 80 dB , 60 , 40 and 20 .

Q : What are the normal latency values ?

- As a general rule at 80 dB : latency of wave I < 2 msec
  latency of wave II < 3
  latency of wave III < 4

And so on IV < 5 , V < 6 , …….

Q : What are the normal inter-peak latencies ?

- (I - III) ≤ 2.5 msec
- (III - V) ≤ 2.5 msec
- (I – V) ≤ 5 msec

Differences Between conductive and sensineural deafness on ABR :

1) Conductive deafness :

Waves from I to IV are late (delayed latency) , but normal inter peak .

(See next page)

2) Sensineural deafness :

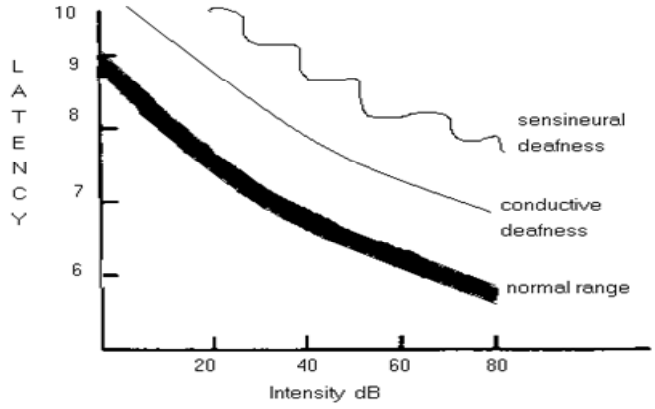
Wave V is late (delayed latency) , but normal inter peak .

Q : when do we get abnormal inter peak latency :

- When there is a problem with the **Brainstem** .

Latency – Intensity curve :

- After identifying the waves on ABR we simply apply the values of wave V on the **Latency – Intensity curve .**
- Latency in msec (Y- axes)
- Intensity in dB (X – axes)
- This curve helps in identifying the type of deafness .



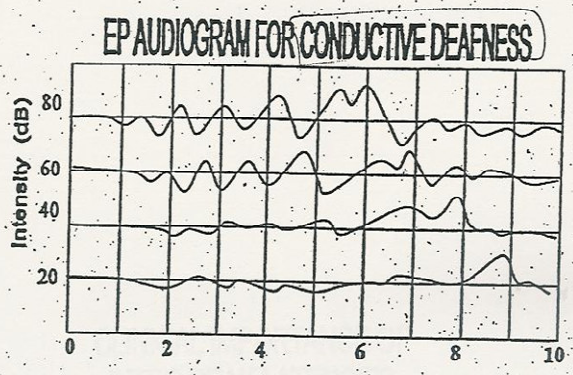


Figure - 6

Q. 1. Calculate the latency of wave V at 80 dB, 60 dB, 40 dB and 20 dB.
2. Draw the latency-intensity curve for wave V.

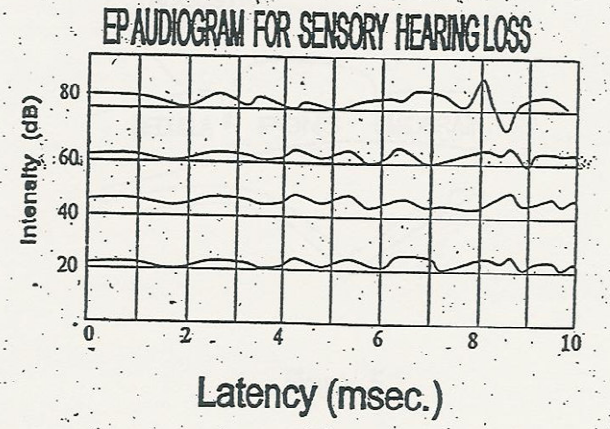


Figure - 7

Q. 1. Calculate the latency of wave V at 80 dB, 60 dB, 40 dB and 20 dB.
2. Draw the latency-intensity curve for wave V.

ELECTROMYOGRAPHY (EMG)

- **Basic knowledge**
  - motor unit : consists of motor neuron and all the muscle fibres it innervates

  ✓ So, when an action potential occurs in a motor neuron all fibres which are innervated will contract

- **What is an EMG ?**
  - Its the recording of the electrical activity of the muscle fibres at REST and CONTRACT

  ✓ Normally a muscle is silent at rest , but when the patient is asked to contract the muscle smoothly an motor unit (MU) is activated and (MUAPs) are recorded

- **What is a motor unit action potential (MUAP)?**
  - It is the summation of the potentials generated by muscle fibres which belong to the same motor unit

    - That means greater the MUAP stronger the MU
    - The amplitude of a MUAP is determined by the number of muscle fibres recorded ((stimulated))

MOTOR UNIT POTENTIAL
DURING MILD EFFORT

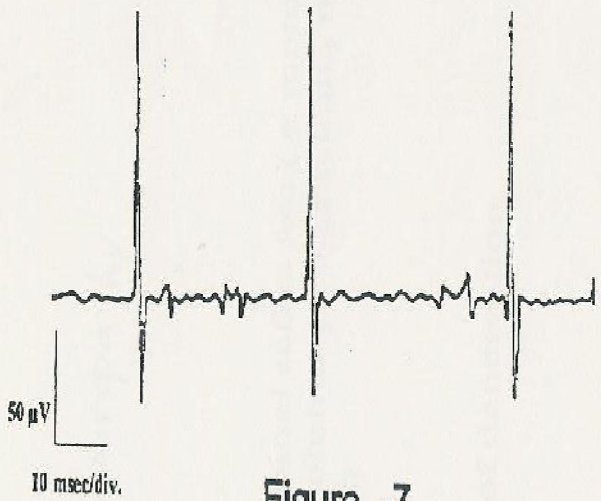
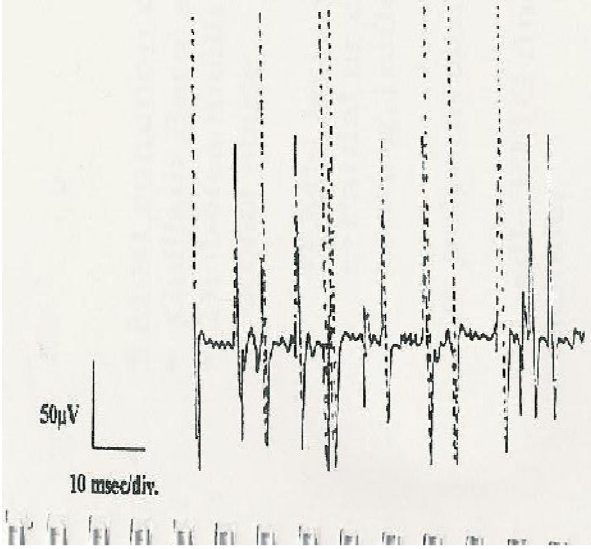
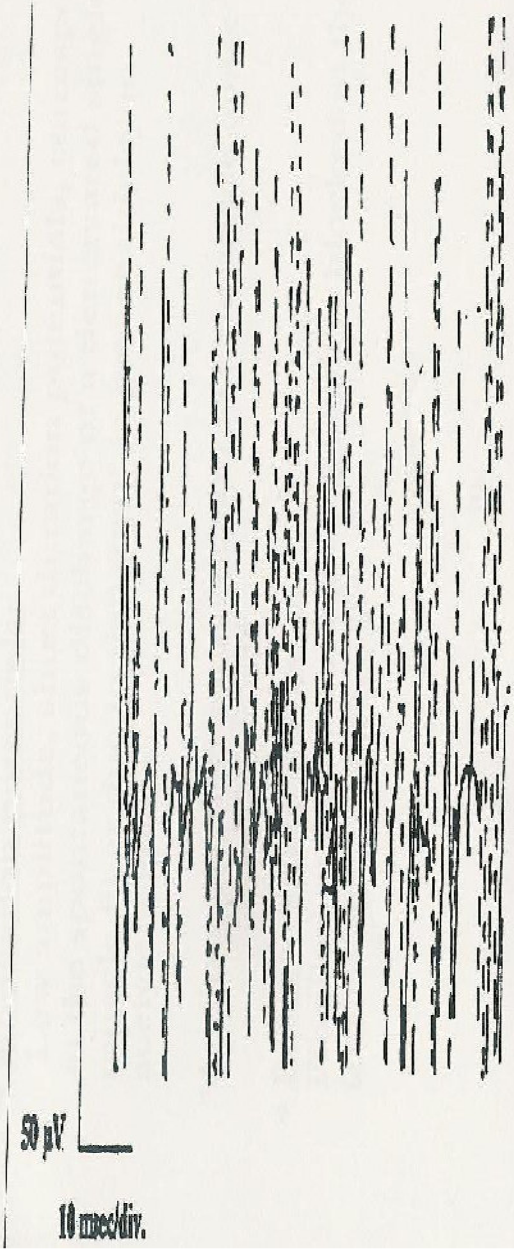


Figure -7

MOTOR UNIT POTENTIAL
DURING MODERATE EFFORT

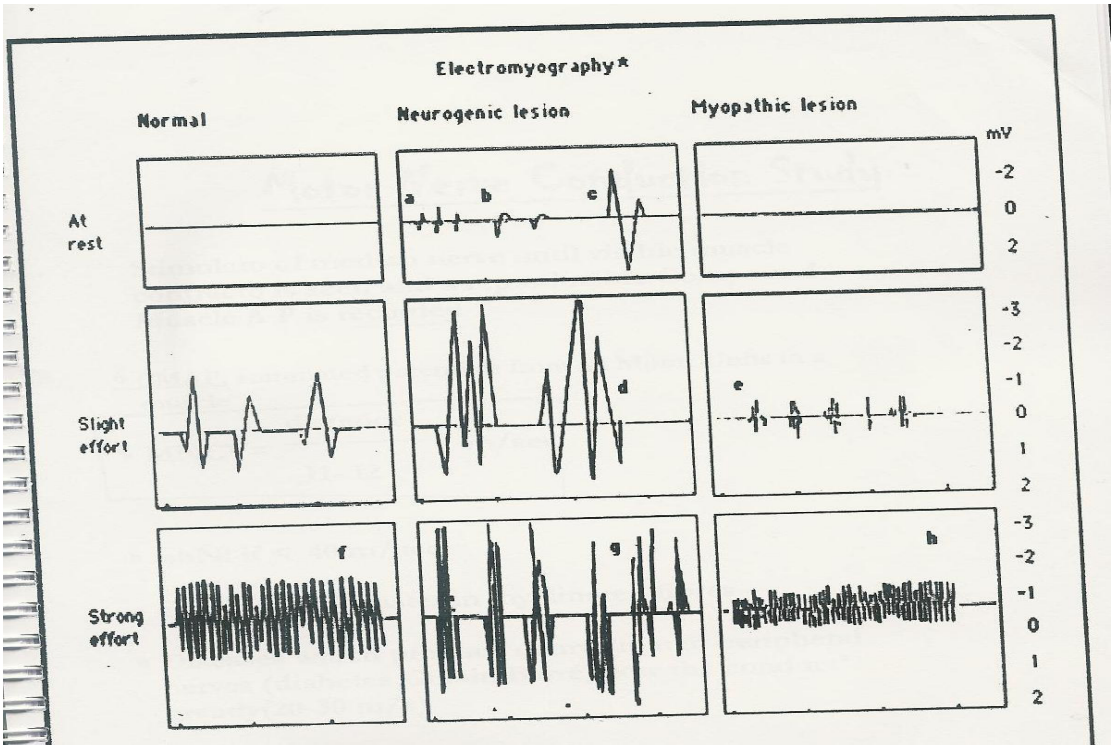


MOTOR UNIT POTENTIAL
AT FULL VOLUNTARY EFFORT



✓ From the figure above we notice that ((at full contraction separated MUAPs will indistinguishable resulting in a complete recruitment =interference pattern))

- **<u>after all the basics , when and where is EMG used ?</u>**
  - Its used to investigate both neuropathic and Myopathic disorders (check terminology box-1)



- Given the figure u can indicate normal . nuropathy and myopathy analysis:

B-NEUROPATHY :

1- Positive sharp wavers

2- Fibrillations

3-gaint motor unit potentials

(check terminology box-1)

C- MYOPATHY:

1- polyphasia

2-short duration

3- reduced voltage of mups

(check terminology box-1)

V. important

B. Analysis of a Motor Unit Potentials (MUP) (Figure – 6):

MUP	NORMAL	NEUROGENIC	MYOPATHIC
Duration msec	10 to 12	Longer	Shorter
Amplitude μV	300 to 500	Larger	Smaller
Phases	Biphasic/Triphasic	Polyphasic	May be Polyphasic
Interference* Pattern	Full	Partial	Full

Terminology box-1

WORD	MEANING
neuropathy	Damage to the distal part of the nerve
myopathy	Degeneration of skeletal muscle fibres
Positive sharp wavers	Fibrillation AP whose propagation is blocked at the level of the recording
Fibrillations	Low amplitude AP due to spontaneous discharge of denervated single muscle fibre
polyphasic	If u trace the AP with your pen , your going to cross the (Y) access more than 3 times
Biphasic	If u trace the AP with your pen your going to cross the (y) access 2 times only

NB: the next 3 pages are a brief revision!

MOTOR NERVE CONDUCTION VELOCITY

(MNCV)

- Stimulation of median nerve until visible muscle contraction is seen and a reproducible compound muscle AP(CAMP) is recorded .

✓ CAMP: summated potentials from all motor units in a muscle .

$$MNCV = \frac{\text{distance}}{(L1-L2)}$$

- If MNCV is above 40m/sec = NORMAL because conduction is faster in myelinated fibres

- SO, demyelination will show slow conduction (20-30)

EEG

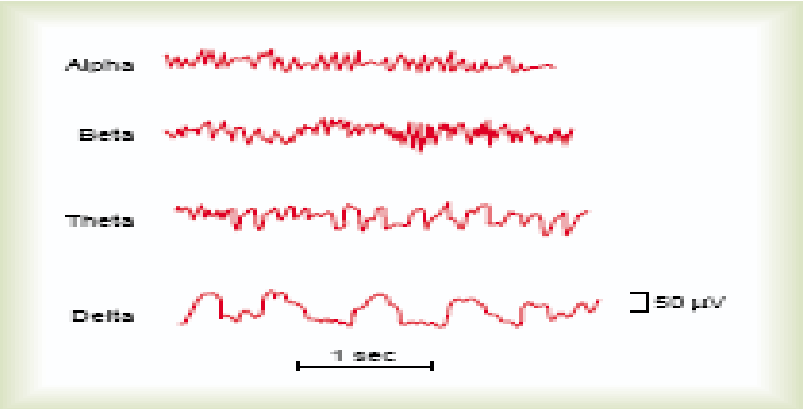
- **Introduction**:
  - The electroencephalogram (EEG) is a recording of the electrical activity of the brain from the scalp.
  - The first recordings were made by Hans Berger in 1929

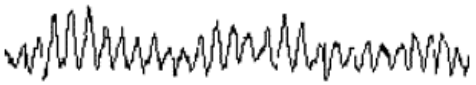
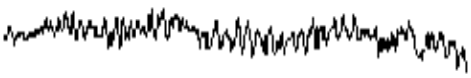
- **What does EEG mean ?**
  - EEG is the record of electrical activity of brain(superficial layer i.e. the dendrites of pyramidal cells) by placing the electrodes on the scalp.

- **how many waves are here in an EEG?**
  - 4waves, which are α, β , theta and Delta

Rythm	Frequency (Hz)
Alpha α	8-13
Beta β	14-30
Theta θ	4-7.5
Delta δ	1-3.5

D T A B



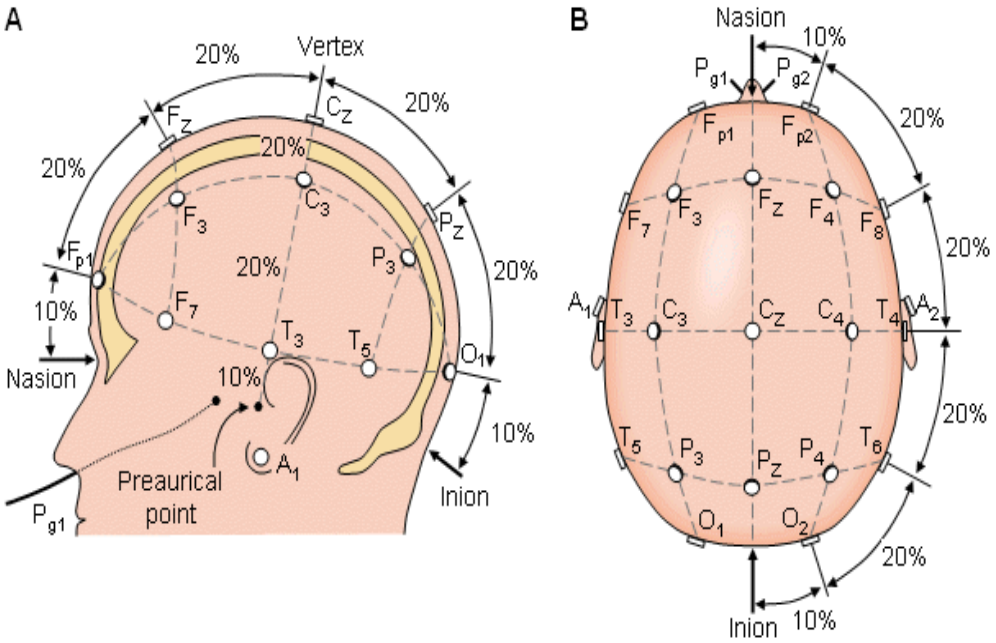
Rhythm	Frequency (Hz)	Amplitude (uV)	Recording & Location	
Alpha(α)	8 – 13	50 – 100	Adults, rest, eyes closed. Desynchronized on eye opening Occipital region	
Beta(β)	14 - 30	20	Adult, mental activity Frontal region	
Theta(θ)	4 – 7 .5	Above 50	Children, drowsy adult, emotional distress Occipital	
Delta(δ)	1 - 3.5	Above 50	Children in sleep	

- **Requirements:**

1. EEG machine (8/16 channels).
2. Silver cup electrodes/metallic bridge electrodes.
3. Electrode jelly.
4. Rubber cap.
5. Quiet dark comfortable room.
6. Skin pencil & measuring tape.

- **Procedure of EEG recording:**

1. A standard EEG makes use of 21 electrodes linked in various ways (Montage).
2. Ask the subject to lie down in bed
3. Apply electrode according to 10/20% system.
4. Check the impedance of the electrodes.
5. Ask the subject to close his/her eyes.
6. Select a montage.
7. Press run switches on to run the paper.
8. Press the calibration knob to check voltages & time constant.
9. Always observe subject for any abnormal muscle activity.
10. Ask the subject to open eyes for 10 sec.and ask him/her to close eyes. (do this procedure for several times in each montage)



- **EEG Electrodes:**

  - Each electrode site is labeled with a letter and a number.

A. The letter refers to the area of brain underlying the electrode (e.g. F - Frontal lobe and T - Temporal lobe).

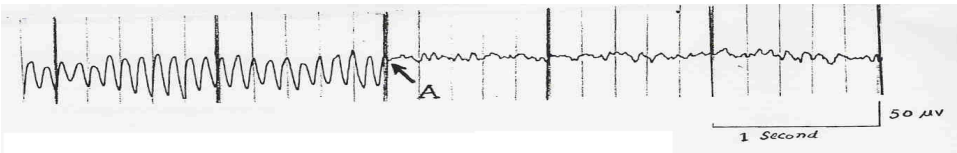
B. Even numbers denote the right side of the head and Odd numbers the left side of the head.

- **NORMAL EEG CHANGES:**

A-Desynchronization or Alpha block:

Cause:

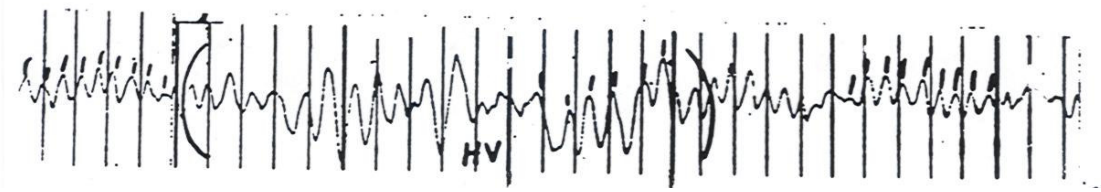
a) **Eyes opening (after closure)** => will change to β waves
b) **Thinking by the subject** (mathematical calculation) => will change to β waves
c) **Sound** (clapping)



B-Provocation test:

a) **Intermittent photic stimulation** => Increase rate & decrease amplitude

b) **Hyperventilation** => Decrease rate & increase in amplitude



- **Uses of EEG :**

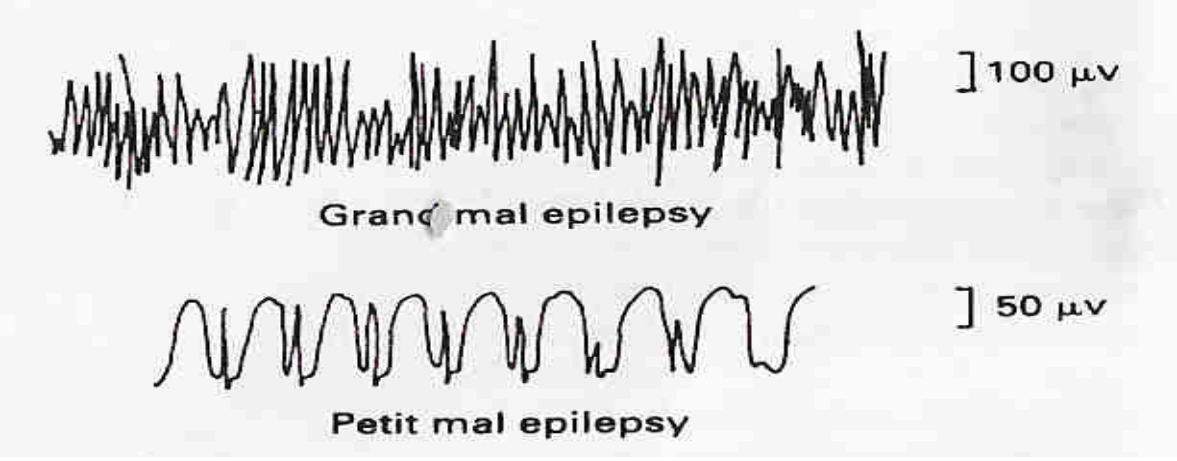
1) **Epilepsy**
   a) Generalized (grandmal) seizures.
   b) Absence (petitmal) seizures.

2) **Localize brain tumors.**

3) **Sleep disorders (Polysomnography)**
   a) Narcolepsy
   b) Sleep apnea syndrome
   c) Insomnia and parasomnia

4) **Helpful in knowing the cortical activity, toxicity, hypoxia and encephalopathy.**

- **Epilepsy And EEG**:



- **Epilepsy and sleep:**

Stages of sleep	EEG pattern	Somatic or Behavioral changes
Alert	Alpha activity on eye closed Desynchronization on eye opening	Respond to verbal commands
I (Drowsiness)	Alpha dropout & appearance of vertex waves & theta.	Reduced HR & RR
II (Light sleep)	Sleep spindles, vertex sharp waves & K-complexes	Reduced HR & RR
III (Deep Sleep)	Much slow background K-complexes	Reduced HR & RR
IV (very deep sleep)	Synchronous delta waves, some K-complexes	Reduced HR & RR
REM sleep (paradoxical sleep)	Desynchronization with faster frequencies	HR, BP & RR irregular Marked hypotonia Rapid eye movement 50 – 60 /min. Dreaming threshold of arousal

Work sheet :

1-What is EEG and what is montage?

- ✓ The electroencephalogram (EEG) is a recording of the electrical activity of the brain from the scalp.
- ✓ Arrangements of electrodes by 10/20% system is known as montage.

2-What is the advantage of provocation test while recording EEG?

- ✓ Provocation test e.g. hyperventilation, intermittent photic stimulation are done to trigger the epileptic focus.

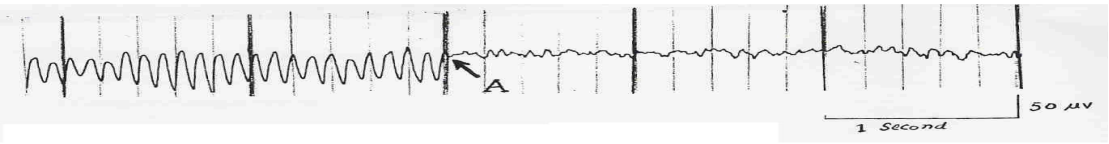
3-Compare & contrast Alpha & Beta waves of EEG?

α	β
In awake resting with eyes closed	**In awake thinking subjects.**
Frequency 8 – 13 Hz	**Frequency - >13Hz. (14 – 30 Hz.)**
Voltage – 50uV	**Voltage – 20uV.**

4-What stage of sleep is indicated by slow waves of EEG(4 – 7Hz.)?

- ✓ 4 – 7 Hz. (Theta) waves are seen during stage 2 & 3 (light and deep) sleep

5-In the following tracing of EEG what changes do you observe after point "A" , What may be it's possible cause?

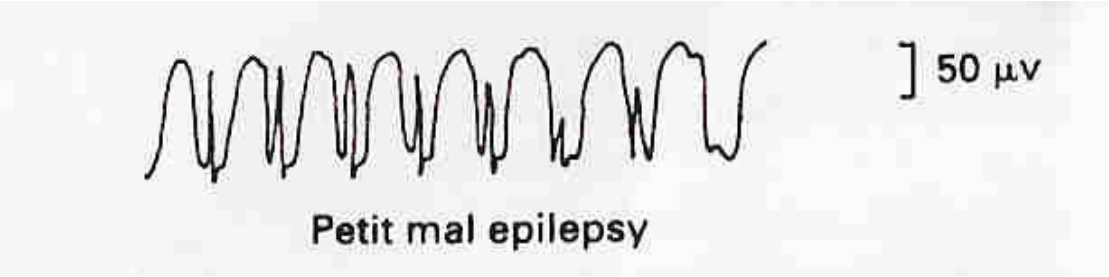


- ✓ Rhythm has changed from α to β(at point "A") , it is called alpha block or desynchronization.

- ✓ **Causes:**
  a) Eyes opening
  b) Thinking
  c) Sound (clapping)

6-What changes are seen in EEG of an epileptic child suffering from absence seizure (petit mal)?

- ✓ In petit mal spike and wave (dome shaped) 3 cps. Pattern is seen



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