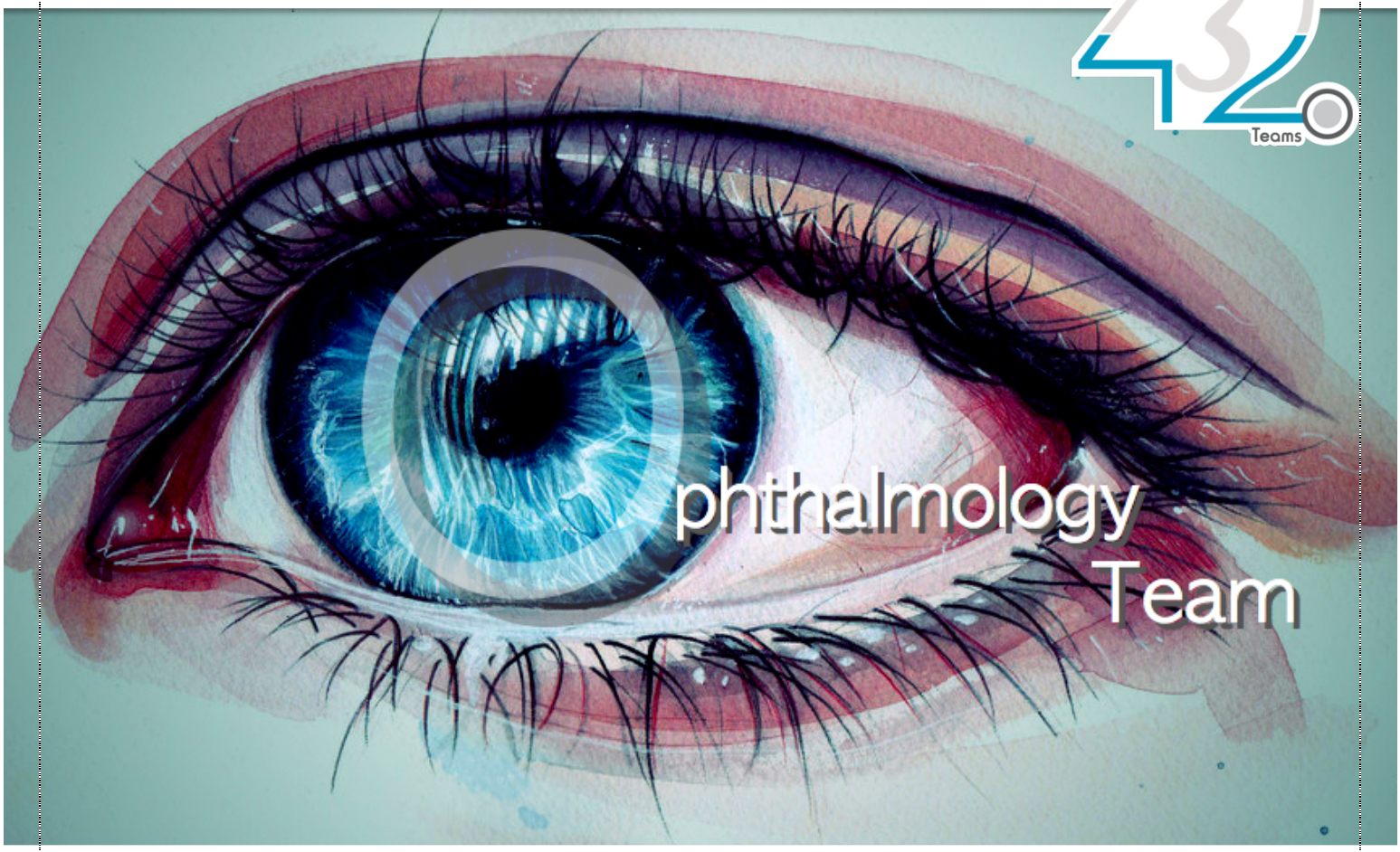


#9- Refractive Errors

Done by: Nadia aljomah

Revised by: Maha Allhaidan

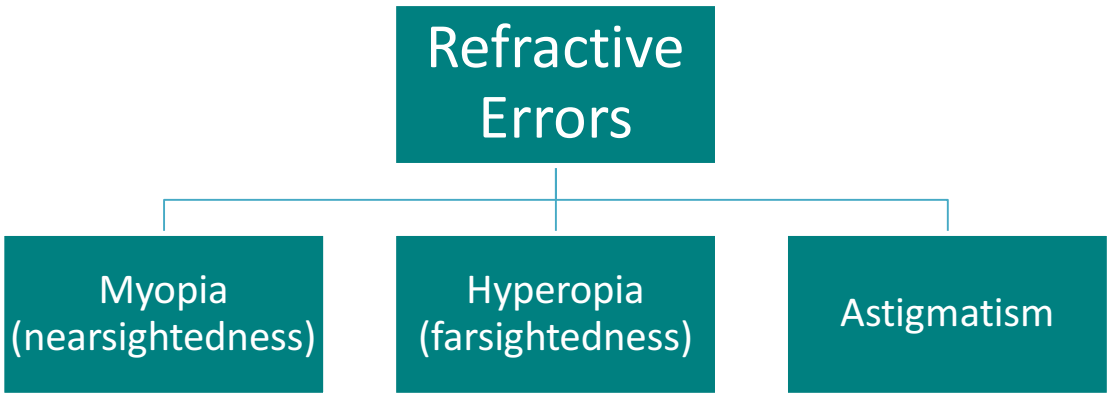
Team Leader: *Shaikha Aldossari*

Doctor's note Team's note Not important

Important **431 teamwork in a yellow box**

Objectives:

Not given



FACTS

(The retina is responsible for the perception of light and the other structures are mainly for foxing)

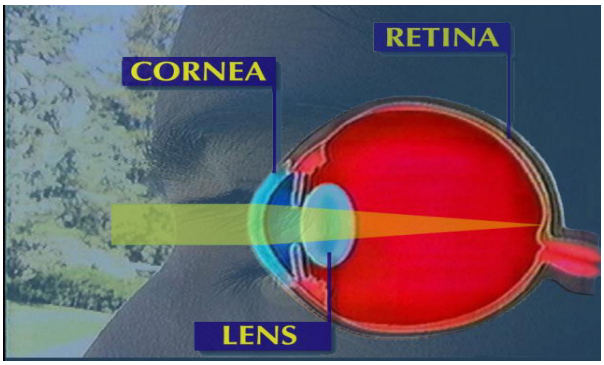
75% of avoidable blindness is due to:

- Uncorrected refractive error
- Cataract
- Trachoma

Blindness due to refractive errors is a substantial public health problem in many parts of the world.

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

How The Eye Works?



The normal power of the eye is 60 diopter

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 **larger** = the picture will be **in front of the retina**

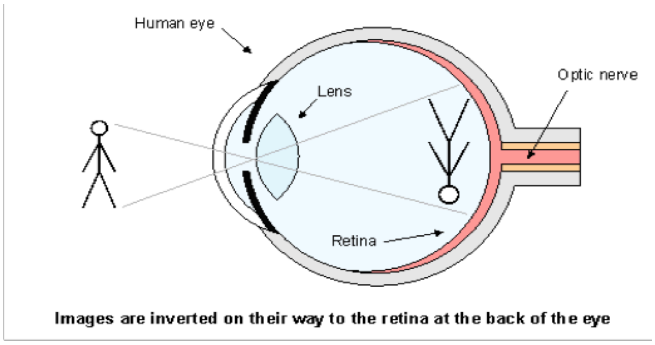
If the axial length is **shorter** = the picture will be **behind the retina**

Myopic eyes: they have extra power (NOT extra vision) -> 80 -> correct them with (-) mines lenses

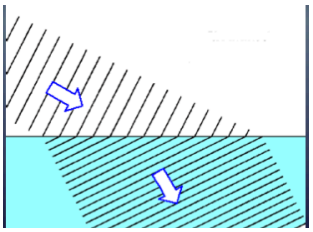
THE HEALTHY EYE:

- Light rays enter the eye through the clear cornea, pupil and lens.
- These light rays are focused directly onto the retina in the same way as a camera focuses light onto a film. (The light sensitive tissue lining the back of the eye)
- The retina converts light rays into impulses; sent through the optic nerve to your brain, where they are recognized as images.

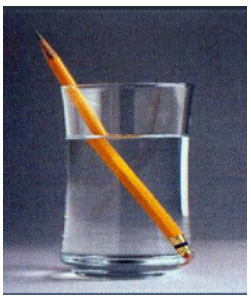
• The eye requires about 60 diopters of power to focus the light from a distant object precisely onto the retina.



REFRACTIONS:

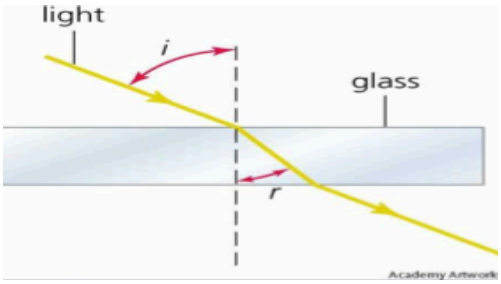


- Refraction indicates the diopter, and the diopter is the focal rate of lens. the stronger the lens the shorter the focal point will be.
- **I**n optics, refraction occurs when light waves travel from a medium with a given refractive index to a medium with another. At the boundary between the media, the wave's phase velocity is altered, it changes direction.



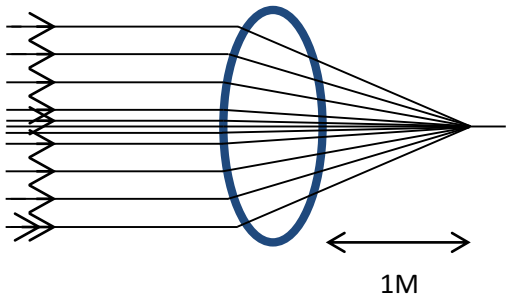
- The amount of bend depends on the refractive index of the media and the angle of incidence

- 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.



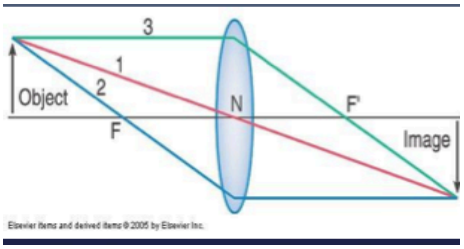
Unit of refraction

$$\text{Dioptre} = \frac{1}{\text{focal length of a lens}}$$



The power of the lens is measured by the diopter (D) The unit of refraction

The stronger the lens means more refractive index of the lens → high power to reflect the rays → the focal point will come closer



THE EYE'S OPTICAL SYSTEM

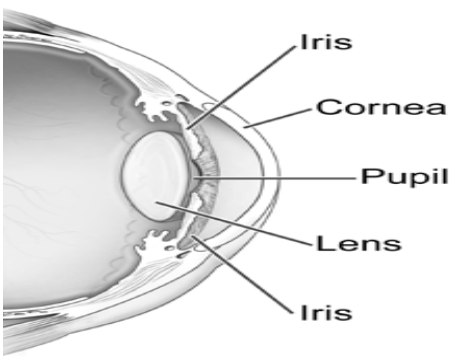
1- CORNEA

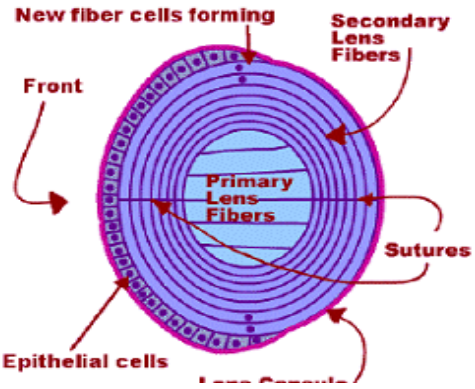
- Main refracting surface (2/3rd the power of the eye)
- The cornea provides 40 diopters, or 75% of the total refracting power of the eye. (the power of the cornea is fixed, it reaches its maximum power at the age of 18).

The axial length of the eye at birth =16 mm and it reaches its normal maximum length at the age of 18. That's why it's NOT recommended to do any refractive surgery before age of 18

2 - CRYSTALINE LENS **ACCOMEDIATING** "acquiring extra power"

- Double purpose: balancing eye's refractive power and providing a focusing mechanism
- The lens provides 20 diopters of refractive power





The relaxed lens = 20 diopter

In **accommodative stage** it can increase the power up to 15 in children (with time it became less)

At the age of 40 = they will have presbyopia

Power of lens at the age of 60 = 0

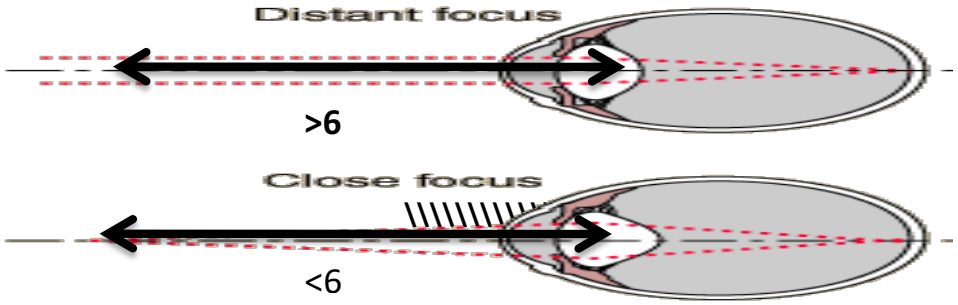
Accommodation

• 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

– 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



After prolonged reading there will ciliary spasm associated headache

THE VISUAL ACUITY

• VA is the vital sign of the eye (and the IOP)

• To assess the effect of pathology on VA the effect of refractive error must be eliminated

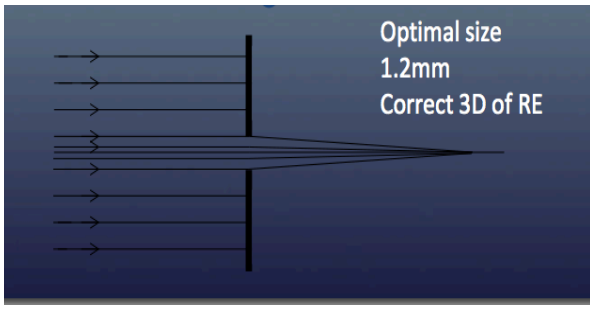
• This is achieved by measuring: the patient's best spectacle correction or viewing the test chart through a pinhole

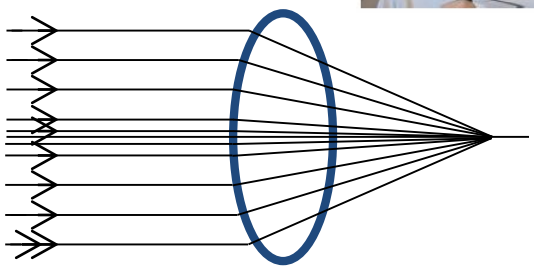
• When examining the patient you should examine each eye alone (and cover the other eye)

PINHOLE

- To eliminate the mild refractive error of the patient
- the pinhole will cause muscle spasm

Optimal size 1.2mm Correct 3D of RE

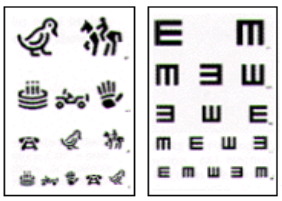


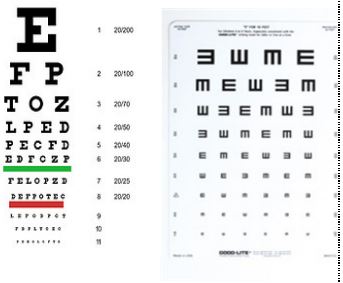


How to test the vision?

Central visual acuity

- Display of different –sized targets shown at a standard distance from the eye.
- Snellen chart.
- 20/20 (feet), 6/6 (m)





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 (lazy eye) EX: vitreous hemorrhage, congenital cataract

In the first 2 months: do light objection test (if the baby objecting or closing the eye in response to light it mean 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)

Age 3 – 6 years: Allen chart
More than 6 years: Snellen chart

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)

- No light perception (NLP)

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

Legal blindness: (he needs assistance)

1. If 20/200 or less in the **best-corrected eye** (that means he has retinal detachment or pathological cause)
2. If the visual field is less than 20 degrees

NEAR VISUAL ACUITY

• 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.

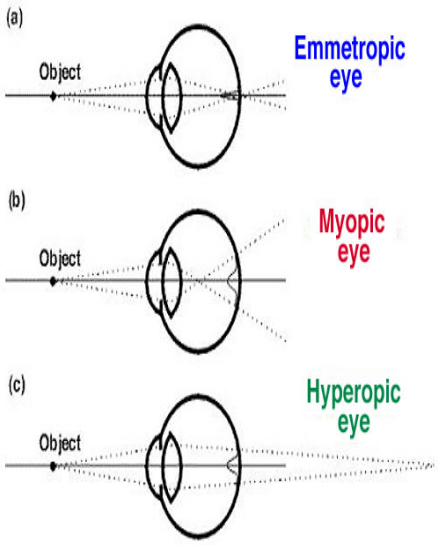
• Three types of refractive errors:

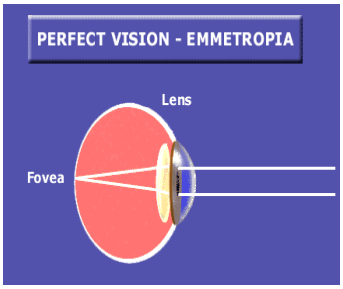
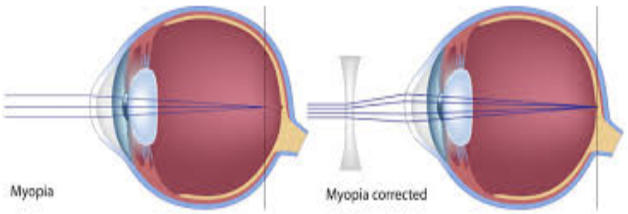
- Myopia (nearsightedness)
- Hyperopia (farsightedness)
- Astigmatism

• Emmetropia (normal)

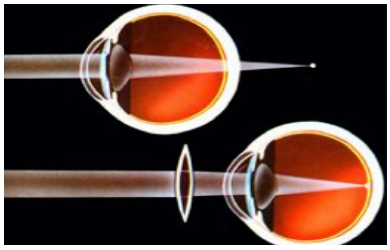
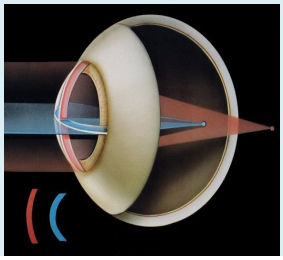
• Ametrpia=RE

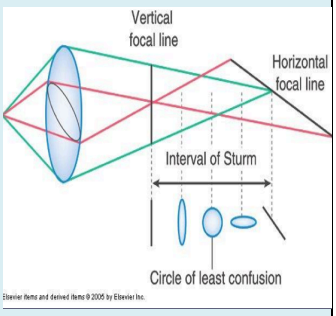
1. Myopia
2. Hyperopia 3. Asrigmatism



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 (90%) The problem could be in the power of the axial length GIVE (-) CONCAVE LENSE to correct it Usually those who have big eyes will be myopic.	•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 factor • Causes: - Excessive refractive power (refractive myopia). - Excessive long globe (axial myopia) "more common"	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, myopia is commonly known as "short-sightedness" 

	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. 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 4. Amblyopia uncorrected myopia > -5 D	**Myopia Forms:** – Benign myopia (school age myopia) • Onset 8-12 years, myopia increase until the child stops growing in height • Generally tapers off at about 20 years of age – Progressive or malignant myopia • Myopia increases rapidly each year and is associated with, fluidity of vitreous and chorioretinal change **Morphologic eye changes:** – Deep anterior chamber – Atrophy of ciliary muscle – Vitreous may collapse prematurely -->opacification – Fundus changes: Loss of pigment in RPE, 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. 

Hyperopia (10%) Give (+) convex lens to correct Here they usually have small eyes Normal child is hyperopic they accommodate strongly	• Parallel rays converge at a focal point posterior to the retina • **Etiology:** not clear, inherited, trauma may cause dislocation of the lens • **Causes** – excessive short globe (axial hyperopia): more common – insufficient refractive power (refractive hyperopia) **Causes of Hyperopia** 1. Decreased refractive power of the eye: a) *Absent (aphakia) or posteriorly repositioned lens* b) *Weak accommodation:* trauma, marijuana 2. Decreased effective axial length (retina pushed forward): tumor, orbital mass	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 •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"  • **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 -->ET – Amblyopia – uncorrected hyperopia **> +5D**
ASTIGMATISM surface of cornea not homogenous (usually congenital) 	• Cornea is usually shaped like half a football. In these eyes there will be no astigmatism. • Parallel rays come to focus in 2 focal lines rather than a single focal point	**Classification** – **Regular astigmatism:** (2 meridians) power and orientation of principle meridians are constant • With the rule astigmatism, Against the rule astigmatism, Oblique astigmatism

	**• Etiology:** hereditary **• Cause:** refractive media is not spherical--> refract differently along one meridian than along meridian perpendicular to it --> 2 focal points. **Causes of astigmatism** ***Corneal causes*** (majority): a) Simple corneal astigmatism b) Keratoconus c) Masses e.g. lid tumor d) Ptosis ***Lenticular causes:*** Lens dislocation, lenticonus	**– Irregular astigmatism:** (different meridians) power and orientation of principle meridians change across the pupil **Symptoms** – Asthenopic symptoms (headache, eye pain) – Blurred vision – Distortion of vision – Head tilting and turning – Amblyopia – Uncorrected astigmatism > 1.5 D
Presbyopia	Physiological loss of accommodation in advancing age	• Deposit of insoluble proteins in the lens with advancing age--> elasticity of lens progressively decrease--> 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
ANISOMETROPIA If difference between 2 eyes: **Less than 3D -->** it's ok to wear glasses **More than 3 but less than 7D** --> pt. can't tolerate glasses but can use contact lenses **More than 7D** --> refractive surgery	A difference in refractive error between the two eyes (more than 3 diopters difference) → if not detected in pediatrics it can cause unilateral amblyopia "in the weaker eye"	• Individuals can tolerates up to 2-3D of anisometropia before becoming symptomatic • Refractive correction often leads to different image sizes on the 2 retinas (aniseikonia) •**Aniseikonia** depend on degree of refractive anomaly and type of correction

Correction of refractive errors

• **Far point:** a point on the visual axis conjugate to the retina when accommodation is completely relaxed

• Placing the imaging of the object at far point will cause a clear image of that object to be relayed to the retina

• **Use correcting lenses** to form an image of infinity at the far point, correcting the eye for distance

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, expense

– ***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 e.g. PRK, LASIK, LASEK, EPILASIK

PRK
(no flap. We just remove the epithelium → apply laser → then the epithelium will grow by itself)
Advantages: more safe on the long run
Disadvantages: severe pain for 1 week, blurred vision for 2-3 weeks

LAISK (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

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 (ICL)

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

Answer B

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

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

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

Answer B

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

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

Answer C

If you have any questions/suggestions
regarding Ophthalmology teamwork please via:

432OphthalmologyTeam@gmail.com