University of Diyala/ College of Medicine
Department of Physiology
Physiology Lab

Examination of the Optic Nerve

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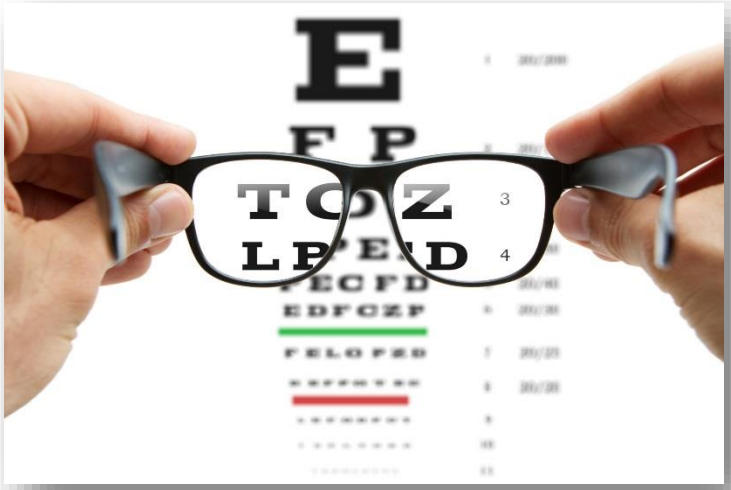


May 9th 2022

Visual Tests

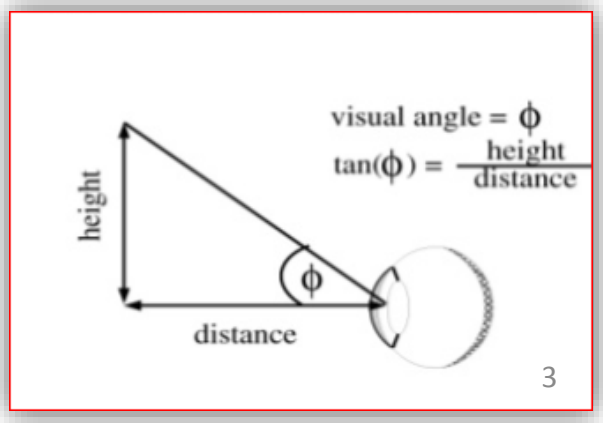
Examination of the optic nerve includes the following:

- Visual acuity
- Eye reflexes
- Visual fields
- Color vision
- Ophthalmoscopy (Funduscopy)

1. Visual Acuity

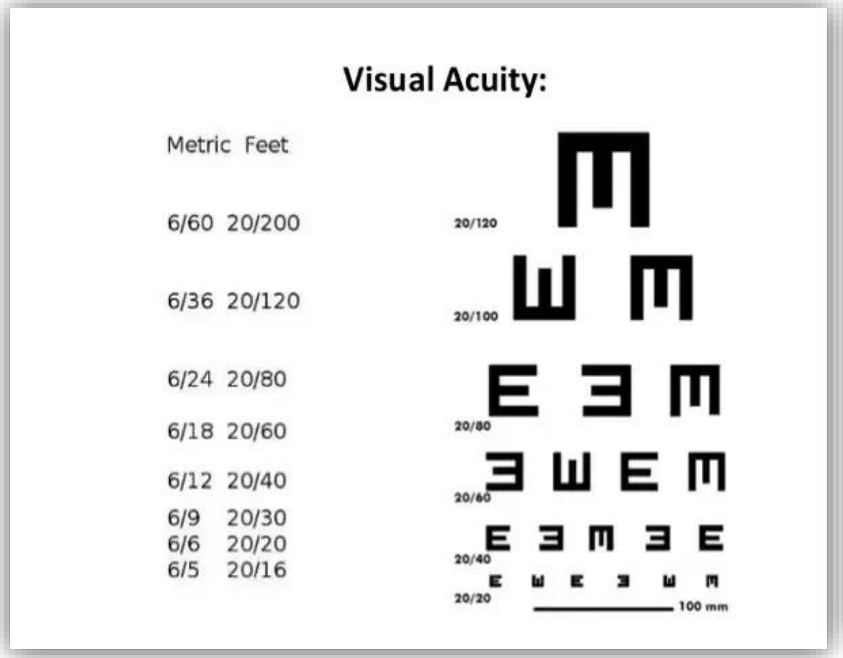
➢ Introduction

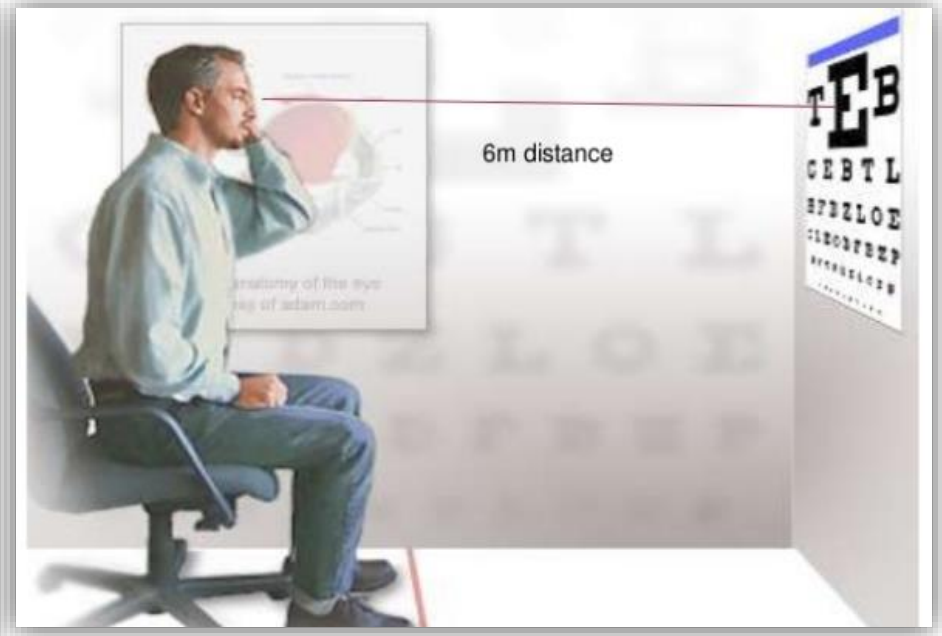
- ***Visual acuity*** is the degree to which the details and contours of objects are perceived. In other words, it is the resolving power of the eye or the ability to see two separate objects as separate.
- Visual acuity is a function not only of the dioptric apparatus of the eye but also of the retain, the nerve pathway, and the central nervous mechanisms.
- The size of the object and the distance between the object and the eye are the main two factors that affect visual acuity.
- Consequently combining these two factors, the most convenient standard to be adopted in visual acuity estimation is the visual angle which is the angle formed by two lines drawn from the extremities of the object through the nodal point of the eye (see figure).



1. Visual Acuity

- Visual acuity should be the first to be tested in any eye examination.
- It is measured by using ***Snellen's test types***, a series of letters of different sizes constructed so that the top letter is visible to the normal eye at 60 meter, and the consequent lines at 36, 24, 18,12, 9, and 6 meters respectively.





1. Visual Acuity

➢ *Examination sequence*

- ✓ Ensure good ambient lighting.
- ✓ Place a Snellen chart 6 meters from the patient (see the figure).
- ✓ Cover one of the patient's eyes with a card and ask him to read from the top down until he can no longer distinguish the letters.
- ✓ Repeat with the other eye.
- ✓ Snellen visual acuity is expressed as ***V=d/D*** where ***V*** is the visual acuity, ***d*** is the distance between the eye and chart (6m), and ***D*** is the distance at which the eye should be capable to read clearly. visual acuity of 6/60 indicates that at 6 meters patients can only see letters they should be able to read 60 meters away.
- ✓ Normal vision is 6/6. In the UK, a visual acuity of 6/12 or better is required for a driving license.

1. Visual Acuity

- ✓ If patients cannot see the top line of the chart at 6 meters, bring them forward till they can and record that vision, e.g. 1/60 – can see top letter at 1 meter.
- ✓ If patients still cannot see the top letter at 1 meter, check whether they can ***count fingers, see hand movements or just see light.***
- ✓ Visual acuity of ***3/60*** is regarded as ***legal blindness***.
- ✓ If a person is wearing glasses we will do the test with and without them. Visual acuity for near vision is tested by using standard reading charts such as (Jaegar card). with the patient wearing any reading glasses. Use a test card, held at a comfortable reading distance, to assess near vision. For more details see:

  https://www.youtube.com/watch?v=dihv9iaZUUM
- ✓ For children who can't yet read, use different-sized objects instead of letters (kindergarten chart).

2. Eye Reflexes

In order to function efficiently, eyes must be able to adapt rapidly to changes in the visual environment such as changes in lighting and changes in distance. These functions are performed through number of eye reflexes.

Eye Reflexes

- **Pupillary reaction to light reflex**
- **Accommodation reflex**
- **Corneal reflex**

Pupillary Reflexes

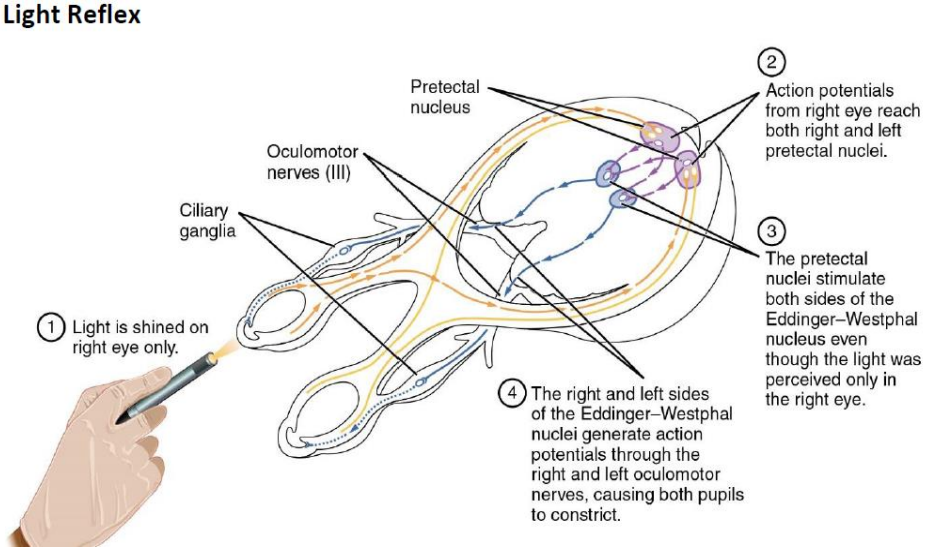
- **Pupillary reflexes** include both of light reflex (direct and indirect (consensual)) and accommodation reflex.
- Pupils modulate amount of light entering eye (like shutter on camera). While they dilate in a dark conditions, the pupils constrict under a bright light.

•Pupils respond to input from either eye.

- ***Direct response***=constriction in response to direct light
- ***Consensual response***=constriction in response to light shined on the opposite eye

- ***Technique:***

- Ask the patient to fix his eyes on a distant point straight ahead.
- Bring a bright torchlight from the side to shine on the pupil.
- Look for constriction of that pupil (direct light reflex).
- Repeat and look for constriction of the opposite pupil (consensual light reflex).



Pupillary Reflexes

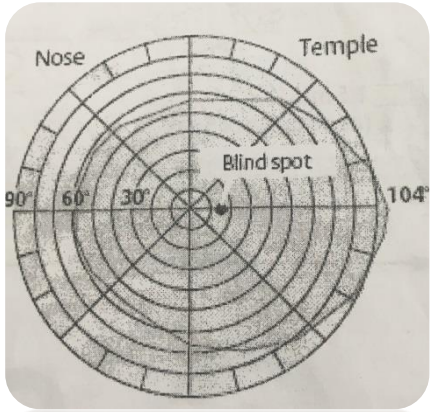
- The afferent limb of the reflex is the ***optic nerve*** and tract. These fibers terminate in the midbrain (pretectal nucleus).
- The efferent limb of the reflex is the ***oculomotor nerve*** that innervates the constrictor muscle of the iris causing constriction of the pupils on both sides.

- ***Abnormalities:*** Impairment or absence of the pupillary reaction could be due to a damage to either afferent or efferent pathway.
  - With afferent pupillary defect; pupil does not have a direct light reflex but constricts when light is shone into the opposite eye (consensual light is preserved).
  - With efferent pupillary defect; one pupil is fixed , dilated , and does not respond to the light directly but the contralateral pupil responds consensually.

  - ***Accommodation Reflex*** is tested by asking the subject first to focus on a far object and then (quickly) at a near object held close to his/her face (at a distance of 10 cm) . Normally there is a convergence of the eyes accompanied by pupillary constriction, this is called accommodation reflex.

3. Visual Fields

- When we look at an object, a number of other objects in the neighborhood , more or less, are seen. ***The full extent of the area that visualized by an immobile eye with the head fixed is called visual field.***
- Visual field is limited by the nose, cheek, and orbit.
- During visual field examination, we are assessing the function of the peripheral and central retina, optic pathways, and visual cortex.
- ***There are two ways for visual field assessment:***
  - Confrontation method (a quick method)
  - Perimeter (an accurate method)
- The extent of the average visual field is : 104° outwards, 50° upwards, 70° inwards and upwards whilst down and in it reaches 45-50°. Fixation is the very center of a patient's visual field. The physiological blind spot is located 15° temporal to the point of visual fixation and represents the optic nerve head.



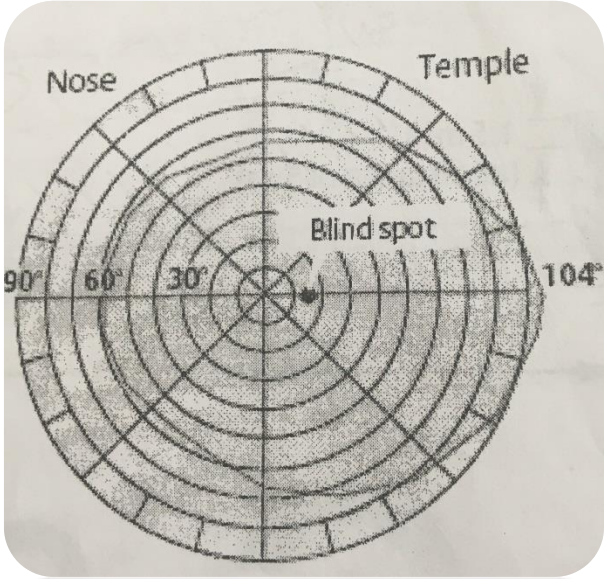
Peripheral Visual Field

➢ ***Confrontation Method***

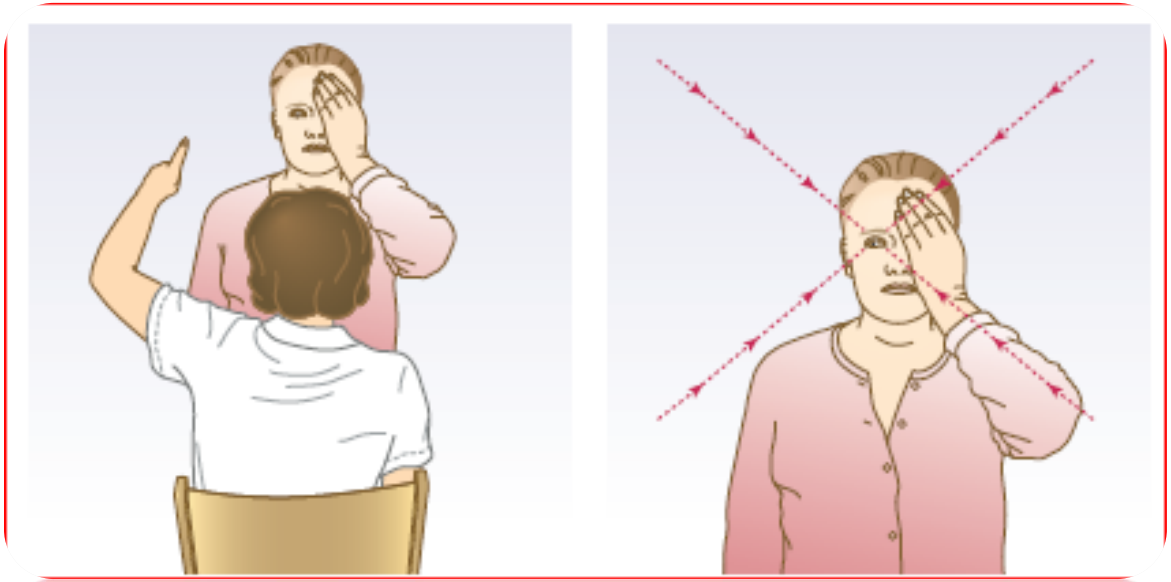
- The examiner's head should be at the same level of subject's head.
- Test each eye separately.
- Ask the patient to cover one eye and look directly into your opposite eye.
- Shut your eye that is opposite the patient's covered eye.
- Test each quadrant separately with a wiggling finger or white-tipped hatpin. Hold the target equidistant between you and the patient.
- Start peripherally and move the target along the diagonal towards the center of vision until the patient detects it.
- Repeat for the other quadrants.
- Compare your visual field with the patient's visual field.

Visual Field

A



B



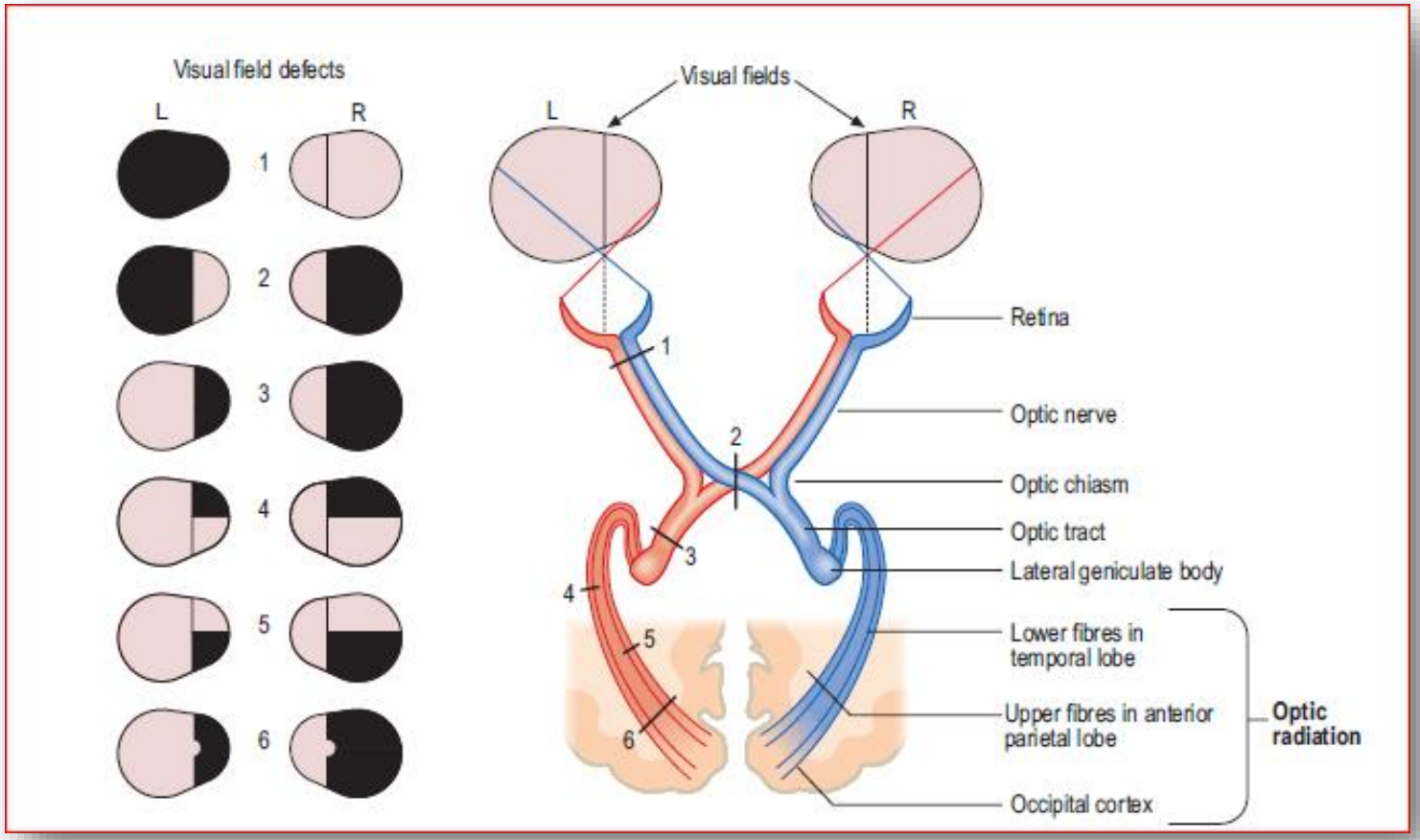
A. Visual field of the right eye.
B. Testing the visual field by confrontation.

Blind Spot

This is a physiological scotoma corresponding to absence of photoreceptors where the optic nerve leaves the eye.

- Test one eye at a time.
- Ask the patient to cover one eye and look directly at you.
- Shut your eye that is opposite the patient's covered eye.
- Hold the red hatpin at the fixation point; you and the patient focus on each other's eye.
- Move the hatpin temporally and horizontally until it disappears from your visual field. Maintaining the same temporal horizontal position, move it anteriorly or posteriorly until it also disappears from the patient's visual field.
- Compare the size of the patient's blind spot to yours.

Visual Field Defects

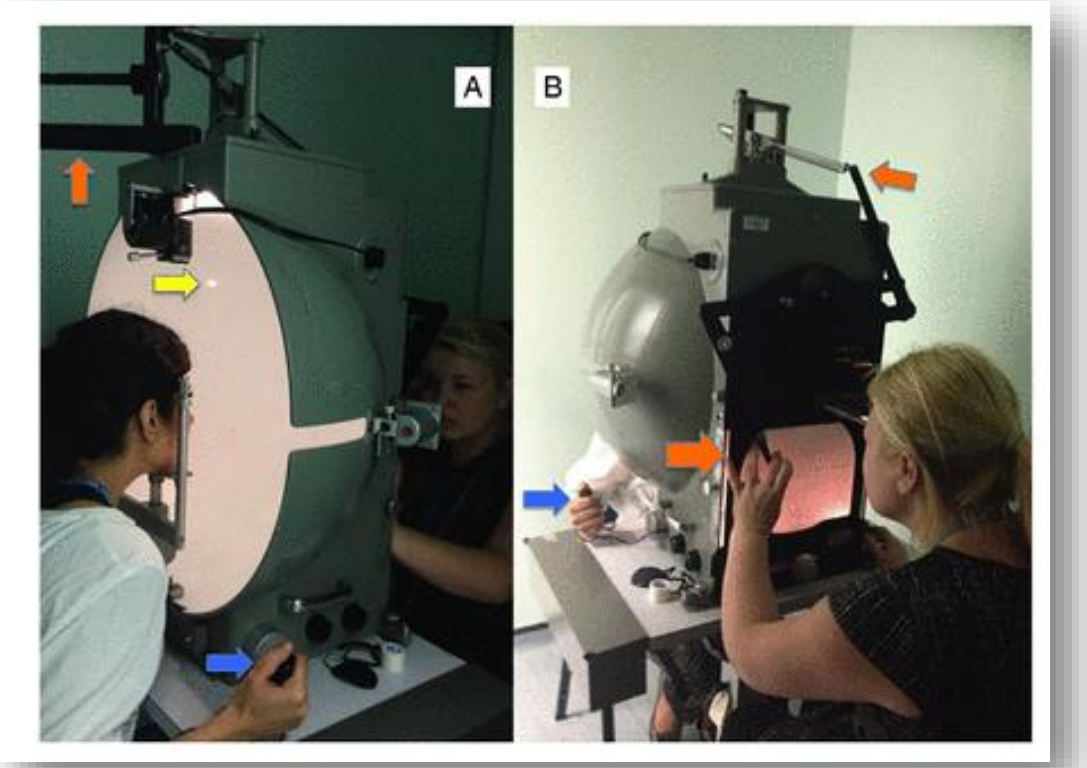


Visual field defects : ***(1) Total loss of vision*** in one eye because of a lesion of the optic nerve. ***(2) Bitemporal hemianopia*** due to compression of the optic chiasm. ***(3) Right homonymous hemianopia*** from a lesion of the optic tract. ***(4) Upper right quadrantanopia*** from a lesion of the lower fibers of the optic radiation in the temporal lobe. ***(5) Lower quadrantanopia*** from a lesion of the upper fibers of the optic radiation in the anterior part of the parietal lobe. ***(6) Right homonymous hemianopia with sparing of the macula*** due to lesion of the optic radiation in the occipital lobe.

Perimetery

- ***Perimetry:*** is one way to systematically test the visual field. Perimetry more carefully maps and quantifies the visual field, especially at the extreme periphery of the visual field.
- ***Procedure:*** During the test, the patient positions their eye opposite the center of a white hemispherical bowl . The patient fixates upon the central target 33 cm away, while the examiner sits opposite viewing through an eyepiece to ensure good fixation throughout the test. The examiner moves an illuminated white target from the periphery towards the center, and the patient presses a buzzer to indicate when they first see the target. This is repeated from different directions—allowing the examiner to plot the patient's field of vision—using targets varying in size and brightness. The examiner plots the blind spot and the edges of scotomas in a similar way, with the patient pressing the buzzer to indicate when they first see the light target moving from a blind to a seeing area.

Perimetery



Goldmann Perimeter: The patient's eye is positioned at the center of a white hemispheric bowl, with the examiner looking through an eyepiece to ensure good fixation. A white light (indicated by yellow arrow in (A) is brought in from the periphery into the patient's field of vision. The examiner does this by controlling connecting levers (indicated by orange arrows in A and B). The patient presses a buzzer when the light target is seen (blue arrow).

https://www.youtube.com/watch?v=SHC0z6iJOnA

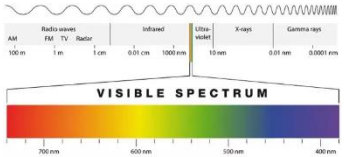
4. Color Vision

➢ ***Introduction***

- Light is defined as that part of the electromagnetic spectrum (400-700 nm) that readily stimulates human retinal receptors.
- The cones mediate color vision and in order to get stimulated, they require a greater intensity of light than the rods.
- The most accepted theory of color vision is that of Young-Helmholtz. At its most basic, ***the Young-Helmholtz theory states that within your eye are tiny cells that can receive waves of light and translate them into one of three colors: blue, green, and red.*** These three colors can then be combined to create the entire visible spectrum of light as we see it.
- **Color sense** is most easily tested using **Ishihara** chart which is a series of plates designed to provide a test that gives a quick and accurate assessment of color vision deficiency.
- **Ishihara chart** is used to **detect only disorders of red and green cones.** Blue cones needs a special chart.

4. Color Vision

- A color defective subject is one whose powers of discrimination between lights of different wavelength are more limited than normal. The most common anomalies are various types of red-green deficiency which is inherited as sex-linked recessive disorders. People with blue-yellow deficiency and with total color defects are rare.



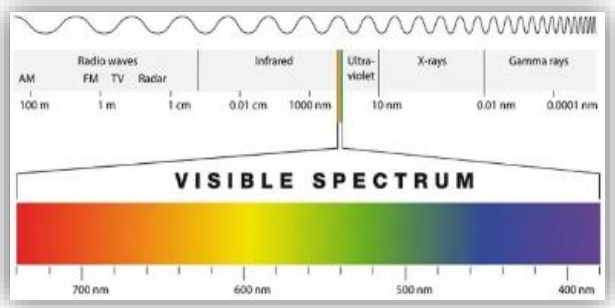
- **There are three types of color vision disorder:**
- ***Protonopes*** **:**In **protanopia**, also called "**red weakness**“, the cone cells sensitive to red light are absent. A protanope is able to see blue, short wavelengths, but as light waves approach green in the spectrum, the perception becomes gray, and longer wavelengths, normally red, are seen as yellows. Partial loss of red cones is called (**protanomalia**).
- ***Deuteranopes:*** In **deuteranopia** the perception of color is very similar to what a person with protanopia sees. In this type, also called "**green weakness**“, cone cells sensitive to green light are absent. Partial loss of green cones is called (**deuteranomalia**).
- ***Tritanopes:*** **tritanopia**, also known as blue-yellow deficiency, results from the absence of cones that are sensitive to blue light. A tritanope sees shades of green at short (normally blue) and middle wavelengths and can normally detect red at the longer wavelengths. Partial loss of blue cones is called (**tritanomalia**).


Normal Colour Vision


Protanopia


Deuteranopia


Tritanopia

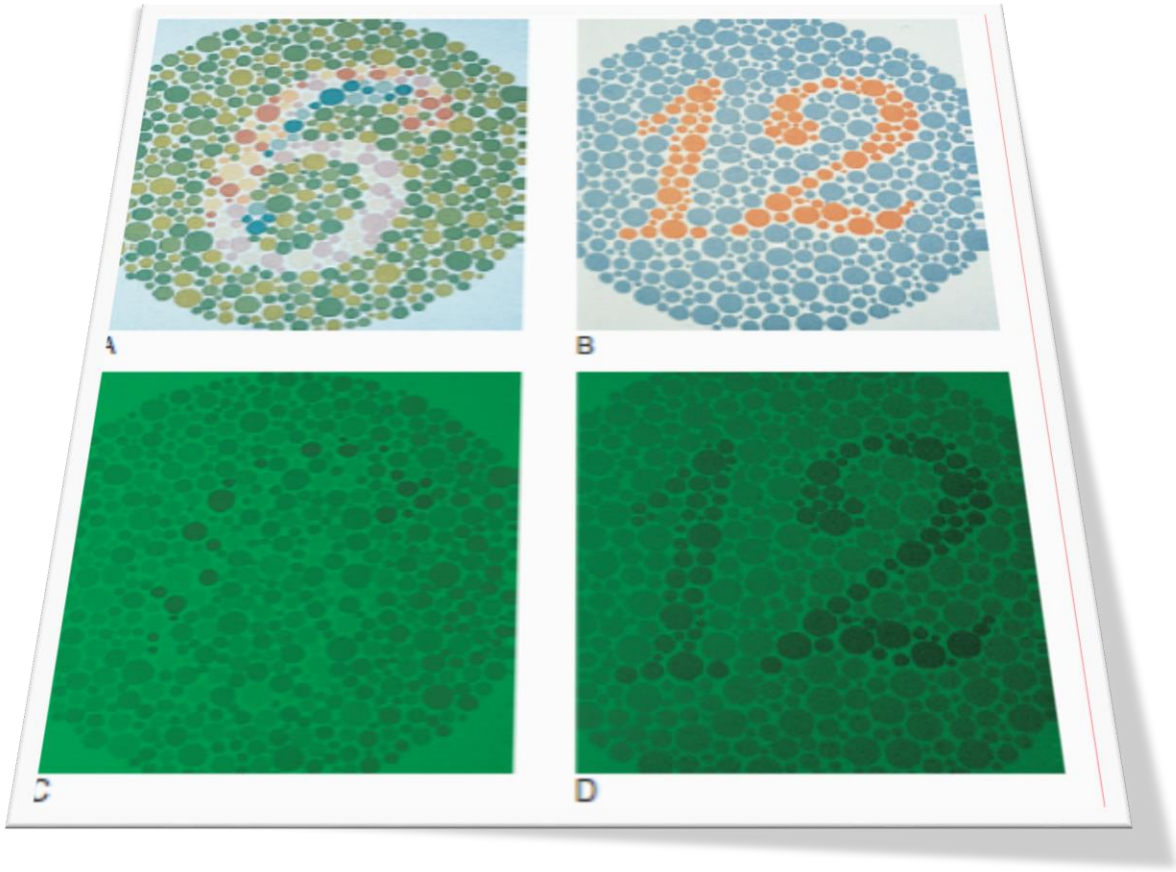

Radio waves
AM
FM
TV
Radar
Infrared
Ultra-violet
X-rays
Gamma rays
100 m
1 m
1 cm
0.01 cm
1000 nm
10 nm
0.01 nm
0.0001 nm
VISIBLE SPECTRUM
700 nm
600 nm
500 nm
400 nm

Color Vision Tests

- Ishihara chart plates are designed to be readable correctly in a day light. Direct sun light or electric light may produce some discrepancy in the results due to an alteration in the appearance of shades of color.
- The plates should be held 75cm from the subject and tilted so that the plain of the paper (plate) is at right angle to the line of vision.
- The correct key of each plate is indicated by a number printed on the ground of the plate.
- The numbers seen on plates 1-17 should be detected within 3 seconds. If the subject is unable to read them, then plates 18-24 are used and the winding lines between two points should be traced with a brush. Each trace should be completed within 10 sec.
- It is unnecessary to use all plates. The test can be simplified to be using 6 plates only:

1. One of number 1.
2. one of numbers 2 or 3.
3. One of numbers 4,5,6,or 7.
4. One of numbers 8 or 9.
5. One of numbers 10,11,12, or 13.
6. One of numbers 14 or 15.

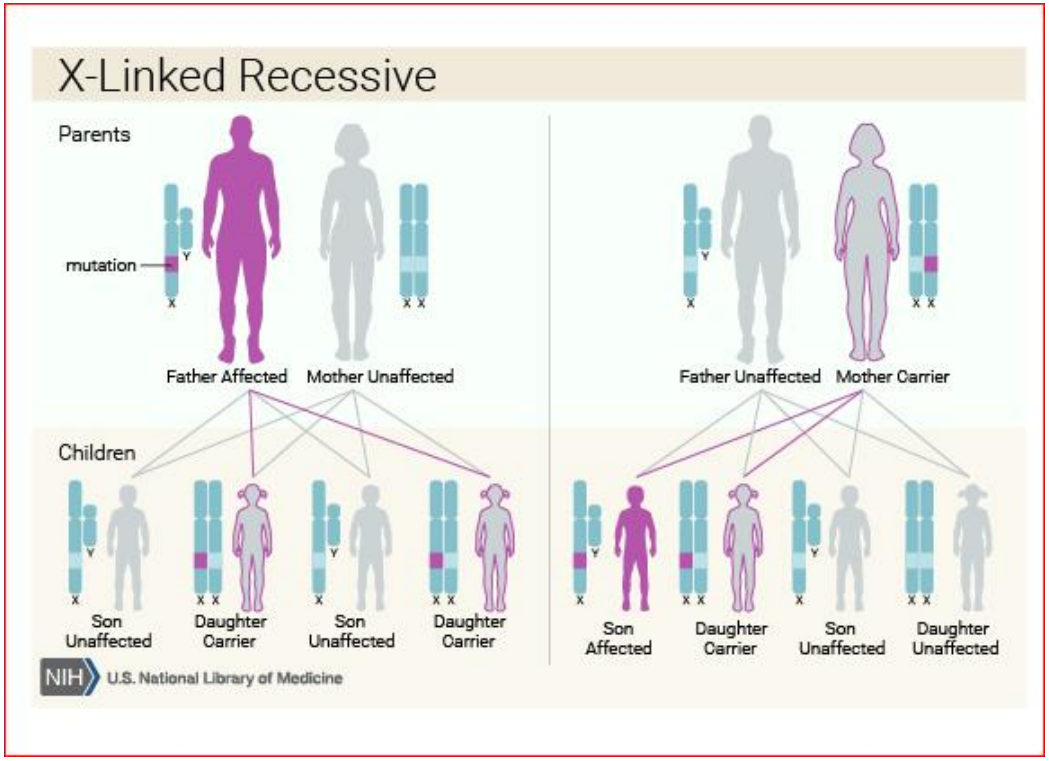
Color Vision Tests



Plates from the Ishihara series. (A and B) Normal colour vision. (C and D) The plates as they appear to someone with colour blindness. The person is unable to read ‘6’ in plate A, and can just read ‘12’ in plate B.

Color Vision

Red-green color vision defects and blue cone monochromacy are inherited in an X-linked recessive pattern. The genes responsible for the condition are located on the X chromosome , which is one of the two sex chromosomes . In males (who have only one X chromosome), one genetic change in each cell is sufficient to cause the condition. Males are affected by X-linked recessive disorders much more frequently (8%) than females (0.4%) because in females (who have two X chromosomes), a genetic change would have to occur on both copies of the chromosome to cause the disorder. A characteristic of X-linked inheritance is that **fathers cannot pass X-linked traits to their sons.**



5. Ophthalmoscopy

- Ophthalmoscopic examination is primarily a mean for investigating the state of the interior of the eye and detecting opacities of ocular media. Apart from obtaining information of local affection, the examination can be of a great help in diagnosing certain disease of the vascular and nervous system.
- The ophthalmoscope consists of :

- A cylindrical base which houses the dry batteries.
- Electrical bulb.
- Series of lenses.
- A plane mirror.

- ***How ophthalmoscope works?***

Basically, the ophthalmoscope is a strong light that can be directed into the subject's eye by reflection from a small plane mirror. The light is then reflected from the fundus of the subject eye back through a small aperture in the ophthalmoscope to the examiner's eye. There are 2 sets of lenses: convex (plus) and concave (minus) which can be moved into the aperture (by rotating the lens wheel) to correct any refractory error in the subject's or examiner's eye to bring the details of the interior of the eye into focus.

5. Ophthalmoscopy

Procedure

1. Examine the eye undilated first to see the pupils and iris; then, ideally, examine the eye dilated using tropicamide drops, to visualize the lens, vitreous and retina.
2. In a dark room, let the subject sits down while you are (the examiner) standing.
3. Ask the subject to fix his eye at a certain point.
4. Hold the ophthalmoscope in your right hand and use your right eye to examine the patient's right eye. Hold the ophthalmoscope in your left hand and examine the patient's left eye with your left eye .
5. The viewing aperture of the ophthalmoscope should be positioned as close as possible to both subject's and examiner's eyes .
6. the ophthalmoscope should be steadied against the side of the nose and supra-orbital margin.
7. Find '0' and then rotate the 'lenses' clockwise until you obtain the number 10 (plus '10'). This should be the same color as the '1' clockwise to '0'. If not, you have gone too far.
8. Place your free hand on the patient's forehead and ask the patient to look down. Catch the upper eyelid and gently retract it against the orbital rim. Holding the eyelid against the brow enables you to approach the patient's head as closely as possible without bumping into it, and prevents the upper eyelid from obscuring your view.
9. From a distance of about 10 cm bring the red reflex into focus. In this way the cornea, iris and lens can be visualized and any opacity appears black against this red background.
10. Now come close to the patient's head so that you are touching the hand you are resting on the patient's forehead.

5. Ophthalmoscopy

Procedure

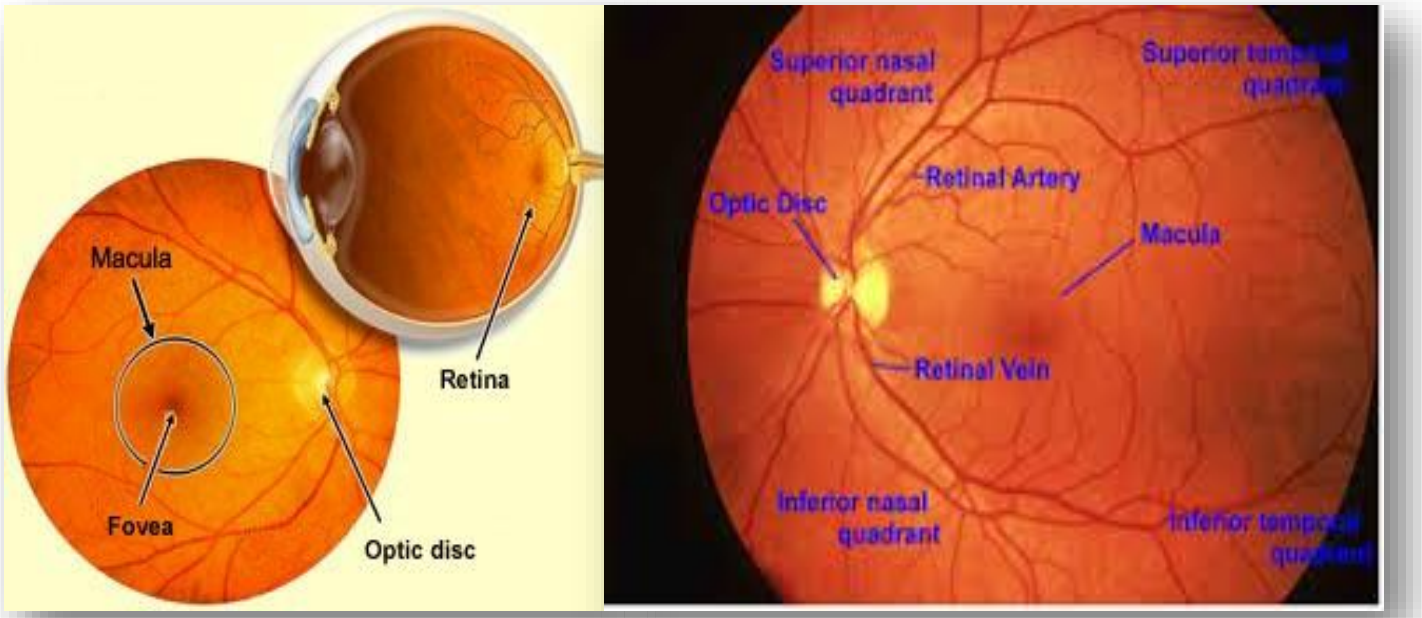
11. With fine manipulation of the ophthalmoscope you can now see the blood vessels of the retina. If you follow the course of the blood vessels towards the center, it will lead you to the optic disc (shape, color, edge, and cup).
12. Do not take more than few seconds over any single attempt, you can repeat the examination after a short interval of rest.
13. Do not forget to turn the light off during the rest interval.

Ophthalmoscopy: correct method. The patient's gaze is fixed on a distant point

5. Ophthalmoscopy

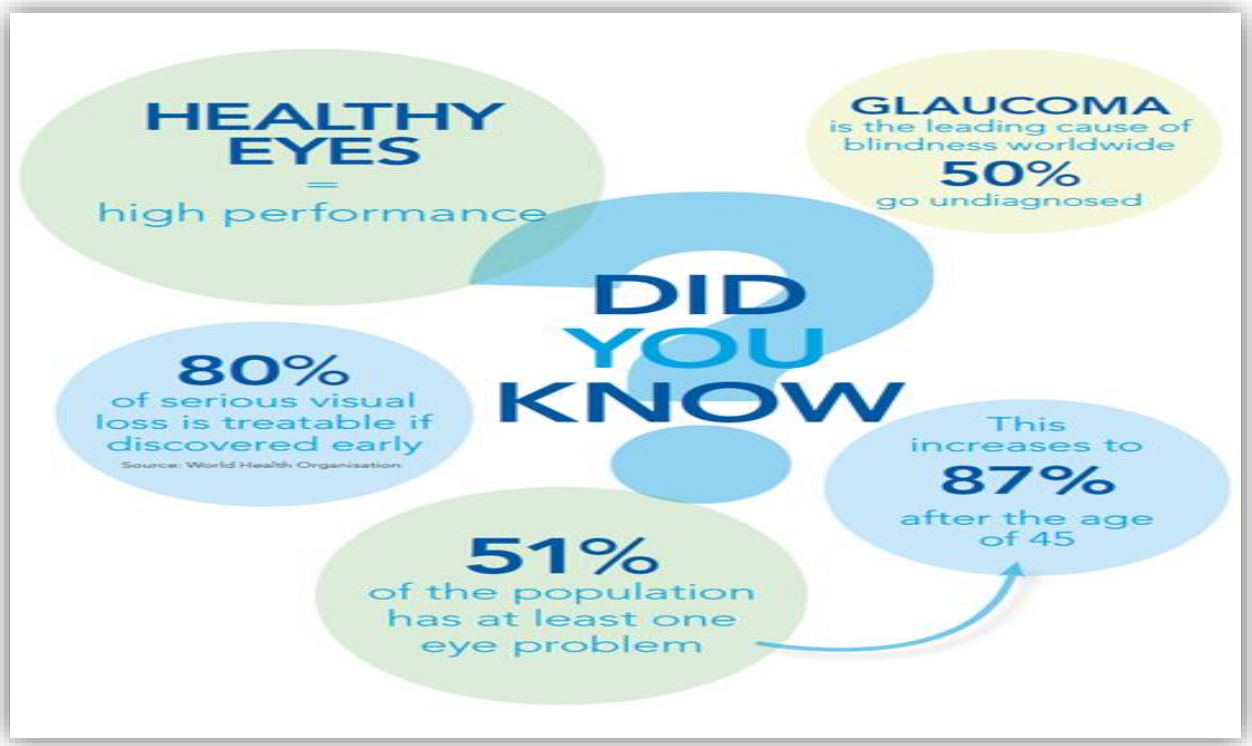
Results of examination:

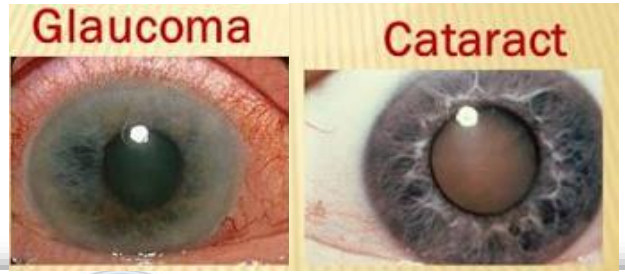
Optic disc is normally circular and some times may looks oval. Its color is paler than the rest of the fundus and the nasal part usually looks redder than the rest. The edge should be clear and well defined . The retinal arteries could be distinguished from the veins : they (arteries) are smaller in diameter than veins (2/3 of the veins diameter), arteries do not pulsate while the veins do, the arteries are bright red in color.

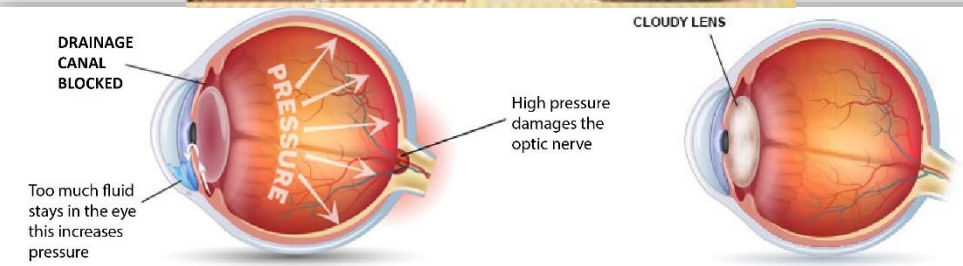


References

1. Macleod's Clinical Diagnosis/book.
2. http://www.authorstream.com/Presentation/optometrist.pal-472784-distance-visual-acuity/







GLAUCOMA VS. CATARACTS

- Optic Nerve Is Damaged
- Sometimes Related To Aging
- Symptoms Are Hard To Detect

Glaucoma is an eye disorder that damages the optic nerve that carries information from the eye to the brain.

It typically relates to high pressure built up inside the eye, commonly known as Ocular Hypertension. **When the optic nerve is damaged, there is no communication between the eye and the brain resulting in Glaucoma.**

Unfortunately, most people notice glaucoma signs and symptoms when the disease has progressed and they have irreversible vision loss and may suffer with permanent blindness. The first signs of glaucoma are critical to keep an eye out for.

- Lens Becomes Clouded
- Due To Age
- Symptoms Are Slow To Develop

When it comes to Cataracts, they can take many years to fully develop.

Usually it affects a small part of the eye to start and slowly clumps up around the entirety of the lens. As this protein that our eye lens are made up begins to clump, it distorts the light that passes through and ultimately damages vision.

This results in dim, cloudy and blurry vision that gets worse over time. Cataracts can occur in both eyes or just one.