433 Teams

OPHTHALMOLOGY

Lecture 8

Refractive Errors

Color index:

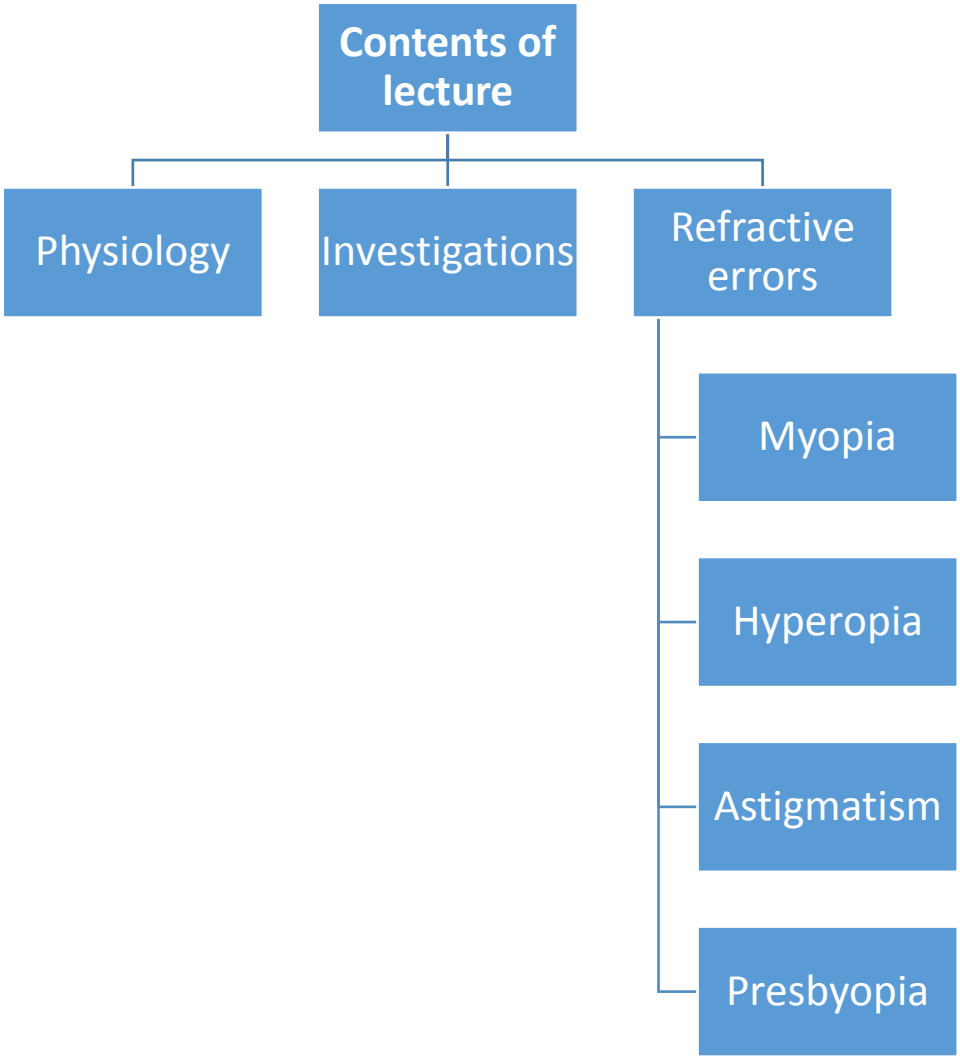
432 Team – **Important** – **433 Notes** – **Not important**

ophthalmology433team@gmail.com

جامعة الملك سعود
King Saud University

Content

Content of lecture



Physiology

-To have a clear picture in the retina & to be seen in the brain, there should be a clear cornea, clear anterior chamber, clear lens, clear vitreous cavity then the picture should be focused on the retina with normal refractive index.

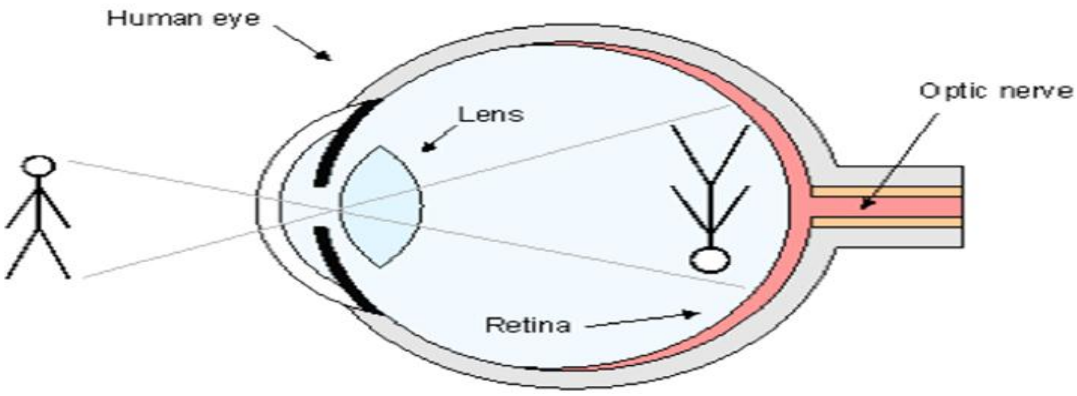
- The retina is responsible for the perception of light. It converts light rays into impulses; sent through the optic nerve to your brain, where they are recognized as images.

-Normal refractive power of the eye is 60 diopters.
(The cornea accounts for approximately two-thirds of this refractive power (about 40 diopters) and the crystalline lens contributes the remaining)

-The normal axial length is 22.5 mml (it's measured from the tip of the cornea to the surface of the retina)

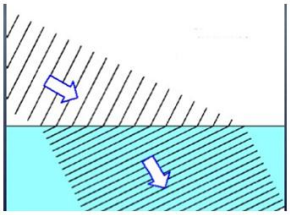
-If the axial length is longer = the picture will be in front of the retina

-If the axial length is shorter = the picture will be behind the retina

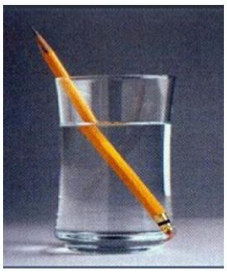


Images are inverted on their way to the retina at the back of the eye

Refractions:



- Refraction indicates the diopter, and the diopter is the focal rate of lens. The more refractive power the lens has the shorter the focal point will be.

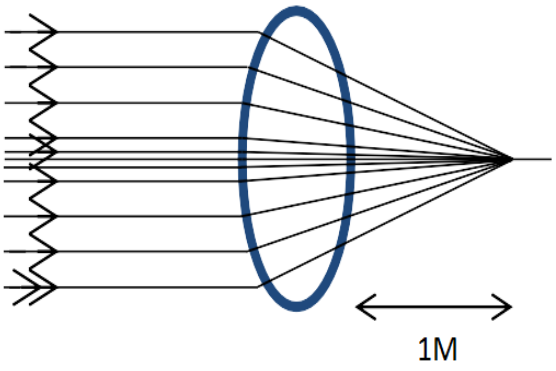


- In optics, refraction occurs when light waves travel from a medium with a given refractive index to a medium with another. At the boundary between the media, the wave's phase velocity is altered, it changes direction.
- The amount of bend depends on the refractive index of the media and the angle of incidence
- The refractive index of a medium is defined as the ratio of the phase velocity of a wave light in a reference medium to its velocity in the medium itself.

Unit of refraction

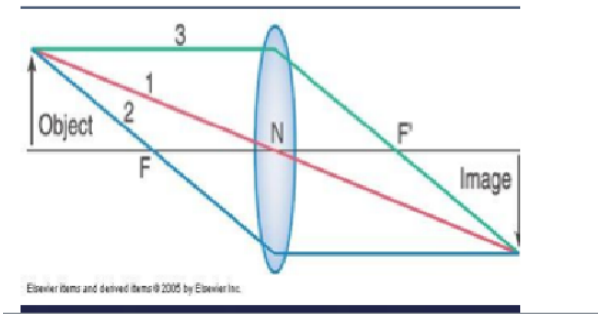
-The power of the lens is measured by the Diopter (D) The unit of refraction.

$$\text{diopter} = \frac{1000}{\text{focal length in mm}}$$



THE EYE'S OPTICAL SYSTEM

- Cornea
- Main refracting surface (2/3rd the power of the eye, 40 diopter)



- **The power of the cornea is fixed, it reaches its maximum power at the age of 18. That's why it's NOT recommended to do any refractive surgery before age of 18.**

**At the age of 40 = they will have presbyopia

**Power of lens at the age of 60 = 0

Lens

- **The lens provides 20 diopters of refractive power.**
- **The relaxed lens = 20 diopter. In accommodative stage it can increase the refractive power up to 15d more like in children (with time it becomes less)**

Accommodation

- Emmetropic (normal) eye

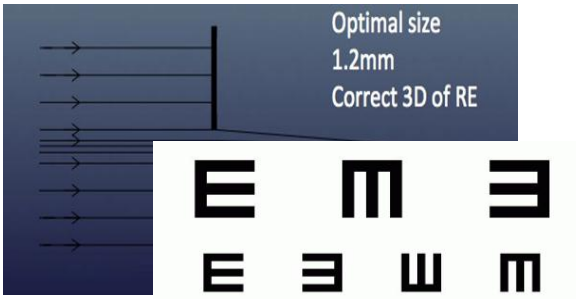
Objects closer than 6 meters send divergent light that focus behind retina; adaptive mechanism of eye is to increase refractive power by accommodation

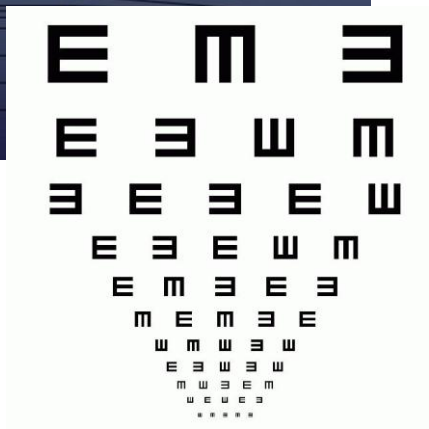
- Helm-holtz theory
- When the eye look at close object -> Contraction of ciliary muscle ⟶ decrease tension in zonule fibers ⟶ elasticity of lens capsule mold lens into spherical shape ⟶ greater dioptic power ⟶ divergent rays are focused on retina
- contraction of ciliary muscle is supplied by parasympathetic third nerve

Note: After prolonged reading there might be ciliary spasm associated headache

Visual acuity (VA)

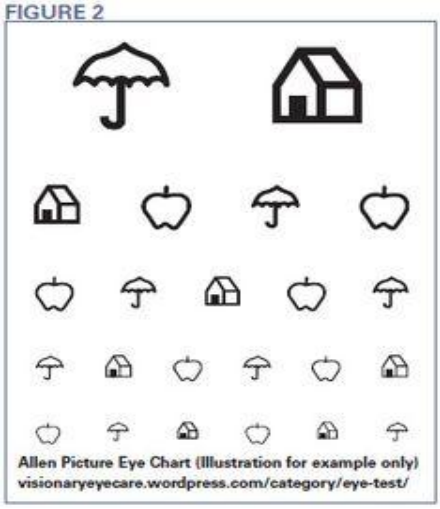
- VA is the vital sign of the eye with IOP (intraocular pressure).
- To assess the effect of pathology on VA. You must eliminate the effect of refractive error. This is achieved by measuring: the patient's best spectacle correction or viewing the test chart through a pinhole.
- The pinhole is used to eliminate the mild refractive error of the patient. The pinhole will cause muscle spasm. Pinhole glasses typically have a hole diameter of about 1mm to 1.2mm. The pinhole corrects for about three diopters.
- When examining the patient you should examine each eye alone (and cover the other eye)





- How to test the vision
- Central visual acuity
    - Display of different –sized targets shown at a standard distance from the eye.
- **In the first 2 months of life:** do light objection test (if the baby objecting or closing the eye in response to light it means he/she is seeing)
- **From 2 months – 3 years:** do follow and fixate test. At this age, babies will start to follow the objects, so bring a toy in front of them and do the test. (If following the toy ⟶ good vision). ***OR*** you can do CSM "Central Steady Maintained" (central= seeing centrally. Steady= no nystagmus. Maintained= baby is following object & after blinking he/she continues following the same object)

FIGURE 2



- **Age 3 – 6 years:** Allen's chart
- **More than 6 years:** Snellen's chart
- The vision maturation is acquired skill for the brain, so babies when they're first born they will be legally blind.
- The axial length of the eye will grow quickly in the first 6 months. So if anything stops the growing they will have amblyopia (lazy eye) E.g: vitreous hemorrhage, congenital cataract.

- ## Testing poor vision

- If the patient is unable to read the largest letter <(20/200)
- Move the patient closer e.g. 5/200
- If patient cannot read:
  - Count fingers (CF)
  - Hand motion (HM)
  - Light perception (LP) OR No light perception (NLP)

What does 20/200 mean? It means that the patient sees at 20 feet what a normal person could see at 200 feet

Legal blindness: (he needs assistance)

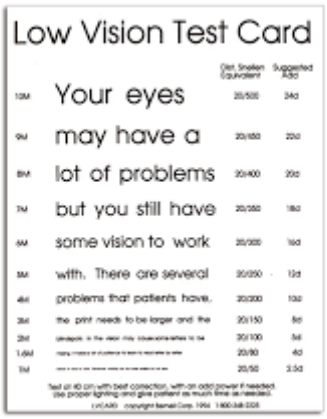
Legal blindness: The criteria used to determine eligibility for government disability benefits and which do not necessarily indicate a person's ability to function. In the US, the criteria for legal blindness are:

- Visual acuity of 20/200 or worse in the better eye with corrective lenses.
- Visual field restriction to 20 degrees diameter or less (tunnel vision) in the better eye.

Note that the definition of legal blindness differs from country to country and that the criteria listed above are for the US.

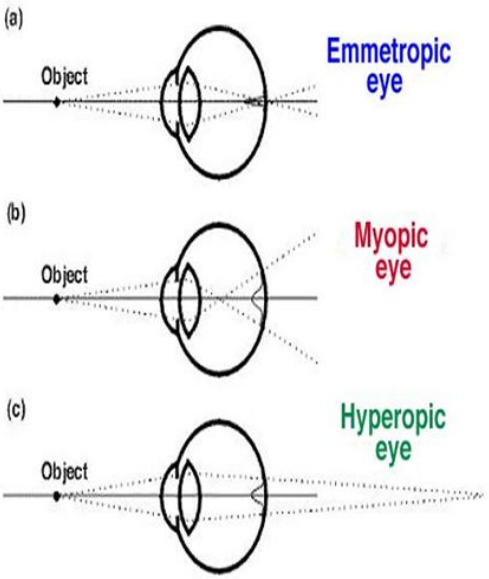
Testing near visual acuity

- It is done at a standard working distance ~ 30-40 cm
- A variety of charts are available



Refractive errors

- A mismatch between the refractive power and the focusing distance of the eye
- Inability to see clearly is often caused by refractive errors.
- Three types of refractive errors (Ametrpia)
  Myopia (nearsightedness), Hyperopia (farsightedness) and Astigmatism.
  - Emmetropia (normal)
  - Ametrpia = Refractive error

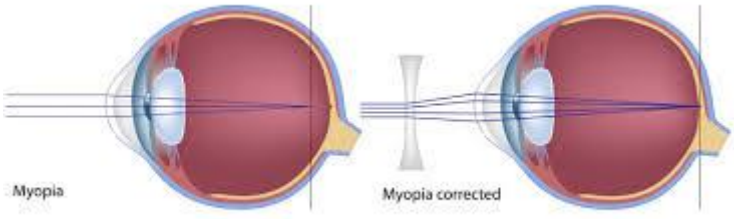


Emmetropia

• Adequate correlation OR matching between axial length and refractive power of the eye
• Rays of light from a distant object are brought to a pinpoint sharp focus on the retina (no accommodation). All refractive errors are some deviation from emmetropia.

Myopia

- Rays of light from a distant objects converge in front of the retina, causing a blurred image on the retina
- Myopes can see close objects clearly, myopia is commonly known as "near-sightedness"
- Most prevalent among Asians (80---90%), followed by 25% of African Americans and 13% of Caucasians.
- Average age of onset:8 years
- Etiology: not clear, genetic factors



Causes of myopia

1.Increased refractive power:

a) Change in lens nucleus or shape: cataract, spherophakia, diabetes

b) Lens repositioning: ciliary muscle shift e.g. miotics.
Or Lens movement e.g. anterior lens dislocation

c) Ciliary muscle tone: excessive accommodation e.g. medical students

d) Increase corneal power: keratoconus, congenital glaucoma

2. Increase axial length: congenital glaucoma, posterior staphyloma

- **Symptoms**

1. Blurred distance vision
2. Squint in an attempt to improve uncorrected visual acuity when gazing into the distance
3. Headache due to eyestrain.

Uncorrected myopia and uncorrected hyperopia in children might lead to amblyopia (see later anisometropia)

Myopia Forms:

– Benign myopia (school age myopia)

• Onset 8-12 years, myopia increases until the child stops growing in height

• Generally tapers off at about 20 years of age

– Progressive or malignant myopia: (also called Degenerative or pathological myopia)

• Myopia increases rapidly each year and is associated with, fluidity of vitreous and chorioretinal change.

Morphologic eye changes in pathological myopia:

– Deep anterior chamber
– Atrophy of ciliary muscle
– Vitreous may collapse prematurely –leading to opacification
– Fundus changes:

Loss of pigment in RPE (Retinal pigment epithelium), large disc and white crescent-shaped area on temporal side, RPE atrophy in macular area, posterior staphyloma, and retinal degeneration ---> hole ---> increase risk of RRD(rhegmatogenous retinal detachment).

Myopia is corrected by (negative) concave lenses.

Hyperopia

- Rays of light from a distant object now focus behind the retina.
- Hyperopic people must accommodate when gazing into distance to bring focal point on to the retina
- However, this reduces their accommodative reserve when they want to view close objects. This means their distance vision is generally better than their near vision, hence the term "long-sightedness"
- **Etiology:** not clear, inherited, trauma may cause dislocation of the lens

Causes of Hyperopia

1. Decreased refractive power of the eye:
   - *Absent (aphakia) or posteriorly repositioned lens*
   - *Weak accommodation:* trauma, marijuana
2. Decreased effective axial length (retina pushed forward): tumor, orbital mass

Symptoms

- Visual acuity at near tends to blur relatively early ''inability to read fine print''
- Asthenopic symptoms: eye pain, headache in frontal region.
- **Accommodative esotropia:** because accommodation is linked to convergence leading to easotropia.

Hyperopia is corrected by (positive) convex lenses.

Astigmatism

- Astigmatism is a common and generally treatable imperfection in the curvature of the eye that causes blurred distance and near vision.

- Astigmatism occurs when either the cornea or the lens, has mismatched curves. Instead of having one curve like a round ball, the surface is egg shaped. This causes blurred vision at all distances.

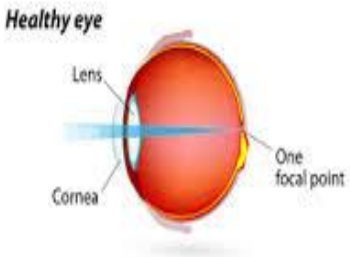
- In astigmatism, surface of cornea is not homogenous. Usually it is congenital.

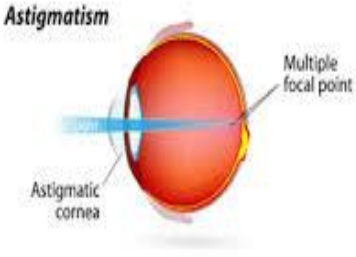
- Parallel rays come to focus in 2 focal lines rather than a single focal point

Causes of astigmatism

- Corneal causes (majority):Simple corneal astigmatism, Keratoconus, Masses e.g. lid tumor, Ptosis

- Lenticular causes: Lens dislocation, lenticonus





Symptoms

- Asthenopic symptoms (headache, eye pain)
- Blurred vision
- Distortion of vision
- Head tilting and turning
- Uncorrected astigmatism > 1.5 Diopters might lead to amblyopia in children

Classification

– **Regular astigmatism:** (2 meridians) power and orientation of principle meridians are constant. The principal meridians are 90 degrees apart (perpendicular to each other).

– With the rule astigmatism, Against the rule astigmatism, Oblique astigmatism

– Irregular astigmatism: (different meridians) power and orientation of principle meridians change across the pupil. The principal meridians are not perpendicular.

Another classification:

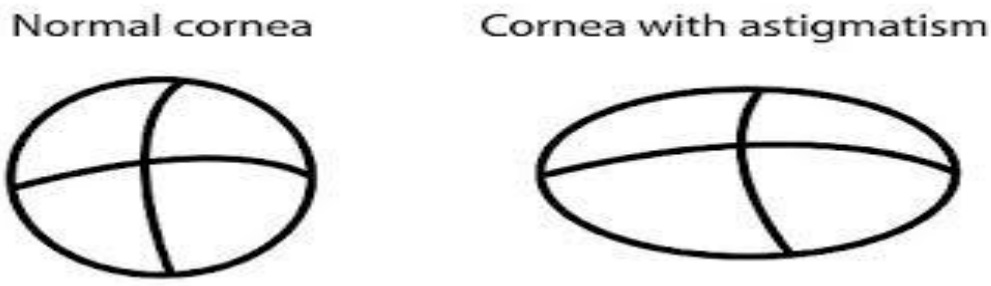
Three primary types of astigmatism:

Myopic astigmatism: One or both principal meridians of the eye are nearsighted.

Hyperopic astigmatism: One or both principal meridians are farsighted.

Mixed astigmatism: One prinicipal meridian is nearsighted, and the other is farsighted.

Astigmatism is corrected by cylindrical lenses



Presbyopia

- Age related Physiological loss of accommodation
- Deposition of insoluble proteins in the lens with advancing age leads to progressive decrease in the elasticity of the lens and decrease accommodation.

- Around 40 years of age, accommodation become less than 3 D . reading is possible at 40-50 cm -> difficultly reading fine print, headache, visual fatigue

  Presbyopia is corrected by convex lenses

Anisometropia

- Anisometropia is the condition in which the two eyes have unequal refractive power. Generally a difference in power of two diopters or more is the accepted threshold to label the condition anisometropia.
- More than 3 diopters difference if not detected in pediatrics and corrected it can cause unilateral amblyopia "in the weaker eye".
- Individuals can tolerate up to 2-3 Diopters of anisometropia before becoming symptomatic.

- If the difference between 2 eyes: (D=Diopter)
  -Less than 3D -> it's ok to wear glasses

  -More than 3 but less than 7D -> patient can't tolerate glasses but can use contact lenses

  -More than 7D -> refractive surgery

Aniseikonia

An ocular condition in which the image of an object in one eye differs in size or shape from the image of the same object in the other eye.

Causes

-Correction of a refractive error

-Anisometropia

-Antimetropia (being myopic (nearsighted) in one eye
and hyperopic (farsighted) in the other.)

-Meridional aniseikonia occurs when these refractive differences only occur in one meridian (see astigmatism).

-Refractive surgery

Types of optical correction

- **Spectacle lenses**

– Monofocal lenses: spherical lenses, cylindrical lenses

– Multifocal lenses

- **Contact lenses**

– Higher quality of optical image and less influence on the size of retinal image than spectacle lenses

– Indication: cosmetic, athletic activities, occupational, irregular corneal astigmatism, high anisometropia, and corneal disease

–Disadvantages: careful daily cleaning and disinfection.

–Complications: infectious keratitis, giant papillary conjunctivitis, corneal vascularization, and severe chronic conjunctivitis

Refractive surgeries

A. Keratorefractive surgery: (work on the cornea. Doesn't correct high power)

- Refractive surgery – flattens corneal surface for myopia or increases it's curvature in Hyperopia.
- Improves unaided visual acuity but may have complications
- Examples: PRK, LASIK, LASEK, EPILASIK

B. Intraocular surgery: for high power

- Give best optical correction for aphakia; avoid significant magnification and distortion caused by spectacle lenses.
- Clear lens extraction.
- Phakic IOL (intraocular lenses): lenses made of plastic or silicone that are implanted into the eye permanently to reduce a person's need for glasses or contact lenses.

Photo refractive keratectomy (PRK)

(no flap. We just remove the epithelium →→ apply laser →→ then the epithelium will grow)

Advantages: safer on the long run

Disadvantages: severe pain for 1 week, blurred vision for 2-3 weeks

laser-assisted-in-situ keratomileusis (LASIK) (thin flap)

Advantages: immediate 20/20 vision, no pain, good visual rehabilitation, can correct high numbers (up to – 8)

Disadvantages: severe trauma →→ the flap can fall down

SUMMARY

THE EYE'S OPTICAL SYSTEM CONSIST OF: CORONEA (60 DIOPTRE) AND CRYSTALINE LENSE (20 DIOPTRE)

We test the visual acuity according to the age:

In the first 2 months: do the light test

After 2 – 3 years: follow the object
Age 3 – 6: Allen test
More than 6 = Snellen test or letters

Emmetropia: Adequate correlation OR matching between axial length and refractive power of the eye

Myopia: Rays of light from distant objects converge in front of the retina, causing a blurred image on the retina. The myopes can see close objects clearly.. GIVE (-) CONCAVE LENSE to correct it

Hyperopia: Rays of light from a distant object now focus behind the retina

- Hyperopic persons must accommodate when gazing into distance to bring focal point on to the retina. Give (+) convex lens to correct

Astigmatism: Parallel rays come to focus in 2 focal lines rather than a single focal point

Presbyopia: Physiological loss of accommodation in advancing age (usually 40)

ANISOMETROPIA: A difference in refractive error between the two eyes

Correction of RE:

- Placing the imaging of the object at far point
- Use correcting lenses

Refractive surgeries: Keratorefractive surgery or intraocular surgery

MCQs

1. A lady wants LASIK surgery for her daughter. She asks for your opinion. All the following things are suitable for performing LASIK except:

A. Myopia of 4 Diopters.
B. Age of 15 years.
C. Stable refraction for 1 year.
D. Corneal thickness of 600 microns

2. In myopia:

A. Length of eyeball is short
B. Image forms in front of retina
C. Lens is less spherical
D. Patient can see far objects clearly

3. The most common cause of reduced vision in the world is

A. Trachoma
B. Diabetic retinopathy
C. Refractive errors
D. Glaucoma

CONTRAINDICATIONS of LASIK (source: http://lessons4medicos.blogspot.com/2008/09/mcqs---opthalmology.html)

- Unstable refractive error.
- Age less than 21 years.
- Active collagen vascular disease (especially in the presence of iritis or scleritis).
- Pregnancy.
- Presence of a pacemaker.
- Any ongoing active inflammation of the external eye (eg, conjunctivitis, severe dry eye).
- Refractive error outside the range of laser correction.
- Keratoconus

Answers: 1- B 2- B 3-C

Done By:

Othman Abid
Khalid Alsuhaibani