



Refractive error

Refractive error

In the emmetropic (normally refracted) eye, entering light rays are focused on the retina by the cornea and the lens, creating a sharp image that is transmitted to the brain. The lens is elastic, more so in younger people. During accommodation, the ciliary muscles adjust lens shape to properly focus images. Refractive errors are failure of the eye to focus images sharply on the retina, causing blurred vision.

PRPPERTIES OF LIGHT

1-Light travel in a straight line as a ray and a set of rays form beam of light

2-Get reflection when it travel in a medium is incident on another medium part of the light sent back in to the first medium this called reflection and the surface which separate between the two media called reflecting surface .which may be smooth and get regular reflection or hard and get irregular (scattering) reflection .

PRPPERTIES OF LIGHT

3-Get refracted when the beam travelling in one medium enters another there is deviation (bending) in the path which arise due to difference in the speed of light at two media . (**refractive index**) is the ratio of speed of light in air to the speed of light in the medium . (speed of light in air 180,000)

PRPPERTIES OF LIGHT

4-Scattering particle of dust .moisture ,scratches on mirror on mirror or lens surface cause scattering (irregular reflection) which lead to loss of brightness

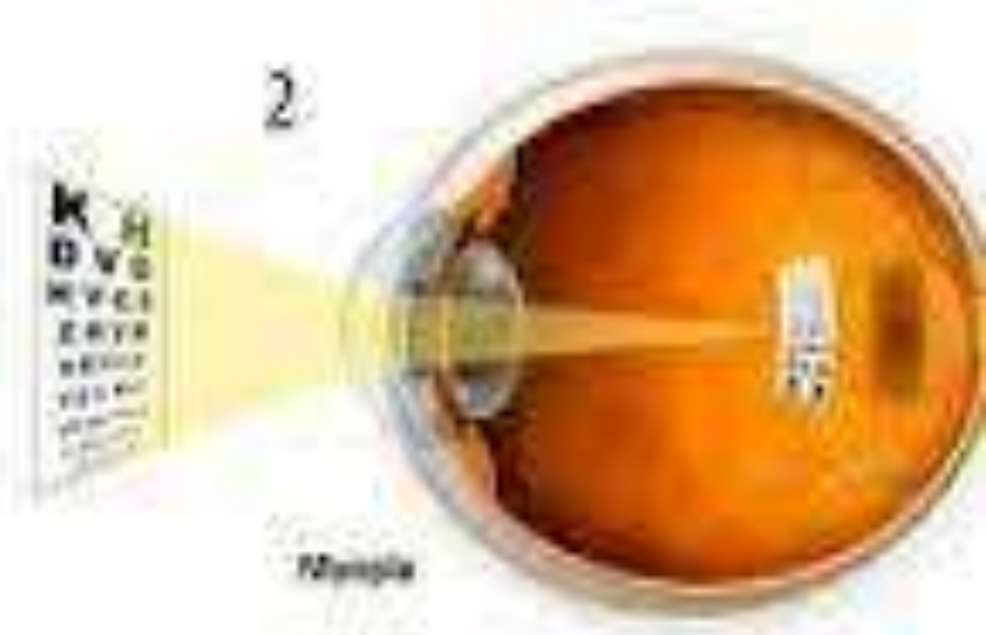
5-Interference light wave of same wave length from deferent sources undergo interference -

1



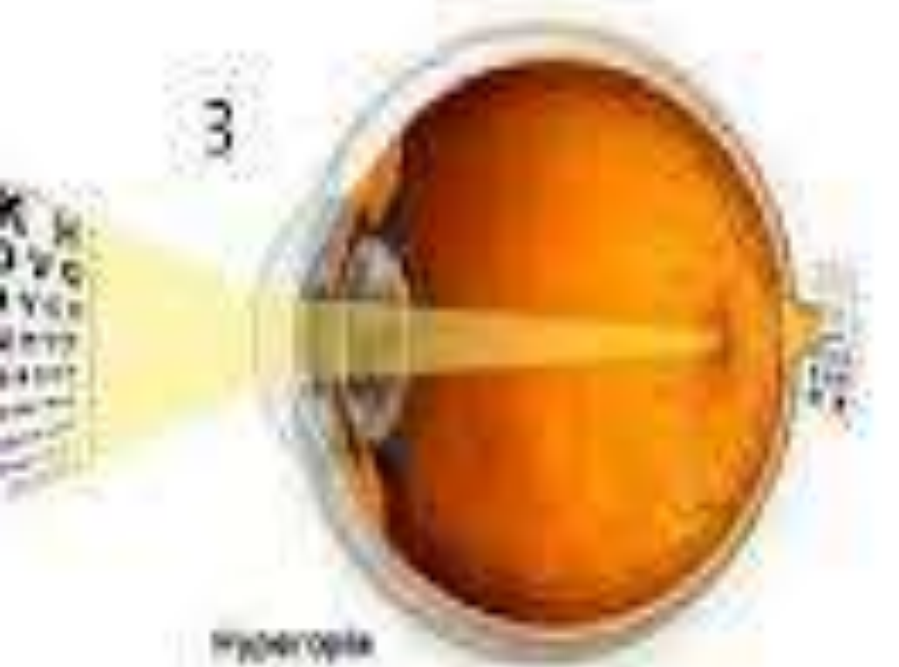
Normal

2



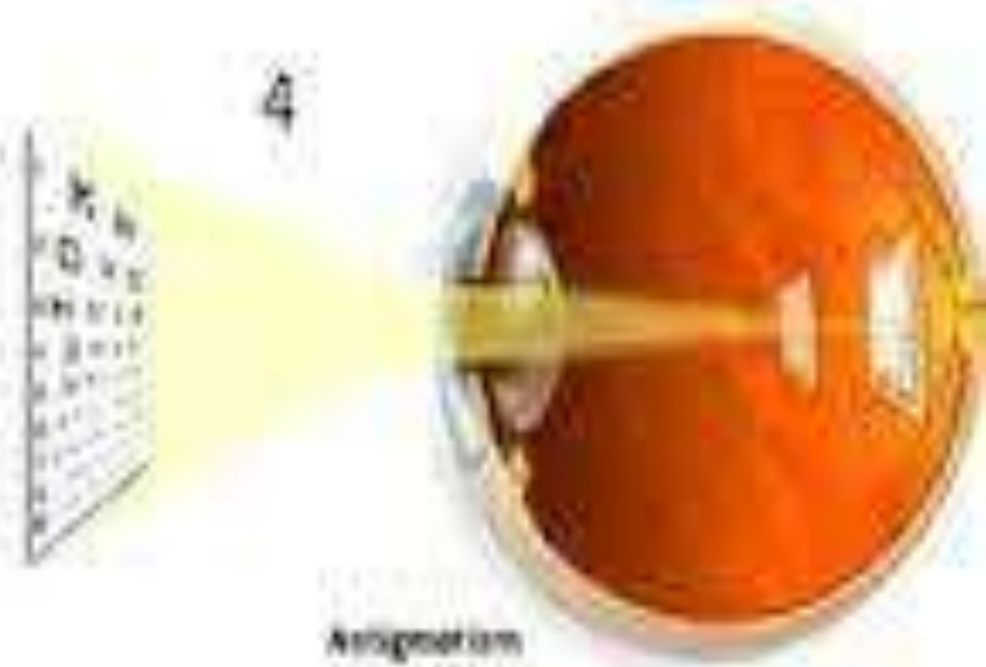
Myopia

3



Hyperopia

4



Astigmatism

myopia (nearsightedness) :-

the point of focus is in front of the retina because □ the cornea is too steeply curved, the axial length of the eye is too long, or both. Distant objects are blurred, but near objects can be seen clearly . To correct myopia, a concave (minus) lens is used. Myopic refractive errors in children frequently increase until the child stops growing

hyperopia (farsightedness) :-

the point of focus is behind the retina because the □ cornea is too flatly curved, the axial length is too short, or both. In adults, both near and distant objects are blurred. Children and young adults with mild hyperopia may be able to see clearly because of their ability to accommodate. To correct hyperopia, a convex (plus) lens is used.

Astigmatism :-

non spherical (variable) curvature of the cornea or lens causes light rays of different orientations (eg, vertical, oblique, horizontal) to focus at different points. To correct astigmatism, a cylindrical lens (a segment cut from a cylinder) is used. Cylindric lenses have no refractive power along one axis and are concave or convex along the other axis. □

Presbyopia :-

is loss of the lens 'ability to change shape to focus on near objects due to aging. Typically, presbyopia becomes noticeable by the time a person reaches the early or mid 40s. □



Visual acuity

Indications

- To provide a baseline recording of VA
- To aid examination and diagnosis of eye disease or refractive error
- To assess any changes in vision
- To measure the outcomes of cataract or other surgery.

Visual acuity



Visual acuity (VA) is a measure of the ability of the eye to distinguish shapes and the details of objects at a given distance. It is important to assess VA in a consistent way in order to detect any changes in vision. One eye is tested at a time.

Equipment



- Multi-letter Snellen or E chart
- Plain occluder, card or tissue
- Pinhole occluder
- Torch or flashlight
- Patient's documentation.

Procedure

- ☐ Ensure good natural light or illumination on the chart. It is important to ensure that the person has the best possible chance of seeing and reading the test chart as treatment decisions are made based on the results of VA testing.
- If the test is done outdoors, the chart should be in bright light and the patient in the shade, with enough light to illuminate the patient's face during the test.

Procedure

- Explain the procedure to the patient. Tell patients that it is not a test that they have to pass, but a test to help us know how their eyes are working. Tell them not to guess if they cannot see. □
- Ensure that any equipment that the patient touches is clean and is cleaned between patients. Infections can be passed between patients if equipment – or the testers' hands – are not clean. □

Procedure

Position the patient, sitting or standing, at a distance of 6 meters from the chart. The patient can hold one end of a cord or rope of 6 meters long to ensure that the distance is maintained □

- Test the right eyes at first time then left eye .
- Ask the patient to cover one eye with a plain occluder, card or tissue. They should not press on the eye; this is not good for an eye that has undergone surgery. It can also make any subsequent intraocular pressure reading inaccurate and it will distort vision when the occluded eye is tested.

Procedure

- Ask the patient to read from the top of the chart and from left to right. If the patient cannot read the letters due to language difficulties, use an E chart. The patient is asked to point in the direction the 'legs' of the E are facing.
- The smallest line read is expressed as a fraction, e.g. 6/18. The upper number refers to the distance the chart is from the patient (6 meters) and the lower number (usually written next to the line on the chart) is the distance in meters at which a 'normal' eye is able to read that line of the chart.

Procedure

- Incomplete lines can be added to the last complete line.
e.g. 6/12+3, indicating that the patient read the '12' line at 6 meters and gained three of the letters on the '9' line.
- Record the VA for each eye in the patient's notes, stating whether it is with or without correction (spectacles).
For example: Right VA = 6/18 with correction, Left VA= 6/24 with correction.



Procedure

- If the patient cannot read the largest (top) letter at 6 meters, move him/her closer, 1 meter at a time, until the top letter can be seen – the VA will then be recorded as 5/60 or 4/60, etc.
- If the top letter cannot be read at 1 meter (1/60), hold up your fingers at varying distances of less than 1 meter and check whether the patient can count them. This is recorded as counting fingers (CF): $VA = CF$

Procedure

- After testing without any correction, test the patient while wearing any current distance spectacles and record the VA in each eye separately, with correction.

If 6/6 (normal vision) is not achieved, test one eye at a time at 6 meters using a pinhole occluder (plus any current spectacles). The use of the pinhole reduces the need to focus light entering the eye □

Procedure

- If the patient cannot count fingers, wave your hand and check if he/she can see this. This is recorded as hand movements (HM): $VA = HM$
- If the patient cannot see hand movements, shine a torch toward the eye and ask if they can see the light. If they can, record 'perception of light' ($VA = PL$). If they cannot, record 'no perception of light' ($VA = NPL$).

Procedure

- If the vision improves, it indicates the visual impairment is due to irregularities in the cornea, a problem in the lens, or refractive error, which is correctable with spectacles or a new prescription.
- Repeat the whole procedure for the second eye
- Summarizes the VA of both eyes in the patient's notes, for example:
 - Right VA= 6/18 without specs, 6/6 with pinhole and Left VA= NPL.

Note:

- ----- there is a one in four chance that the patient can guess the direction; therefore it is recommended that the patient should correctly indicate the orientation of most letters of the same size, e.g. four out of five or five out of six.

Note:

- Some people prefer to always test the right eye first. Others prefer to test the ‘worse’ eye first (ask the patient out of which eye they see best). This ensures that the minimum is read with the ‘worse’ eye, and more will be read with the ‘good’ eye. This means that no letters are remembered, which could make the second visual acuity appear better than it is.

Age	Visual milestone
29 Weeks of gestation	Pupillary reaction
Soon after birth	Blinks at light
2 week	Small saccade develops, follows horizontal moving object
2 months	Fixation well developed, develops bifoveal fixation
3 months	Reaches out for objects
4 months	Sensory fusion and accommodation begins to develop
5 months	Meance reflex blink to visual threat
6 months	Accommodation and fusional vergence well developed, stereopsis begins to develop
9 months	Visual differentiation of objects
2 years	Picture matching
3 years	Picture and letter matching
5 years	Stereopsis well developed



Visual Acuity Assessment for infant

Infants

- Fixation.
- Menace Reflex
- Brukner's reflex
- Opto-kinetic nystagmus
- Catford drum test
- Preferential Looking test
- Teller's acuity cards

Fixation.

The fixation normally should be central, steady and maintained (CSM)

Fixation behavior and fixation preference testing can be described using the CSM (Central, Steady and Maintained) notation. Fixation during monocular viewing is described as central (foveal) or non central (eccentric), and steady (stable eye position) or non-steady (roving eye movements or nystagmus). Maintained refers to fixation that is held during binocular viewing after the opposite eye is uncovered during fixation preference testing.

Menace Reflex



- Menace reflex is a reflex blinking that occurs in response to a rapid moving object and visual threat. The reflex develops by 5 months of age.

Bruckner's reflex

- □ Bruckner's reflex can help in rapid screening of the refractive errors. The test is performed in a dark room and both the eyes are illuminated with the direct ophthalmoscope and the reflex is noted at a distance of 1 meter as well as at 3 meter . An inferior crescent suggests myopia, a superior crescent is seen hyperopia. Resistance to occlusion of the eye with good vision also gives an estimation about the visual acuity discrepancies.

Opto-kinetic nystagmus

Opto-kinetic nystagmus is used to objectively determine the visual acuity of the child. A succession of black and white stripes are passed through the patient's visual field. The visual angle subtended by the narrowest width of the strip eliciting an eye movement measures the visual acuity. The visual acuity in the newborn child is at least 6/120 (20/400) by opto-kinetic nystagmus

. □

Opto-kinetic nystagmus

that improves in the first few months of life. □
However, the opto-kinetic nystagmus can be false positive in the patients with cortical blindness as sub-cortical mechanisms have been suggested to be involved in the generation of opto-kinetic nystagmus. The test can be false negative in infants with delayed development of the motor pathways and due to lack of attention

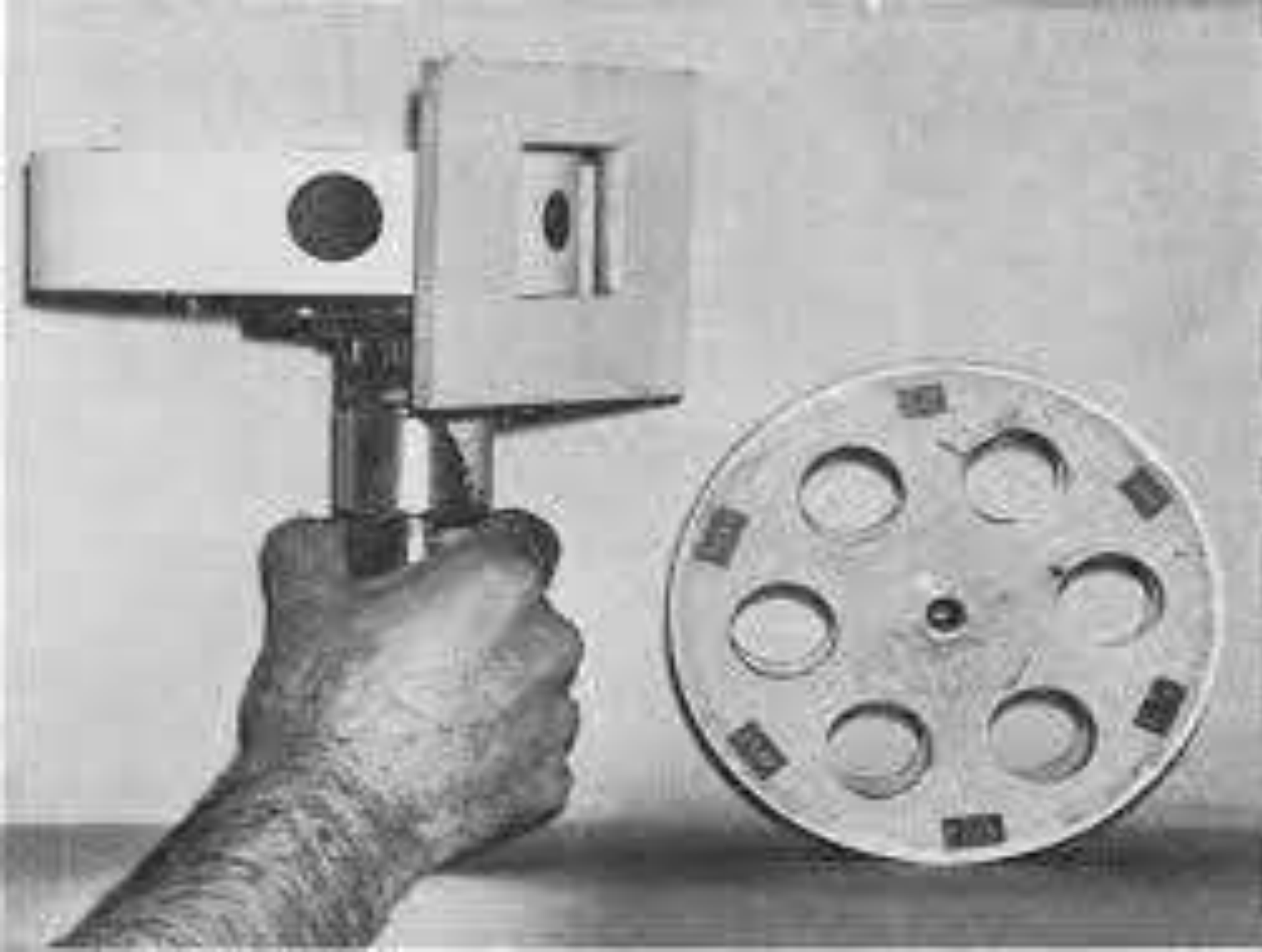


Catford drum test

- Catford drum test was introduced by Olive and Catford. It is an objective method to evaluate the objective visual acuity by inducing optokinetic nystagmus. The motor driven drum consist of separated black dots of various sizes on a white background projected through a screen measuring 4*6 cm. These dots can be rotated from left to right and then back from right to left in a rotating manner

Catford drum test

- instructed to watch the dot. The visual acuity is assessed by reducing the size of the dot until the smallest dot is found that can no longer induce optokinetic nystagmus. The end point is recorded and converted to given Snellen's equivalent. The drum has been calibrated between the visual acuity of 20/20 to 20/600 of Snellen's acuity based on the dot size at 60 cm



Preferential Looking test

- These tests are based on the principle that infant's attention is more attracted by a patterned stimulus as compared to a homogenous surface. Hence, if the infant is given a choice between a pattern and a plain surface the infant prefers towards the patterned surface

Teller's acuity cards

- The Teller's acuity test was first described by Fantz [8] and was further developed by Dobson and Teller. During the test the observer is hidden behind the screen. The screen consists of a homogenous surface on one side and is alternated randomly with black white stripes on the other side. The baby is faced towards the screen and the observer records the direction of head movement and eye movements in response to the patterned stimulus. The test is suitable for testing visual acuity in infants up to 4 months of age as older infants are easily distracted. Visual acuities tested by this method range from 6/240 (20/800) in the newborn to 6/60 (20/200) at 3 months and 6/6 (20/20) at 36 months of age

Teller's acuity cards

- Later Teller's acuity cards were introduced by Mc-Donald et al. Teller's acuity cards contain grating patterns of spatial frequencies. The cards are shown at a distance of 38 cm, an observer watches an infant's eye and head movements in response to repeated presentation of these cards. In children with amblyopia grating acuity is affected, because of which visual acuity can be under-estimated. As a visual screening test Teller cards has a high false positive results





Visual Acuity Assessment for Various Age Groups

1-2 Years

- Worth's Ivory ball test.
- Boeck Candy test

Worth's Ivory ball test.

Claud Worth in 1896 introduced the ivory ball test for the visual acuity assessment of children between 1-3 years of age. There is a set of 5 balls ranging from 0.5 inch to 2.5 inch. The child with both eyes opened is initially made familiar with the balls. One eye is then covered and each ball is then thrown at a distance of 18 feet beginning from the largest and the child is asked to retrieve each of the balls. Visual acuity is assessed by the size of the smallest ball that can be seen by the child.



Boeck Candy test



- In this test the child is shown candy beads of different sizes at a distance of 40 cm. The child is then expected to pick up the candy beads. The smallest bead that the child can pick up gives the approximate estimation of the visual acuity

2-3 years

- Cardiff Acuity test

- Miniature toy test

- Coin test

- Lea symbols

Coin test

Coins of different sizes are shown to the child • □
and is expected to pick up the coins easily visible.

. □



3-5 years

Allen's picture test ☐

Sheridan letter test ☐

Lippman's HOTV test ☐

Tumbling E chart ☐

Snellen's chart ☐

Allen's picture test

- The pre-school vision test or the Allen picture card test consists of seven black and white line drawing of birth day cake, telephone, horseman, teddy bear, automobile, house and tree. These line drawings are drawn on a plastic (10cmx10cm) white cards. The child patient will be shown at a closer distance so that he recognizes and identifies them.





Myopia

Ememetropia



when parallel rays of light coming from infinity are focused in sensitive layer of retina with accommodation being at rest

Ametropia

- .

Parallel ray of light coming from infinity (with accommodation at rest)are focused either in front or behind retina .

Type

- :
- -----Axial length and
- -----AC depth
- -----Corneal curvature
- .

Myopia

Dioptric condition □

in which Myopia or shortsightedness is a type □
of refractive error parallel rays of light coming
from infinity are focused in front of retina
with the accommodation is at rest .

□

Optic myopia

The optical system is too powerful for its axial length distant object on retina is made up of circle of diffusion formed by divergent beam since the parallel rays of light coming from the infinity are focused in front of the retina .

Type of classification

Clinical classification ☐

Age of onset ☐

Degree of myopia ☐

Clinical classification

- 1- Congenital myopia □
- 2- Simple or developmental myopia □
- 3- Pathological myopia □
- 4- Acquired myopia (secondary)which may be □
 - Post traumatic □
 - --Post keratitis □
 - Drug induced □
 - --Night myopia- □

Congenital myopia

--- Since birth □

----Mostly unilateral □

Diagnosed at 2-3 years----- □

Child may develop convergent squint in order to □
preferentially see clear at its far point (10 – 12 cm)

May Associated with cataract ,microphthalmos □
megaloconeia ,congenital separation of retina.,

Simple myopia □

myopia

Developmental myopia – commonest variety □
(school going age 8-12 years)

Axial type (physiological variation in length of eye □
- ball ,powerful neurological growth during
childhood.

-Curvature type (un development of eye ball)- □

Pathological myopia

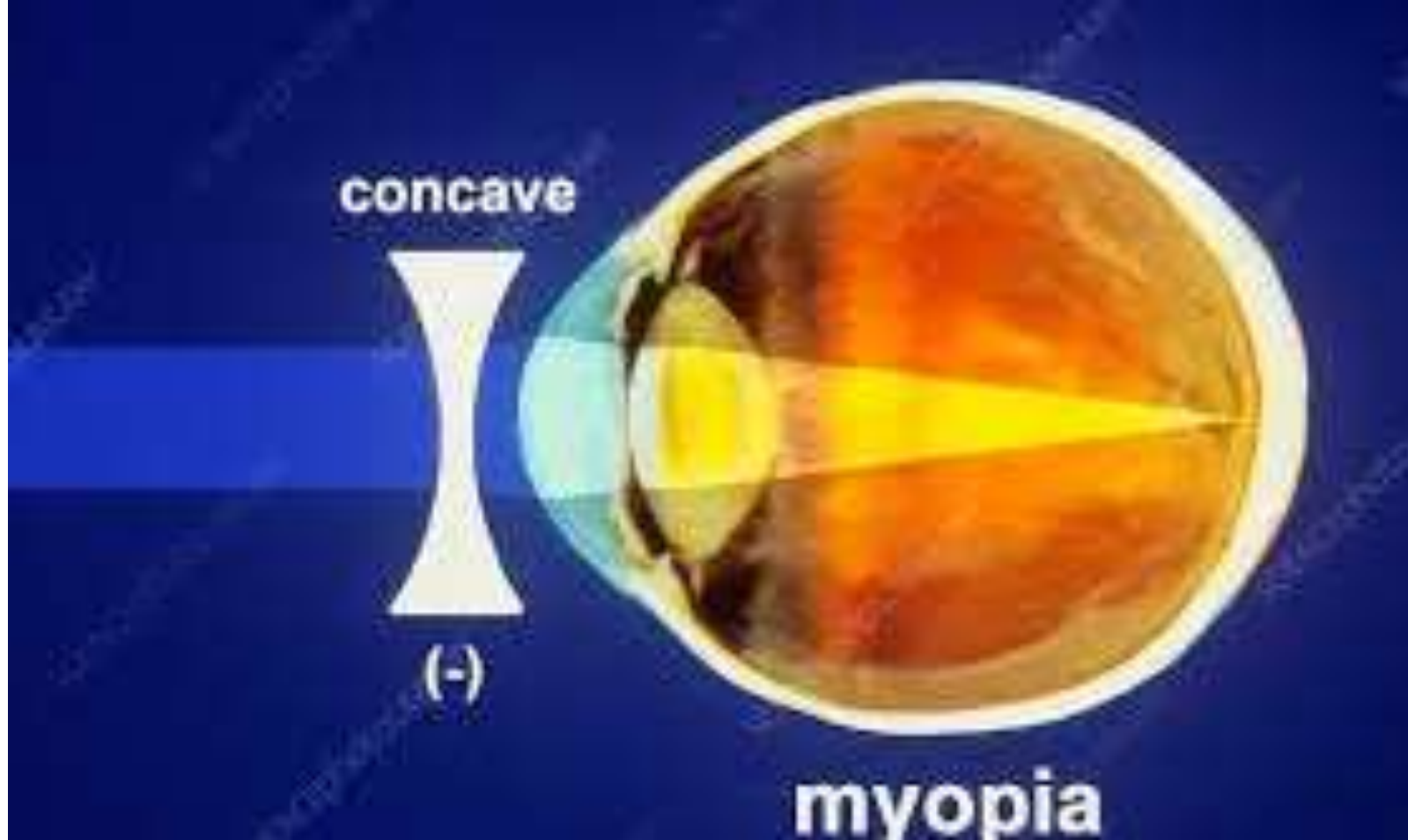
- degenerative or progressive myopia □
- rapidly progressive error which starts in childhood at 5-10 year of age . □

It may be heredity or in some times choroid □ undergo due to stretching degeneration

((lengthening of posterior segment of eye globe □ commences only during the period of active growth and ends with termination of active growth .))

Degree of myopia

: very low -----(up to 1.00 D
low — --- (1.00---3.00)D -
medium - 3.00 ---- 6.00)D- :
high - - (6.00 ---10.00)D - : □
very high 10.00 D -: above □



Correction of myopia

Treatment options for myopia correction include:



Eyeglasses •

Contact Lenses •

Orthokeratology •

LASIK and other vision correction surgery •

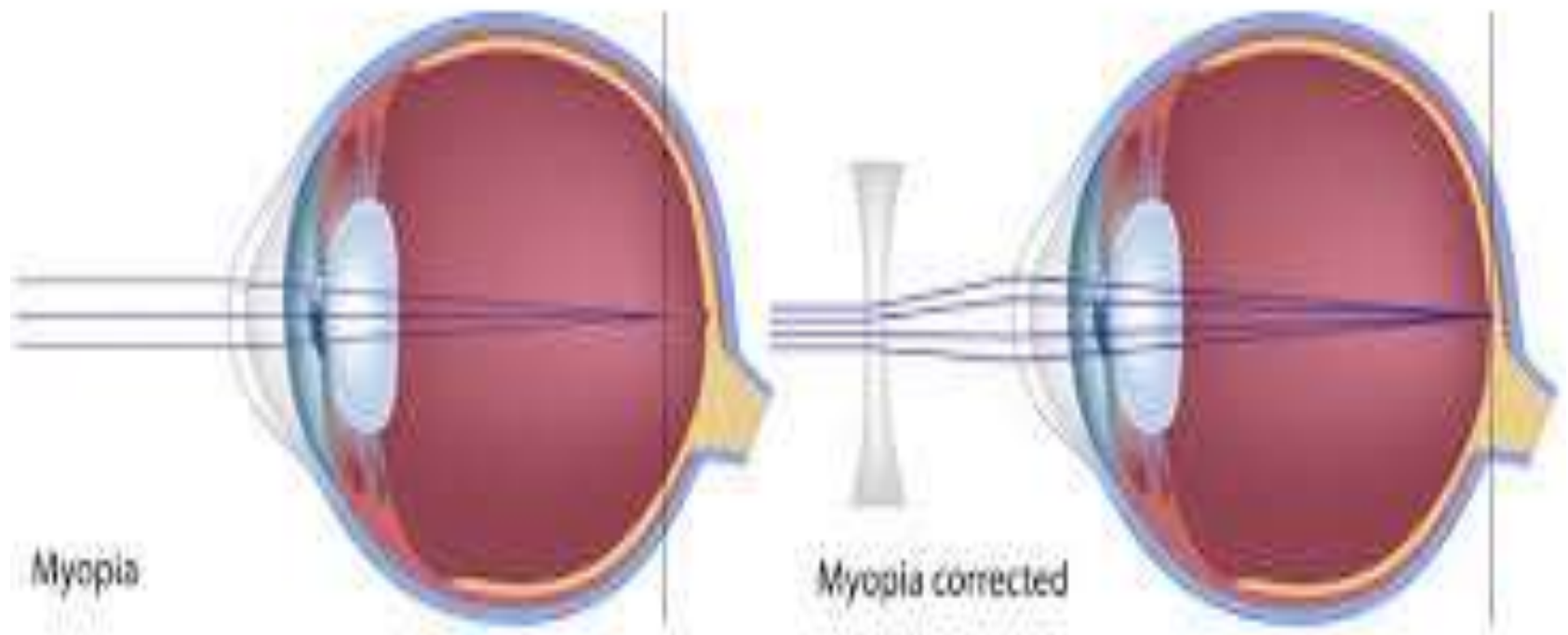
Treatment

Depending on the degree of myopia, we may need □ to wear our glasses or contact lenses all the time or only when we need very clear distance vision, like when driving, seeing a chalkboard or watching a movie.

Treatment

- . For children with progressive nearsightedness, □
there are some effective myopia
control methods available, including
 - atropine eye drops, □
 - myopia control glasses, □
 - myopia control contact lenses. □

Eyeglasses



Orthokeratology

This is the fitting of specially designed □ contact lenses that reshape the cornea of the eye to temporarily correct mild to moderate myopia. Ortho-k lenses are worn only at night during sleep. When the lenses are removed in the morning, the cornea maintains the shape required for clear vision during the day without corrective lenses.

malignant myopia

(also called malignant or pathological myopia) is a relatively rare condition that is believed to be hereditary and usually begins in early childhood

elongation of the eyeball can occur rapidly, leading to a quick and severe progression of myopia and loss of vision

malignant myopia

People with this condition have □
a significantly increased risk of
retinal detachment and other
degenerative changes in the back
of the eye (such as bleeding in the
eye from abnormal blood vessel
growth).

Excimer laser.

In PRK the laser removes a layer of corneal tissue, which flattens the cornea and allows light rays to focus more accurately on the retina.



Excimer laser.

In LASIK — the most common refractive □ procedure — a thin flap is created on the surface of the cornea, a laser removes some corneal tissue, and then the flap is returned to its original position.



Hypermetropia

Hypermetropia

It is refractive state of the eye where □ in parallel rays of light coming from infinity are focused behind the sensitive layer of the retina with accommodation being at rest .

Etiology

1-AXIAL □

2-CURVATURE □

3-POSITIONAL

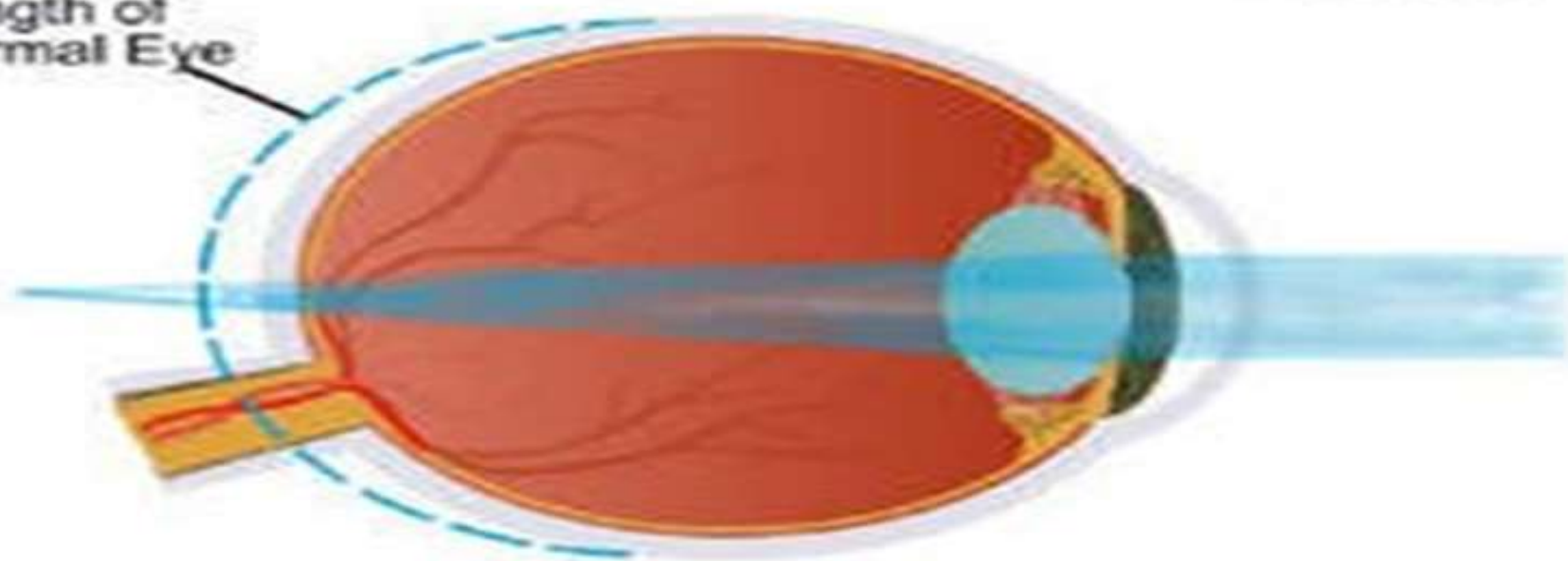
4-NO LENS

AXIAL HYPERMETROPIA

Most common ,total refractive power of eye is normal ,axial length is shorter than normal (1 mm short = -3 D). □

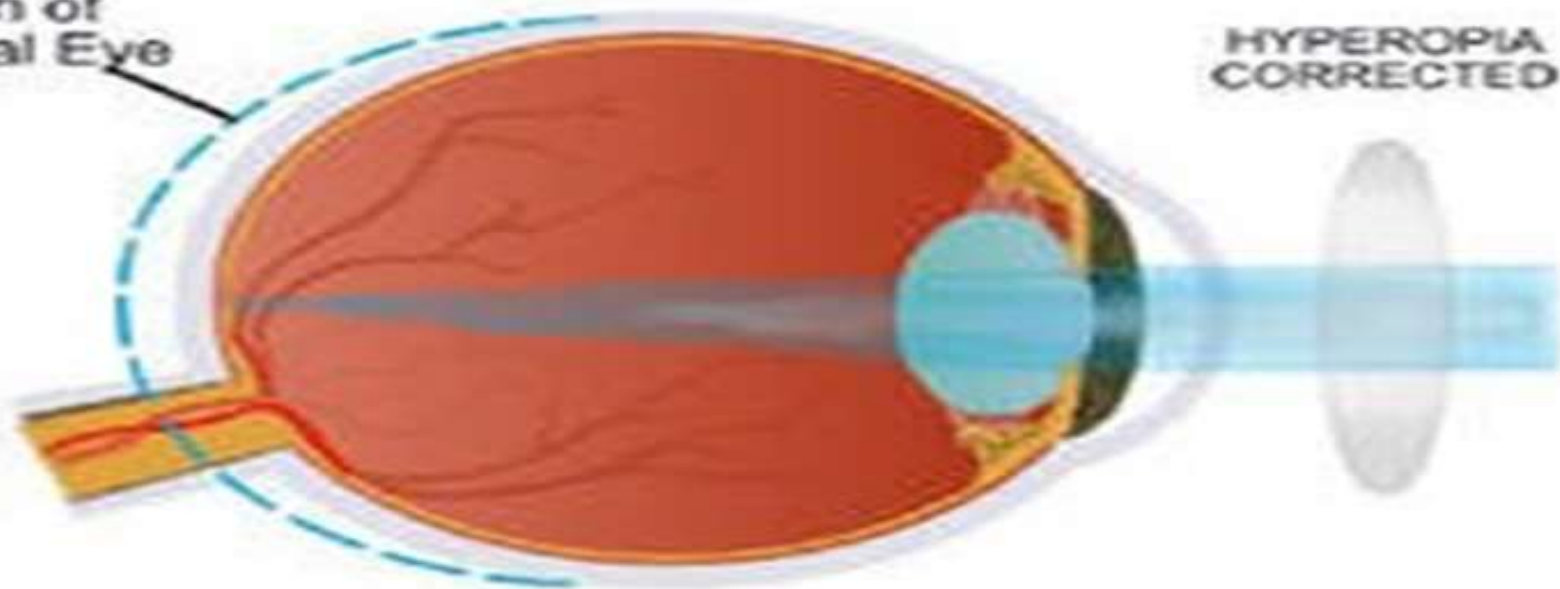
HYPEROPIA

Length of
Normal Eye



Length of
Normal Eye

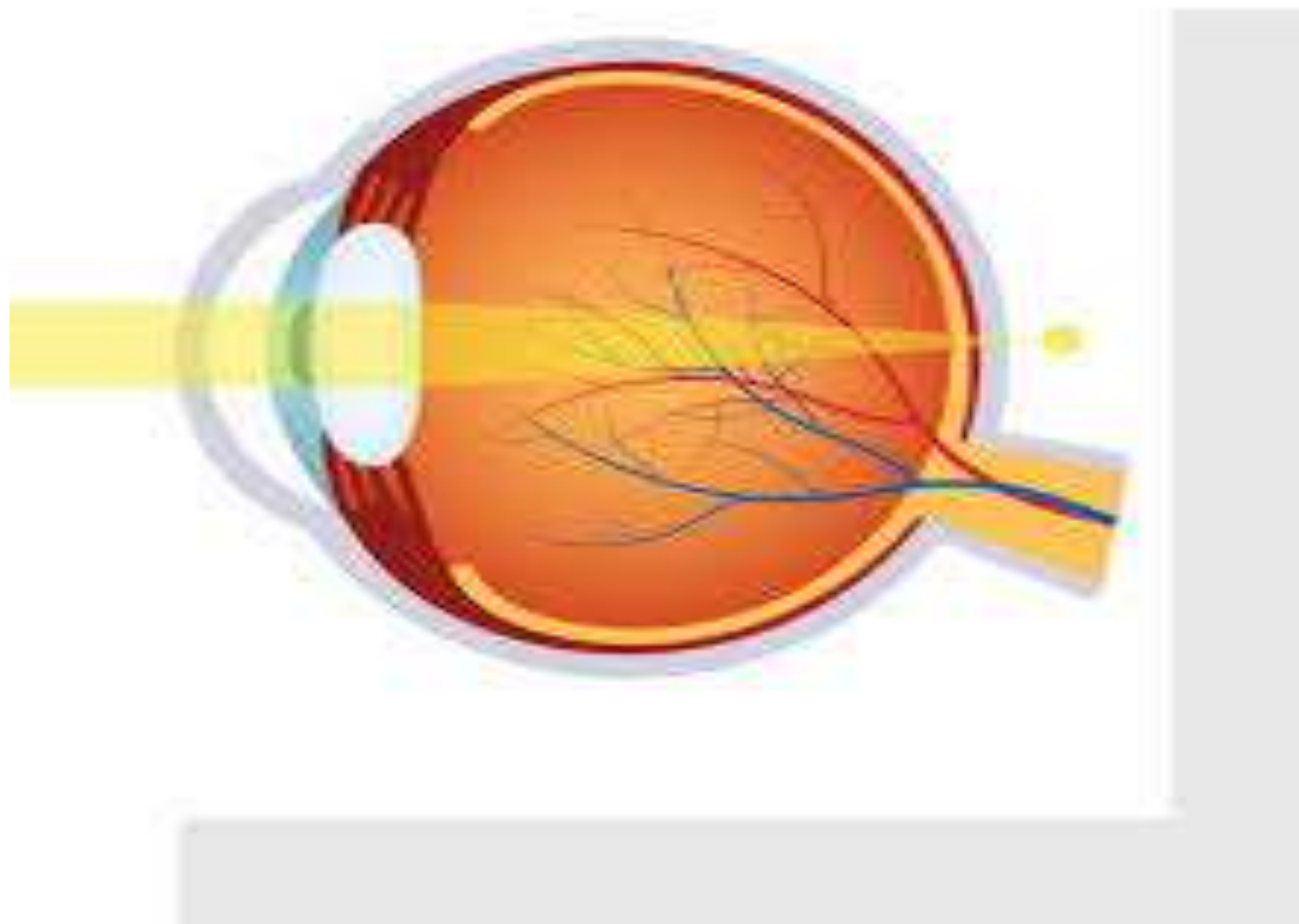
**HYPEROPIA
CORRECTED**



CURVATURE HYPERMETROPIA

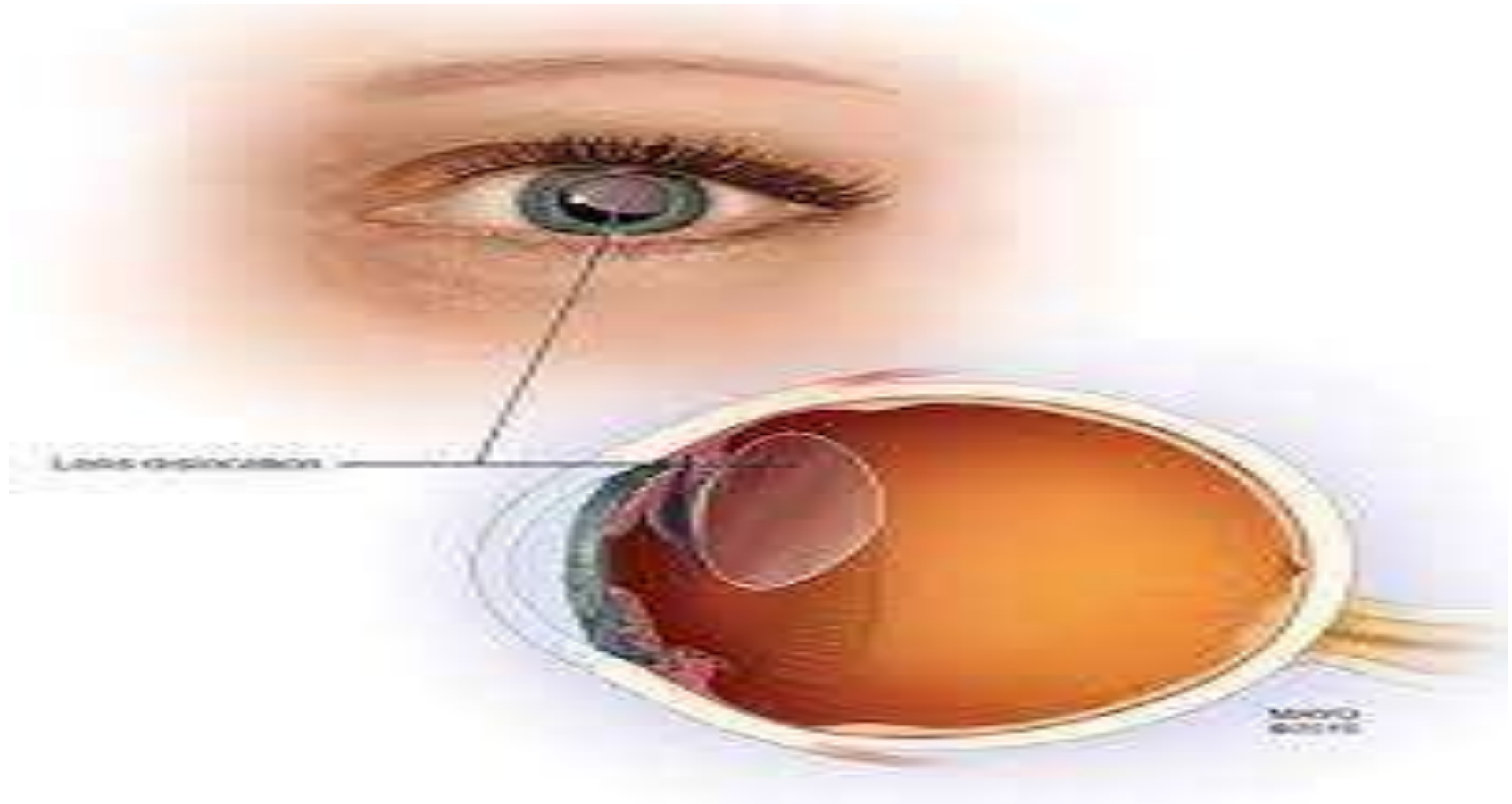
Flattening of cornea, 1 mm increase in radius of curvature lead to +6 D. □

According to age .and mostly at old age □
,pathologically in diabetic under treatment

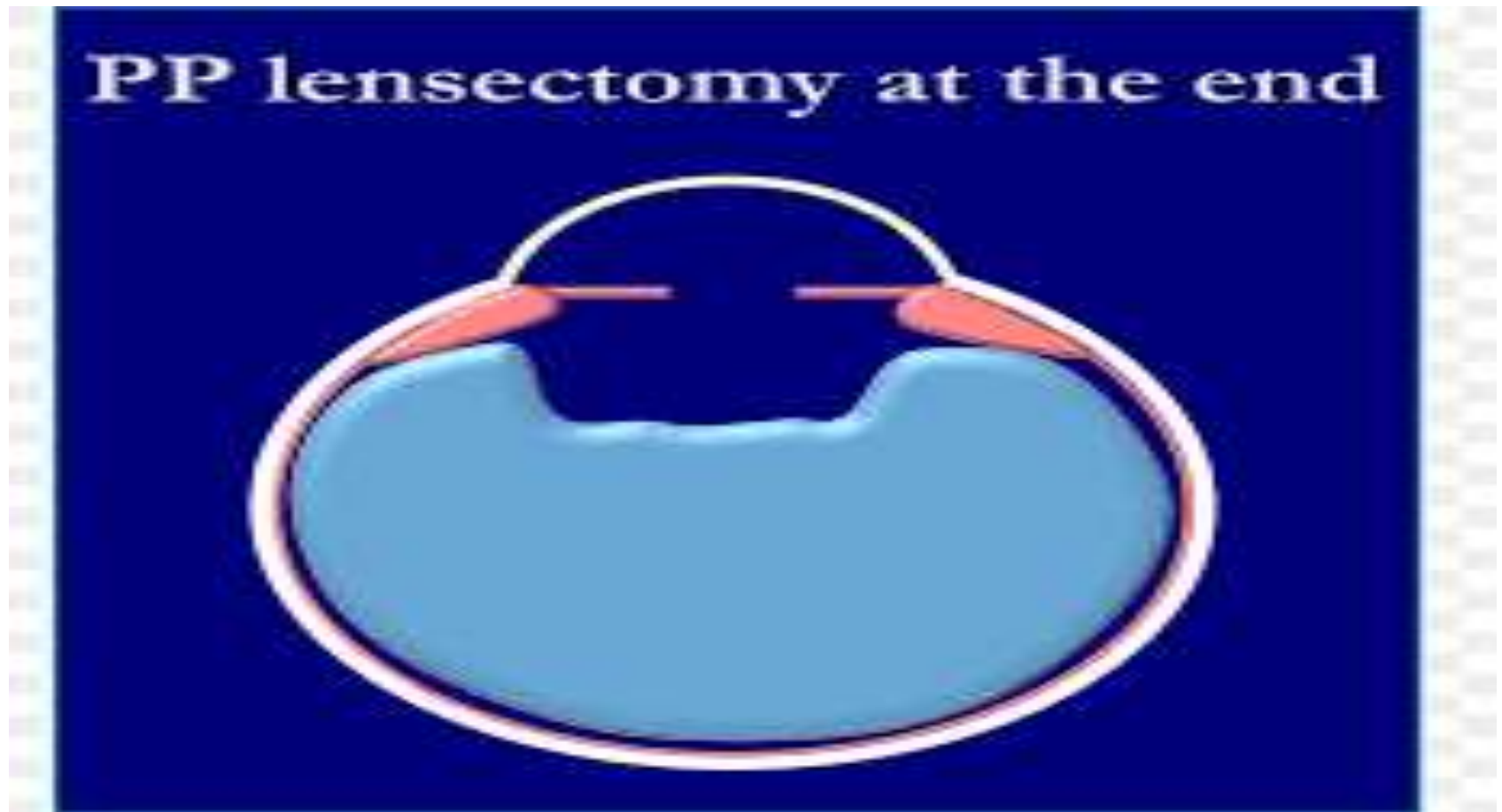


POSITIONALHYPERMETROPIA

Occurs as congenital anomaly ,or trauma □



NO LENS



PHYSIOLOGICAL HYPERMETROPIA


Many children are born with hyperopia and the prevalence of hyperopia unlike that of myopia change very slowly with years and once it presented it progress slowly or not at all . □


Most new born infant have mild hyperopia with only small number of cases falling within the moderate to high range . □

Infant with moderate to high hyperopia ($+3.50$)are more likely to develop strabismus by 4 years of age □

CATEGORISED BY DEGREE OF REFRACTION ERROR



Low hyperopia (-----+ 2.00 D) 

Moderate hyperopia (+ 2.50 D+5.00 D) 

High hyperopia (+ 5.00 D) 



Hypermetropia

Signs and symptoms

In young patients, mild hypermetropia may not produce any symptoms. The signs and symptoms of far-sightedness include blurry vision, frontal or fronto temporal headaches, eye strain, tiredness of eyes etc. The common symptom is eye strain. Difficulty seeing with both eyes (binocular vision) may occur, as well as difficulty with depth perception. The asthenopic symptoms and near blur are usually seen after close work, especially in the evening or night.

Complications

Far-sightedness can have rare complications such as strabismus and amblyopia. At a young age, severe far-sightedness can cause the child to have double vision as a result of "over-focusing". □

Hypermetropic patients with short axial length are at higher risk of developing primary angle closure glaucoma, so, routine gonioscopy and glaucoma evaluation is recommended for all hypermetropic adults. □

Causes



Simple hypermetropia, the most common form □
of hypermetropia, is caused by normal
biological variations in the development of
eyeball. Aetiologically, causes of
hypermetropia can be classified as:

Causes

Axial: Axial hypermetropia occur when the □ axial length of eyeball is too short. About 1 mm decrease in axial length cause 3 diopters of hypermetropia. One condition that cause axial hypermetropia is nanophthalmos.

Curvatural: Curvature hypermetropia occur □ when curvature of lens or cornea is flatter than normal. About 1 mm increase in radius of curvature results in 6 diopters of hypermetropia. Cornea is flatter in micro cornea and cornea plana

Causes

Index: Age related changes in refractive index □
(cortical sclerosis) can cause hypermetropia.
Another cause of index hypermetropia is diabetes.
Occasionally, mild hypermetropic shift may be seen
in association with cortical or sub capsular cataract
also.

Positional: Positional hypermetropia occur due to □
posterior dislocation of Lens or IOL. It may occur
due to trauma.

Causes

- **Consecutive:** Consecutive hypermetropia occur due to surgical over correction of myopia or surgical under correction in cataract surgery
- **Functional:** Functional hypermetropia results from paralysis of accommodation as seen in internal ophthalmoplegia, etc.
- **Absence of lens:** Congenital or acquired aphakia cause high degree hypermetropia.

Diagnosis

A diagnosis of far-sightedness is made by utilizing □ either a retinoscope or an automated refractor-objective refraction; or trial lenses in a trial frame or a phoropter to obtain a subjective examination. Ancillary tests for abnormal structures and physiology can be made via a slit lamp test, which examines the cornea, conjunctiva, anterior chamber, and iris

Classification



Classification according to severity ☐

Clinical classification ☐

Clinical classification

Simple hyperopia: Occurs naturally due to biological diversity. •

Pathological hyperopia: Caused by disease, trauma, or abnormal development. •

Functional hyperopia: Caused by paralysis that interferes eye's ability to accommodate. •

Classification according to severity

Low: Refractive error less than or equal to $+2.00$ diopters (D).

Moderate: Refractive error greater than $+2.00$ D up to $+5.00$ D.

High: Refractive error greater than $+5.00$ D

Treatment



Corrective lenses ☐

Surgery ☐

-----Laser procedures ☐

-----IOL implantation ☐



Refractive surgery

Refractive surgery

Refractive eye surgery is optional eye surgery used to improve the refractive state of the eye and decrease or eliminate dependency on glasses or contact lenses. This can include various methods of surgical remodeling of the cornea, lens implantation or lens replacement. The most common methods today use excimer lasers to reshape the curvature of the cornea. Refractive eye surgeries are used to treat common vision disorders such as myopia, hyperopia, presbyopia and astigmatism.

Techniques



Excimer laser ablation is done under a partial-thickness lamellar corneal flap

Flap procedures



Automated lamellar keratoplasty (ALK):

The surgeon uses an instrument called a microkeratome to cut a thin flap of the corneal tissue. The flap is lifted like a hinged door, targeted tissue is removed from the corneal stroma, again with the microkeratome, and then the flap is replaced

Flap procedures

Laser-assisted in situ Keratomileusis (LASIK):

The surgeon uses either a microkeratome or a femtosecond laser to cut a flap of the corneal tissue (usually with a thickness of 100–180 micrometres).

The flap is lifted like a hinged door, but in contrast to ALK, the targeted tissue is removed from the corneal stroma with an excimer laser. The flap is subsequently replaced.

When the flap is created using an IntraLase brand femtosecond laser, the method is called IntraLASIK;

Flap procedures

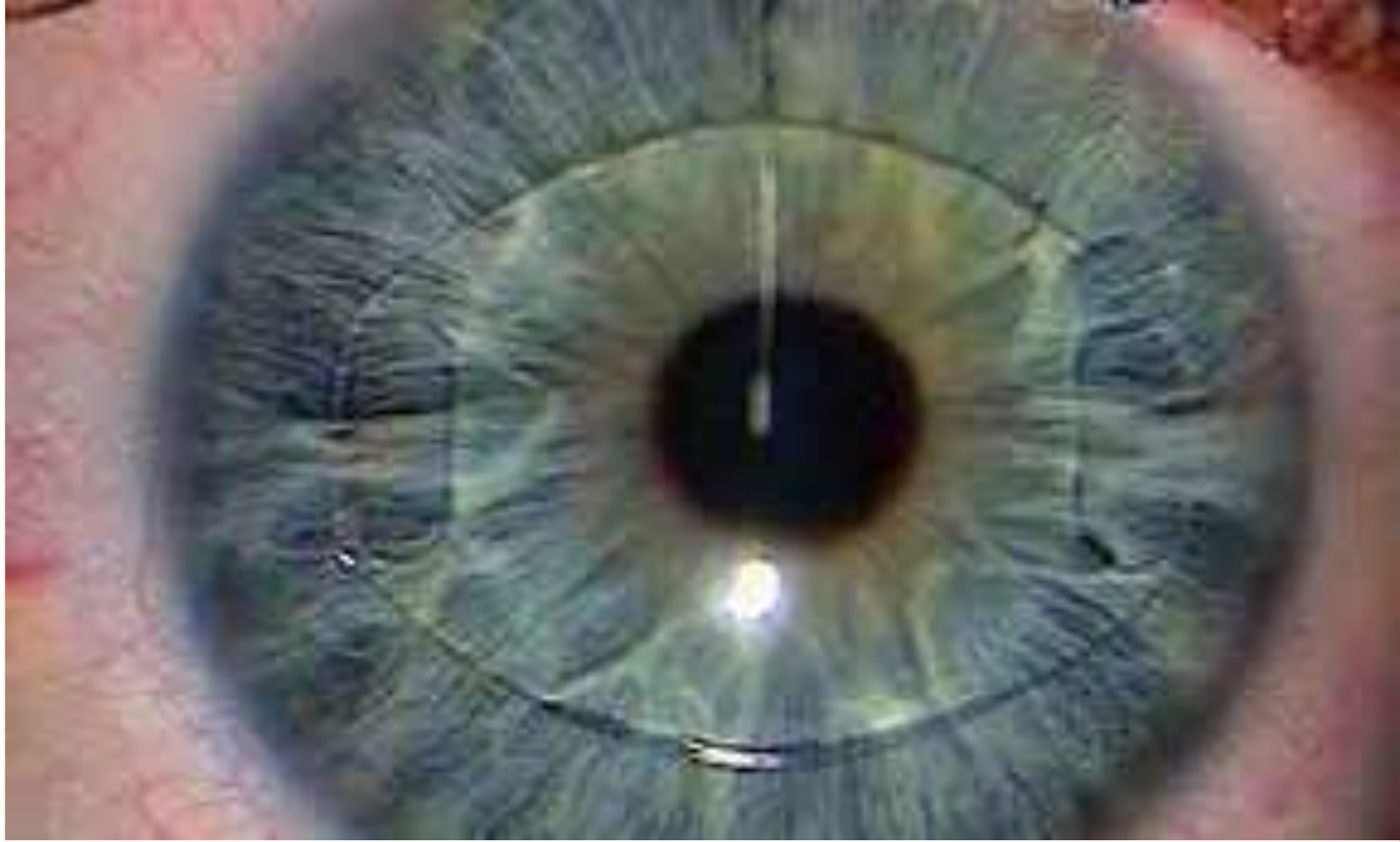
other femtosecond lasers such as the Ziemer create a flap similarly. Femtosecond lasers have numerous advantages over mechanical microkeratome based procedure. Microkeratome related flap complications like incomplete flaps, buttonholes or epithelial erosion are eliminated with femtosecond laser procedure. Absence of microscopic metal fragments from the blade will reduce the risk of lamellar keratitis also

Surface procedures

Photorefractive keratectomy (**PRK**) is an outpatient procedure generally performed with local anesthetic eye drops. It is a type of refractive surgery which reshapes the cornea by removing microscopic amounts of tissue from the corneal stroma, using a computer-controlled beam of light (excimer laser). The difference from LASIK is that the top layer of the epithelium is removed (and a bandage contact lens is used), so no flap is created. Recovery time is longer with PRK than with LASIK, though the final outcome (after 3 months) is about the same (very good). More recently, customized ablation has been performed with LASIK, LASEK, and PRK.

Surface procedures

Transepithelial photorefractive keratectomy (Trans PRK) is a laser-assisted eye surgery to correct refraction errors of human eye cornea. It employs excimer laser to ablate outer layer of cornea, epithelium, as well its connective tissue, stroma, to correct eye optical power. □



Intraocular lens

Intraocular lens

lens implanted in the eye as part of a treatment for cataracts or myopia. If the natural lens is left in the eye, the IOL is known as phakic, otherwise it is a pseudophakic, or false lens. Such a lens is typically implanted during cataract surgery, after the eye's cloudy natural lens (colloquially called a "cataract") has been removed. The pseudophakic IOL provides the same light-focusing function as the natural crystalline lens. The phakic type of IOL is placed over the existing natural lens and is used in refractive surgery to change the eye's optical power as a treatment for myopia (nearsightedness).

COMPLICATION

- 1-a yearly loss of 1.8% of the endothelial cells, -
- 2-0.6% risk of retinal detachment, -
- 3-0.4% risk of corneal swelling.: -
- 4-0.03–0.05% eye infection risk, which in worst case -
can lead to blindness. (This risk exists in all eye
surgery procedures and is not unique to IOLs.)
- 5-glaucoma, -
- 6-astigmatism, -
- 7-remaining near or far sightedness, -
- 8-rotation of the lens inside the eye one or two days -
after surgery.

Location of implant

Posterior chamber IOL (PCIOL). This is by far the most common type of implanted lens after cataract surgery in the United States. •

Anterior chamber IOL (ACIOL). A less-common type of intraocular lens, which is sometimes used if a PCIOL is not an option for a patient or if the situation requires a phakic IOL (PIOL). •

Pseudophakic IOL

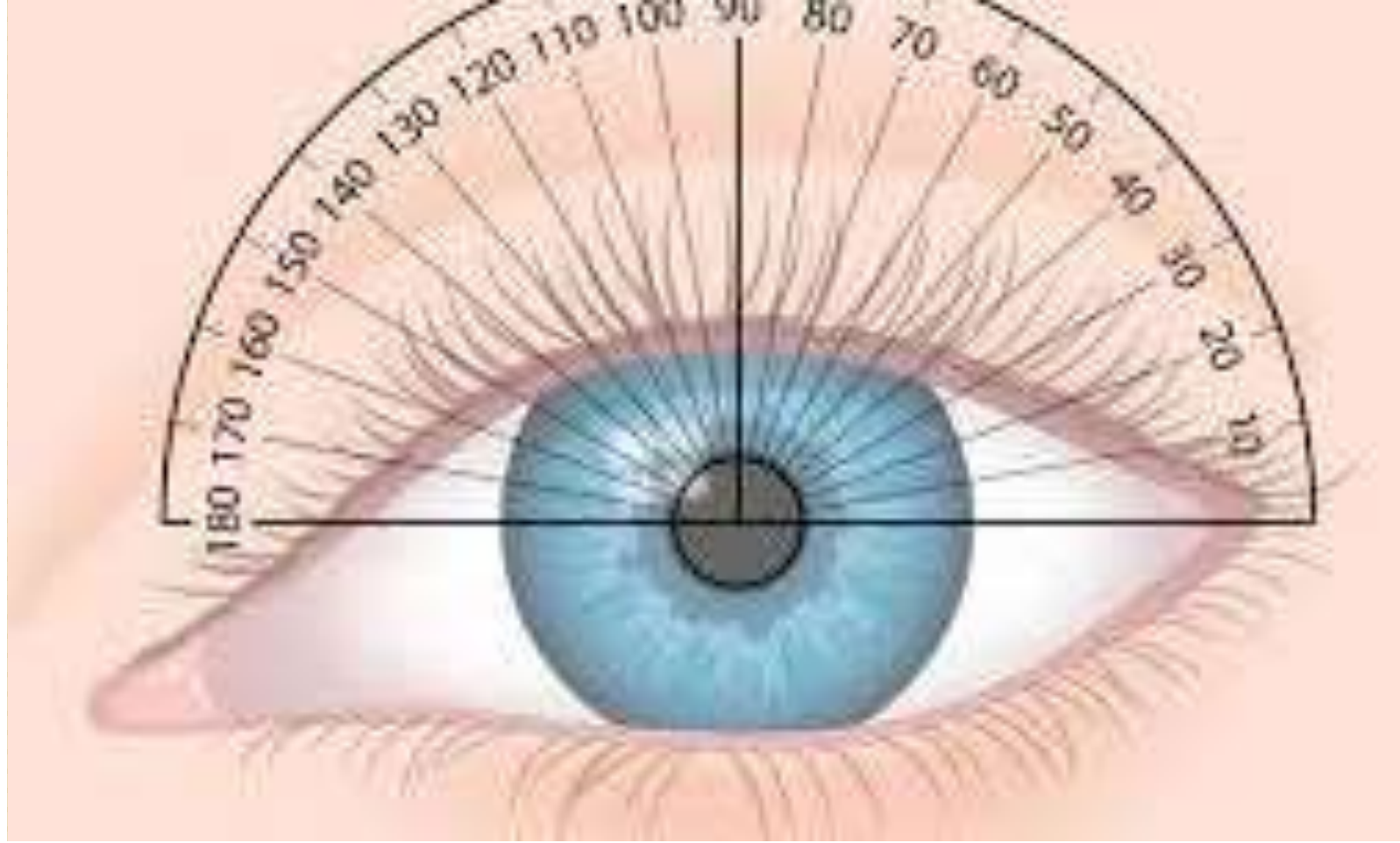
Monofocal ☐

Multifocal ☐

Toric ☐

Multifocal toric ☐

Artizan ☐



Astigmatism

Astigmatism

is a type of refractive error in which the eye does not focus light evenly on the retina. This results in distorted or blurred vision at all distances. Other symptoms can include eyestrain, headaches, and trouble driving at night. If it occurs early in life it can result in amblyopia .

The cause of astigmatism is unclear. It is believed to be partly related to genetic factors. The underlying mechanism involves an irregular curvature of the cornea or abnormalities in the lens of the eye. Diagnosis is by an eye exam

Astigmatism

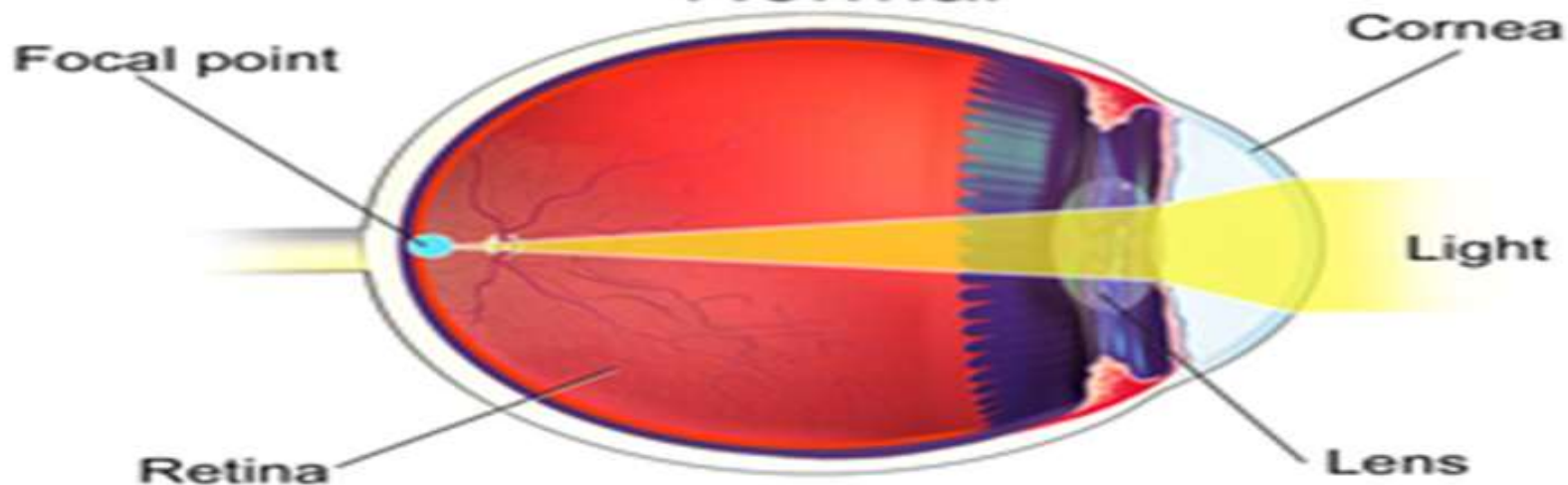


Three options exist for the treatment: glasses, - contact lenses, and surgery. Glasses are the simplest. Contact lenses can provide a wider field of vision. Refractive surgery permanently changes the shape of the eye.

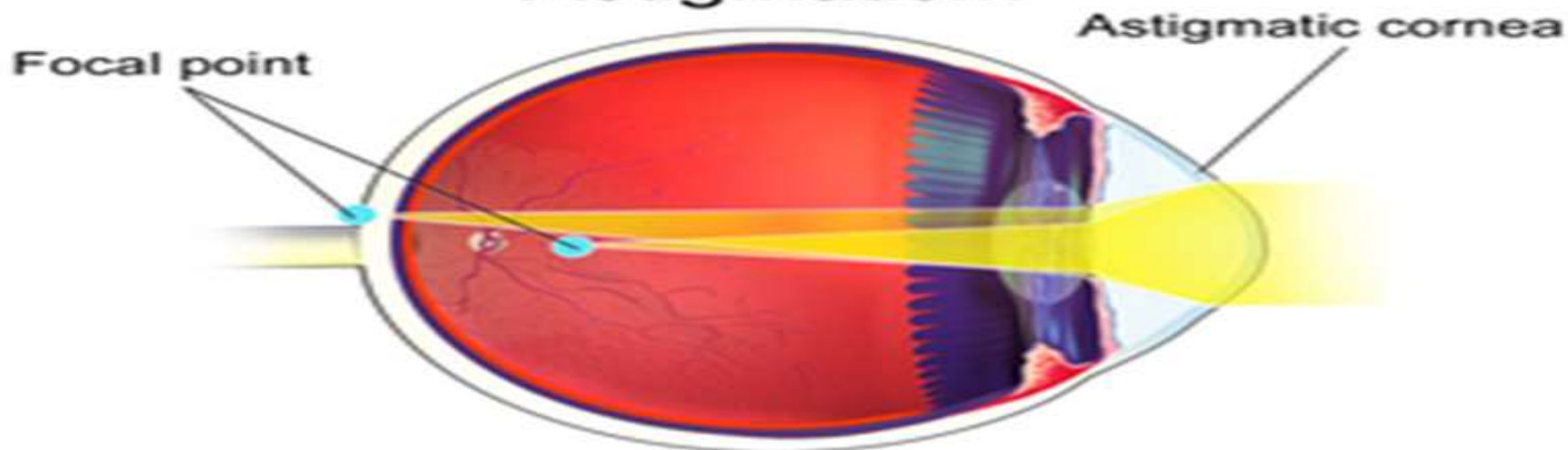
Signs and symptoms

Although astigmatism may be asymptomatic, higher degrees of astigmatism may cause symptoms such as blurry vision, double vision, squinting, eye strain, fatigue, or headaches. Some research has pointed to the link between astigmatism and higher prevalence of migraine headaches.

Normal



Astigmatism



Astigmatic cornea distorts the focal point of light in front of and/or behind the retina

Axis of the principal meridian



Regular astigmatism ☐

Irregular astigmatism ☐

Regular astigmatism

principal meridians are perpendicular. □
(The steepest and flattest meridians of the eye are called principal meridians.)

Regular astigmatism

- **1** **With-the-rule astigmatism** – the vertical meridian is steepest (a rugby ball or American football lying on its side).
- **2** **Against-the-rule astigmatism** – the horizontal meridian is steepest (a rugby ball or American football standing on its end).
- **3** **Oblique astigmatism** – the steepest curve lies in between 120 and 150 degrees and 30 and 60 degrees

Irregular astigmatism

- principal meridians are not perpendicular.

- Simple astigmatism
 - Simple hyperopic astigmatism – first focal line is on the retina, while the second is located behind the retina.
 - Simple myopic astigmatism – first focal line is in front of the retina, while the second is on the retina.
- Compound astigmatism
 - Compound hyperopic astigmatism – both focal lines are located behind the retina.
 - Compound myopic astigmatism – both focal lines are located in front of the retina.
- Mixed astigmatism – focal lines are on both sides of the retina (straddling the retina)