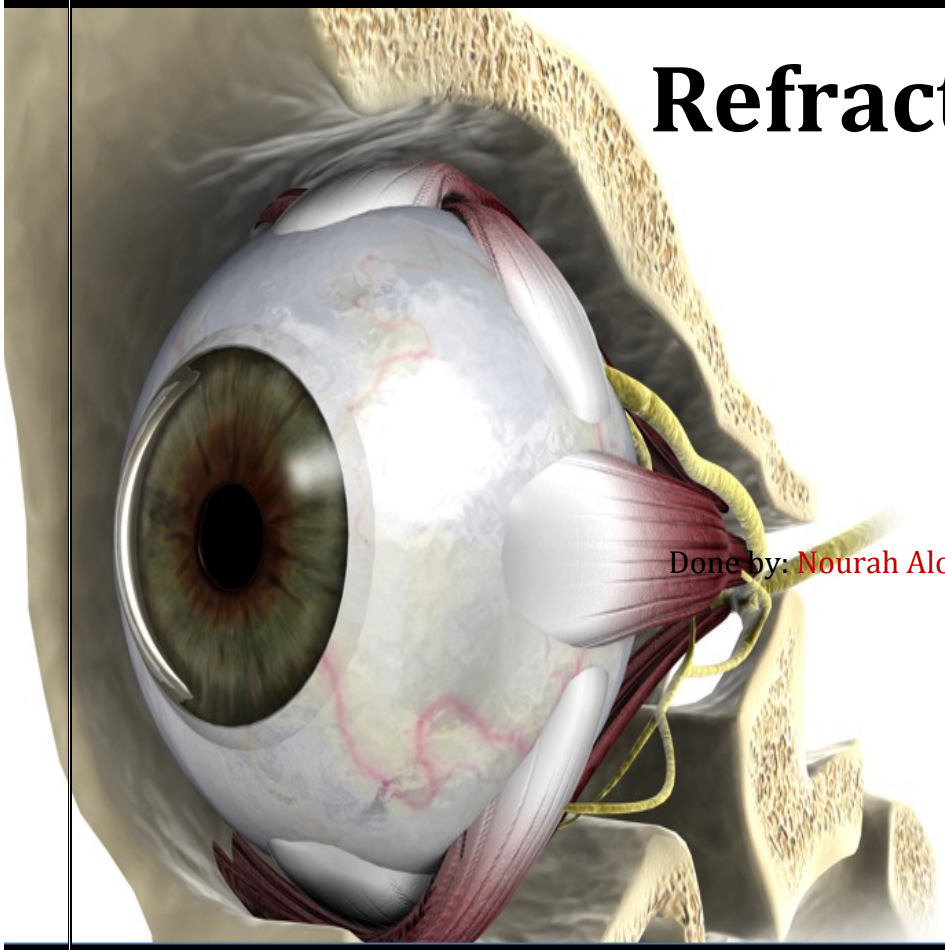
430 Ophthalmology Team

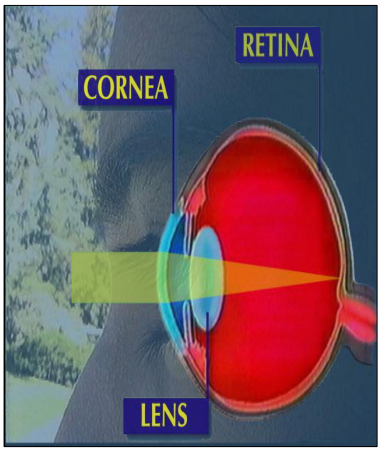


Refractive Errors

Done by: Nourah Alohali

"The most pathetic person in the world is someone who has sight but no vision."

The old slides were available in the download center / by doctor (Hani Almezaine)
My sources for this lecture are:
The slides+ ophthalmology 429 team handout +the lecture's note +Lecture Notes in Ophthalmology book
Important Notes in red
Copied slides in Black
notes in green/ blue

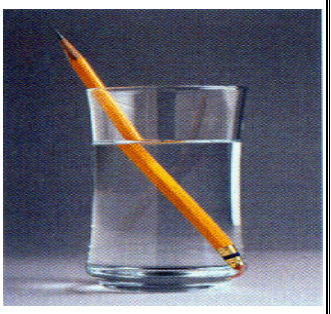


How the eye works?

Our eyes perceive the environment around us in a form of electro-magnetic wavebands (light) in a spectrum lies between 390inm to 760inm. whenever we see a distant object (far more than 6 meter), the (parallel) rays coming from that object get converged by both the cornea and the lens in order to generate accurate visual information by focusing these rays exactly on the retina.

How does that happen?

In the well known experiment of the pen refraction in a glass of water: whenever the rays travel from one medium to another, they bend and change their direction. this happens because every medium has a specific refraction index depends on the density of that medium (The velocity of light is reduced in a dense medium so that light is refracted towards the normal).

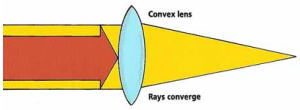


The cornea has a higher refractive index than air; the lens has a higher refractive index than the aqueous humour. When passing from the air to the cornea or aqueous to lens the rays therefore converge.

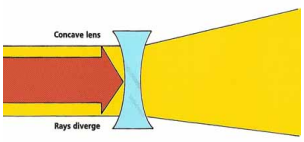
Accommodation:

Objects closer than 6 meters send)(divergent light that focus behind retina, adaptive mechanism of eye is to increase refractive power by accommodation.
(because the rays at this case are divergent, more refractive power is required to converge and focus the rays on the retina. one way to achieve this is to change the density and the shape of the medium)

- Accommodation is Thicker, more convex lens (Helm-holtz theory)



Activation of the parasympathetic activity of the third nerve that supplies the
contraction of ciliary muscle >decrease tension in zonule fibers >elasticity of lens capsule molds lens into more spherical shape >greater dioptic power >divergent rays are focused on retina.



- When humans accommodate to a near object, they also converge their eyes and constrict their pupils. The combination of these three movements (accommodation, convergence and miosis) is referred to as the near triad, or accommodation reflex.

THE EYE'S OPTICAL SYSTEM:

Refractive power is the degree to which a lens can bends light. High optical power corresponds to short focal length.

For example: if a lens can bend the light coming from an object that's 1 meter away from you, the refractive power of that lens is 1 dioptre. at the same concept, if this lens can bends the light coming from an object that's 25 cm away from you, the refractive power will be 4.

The power of the lens is measured by the diopter (D) The unit of refraction.
Dioptre= 1/focal length of a lens

The refractive power of the eye is obtained by 2 elements:

CORNEA:

Main refracting surface
The cornea provides 40 dioptres, or 75% of the total refracting power of the eye.

CRYSTALINE LENS:

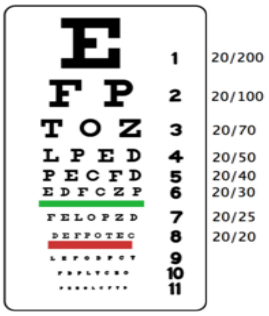
Double purpose: balancing eye's refractive power and providing a focusing mechanism
•The lens provides 20 dioptres of refractive power
The eye requires about 60 dioptres of power to focus the light from a distant object precisely onto the retina

Visual Acuity:

it's the vital sign of the eyes.

Central visual acuity:

by Snellen chart:



display of different –sized targets shown at a standard distance from the eye.

how to interpret the result?

6\6, 20\20: normal

20\x (x is greater than 20) : means the subject can see a specific object at only x distance while a normal person can see the same object at 20m distance. the result is abnormal.

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): measures if the patient is able to correctly counts the numbers of the examiner's fingers shown
he can't count fingers correctly?! move to next step:
Hand motion (HM): meaning that while the patient can recognize a hand being waved, he or she cannot count the fingers on the hand
he can't recognize hand motion?! move to next step
Light perception (LP) : it describes the ability to perceive the difference between light and dark, or daylight and nighttime. An individual can have severely reduced vision and still be able to determine the difference between light and dark.

No light perception (NLP)?! = Blindness
note: dense cataract does not worsen to NLP. even with sever forms there's still LP unless the cataract is combined with another disorders, usually of the retina and optic nerve.

NEAR VISUAL ACUITY:

At a standard working distance ~ 30-40 cm
• A variety of charts are available

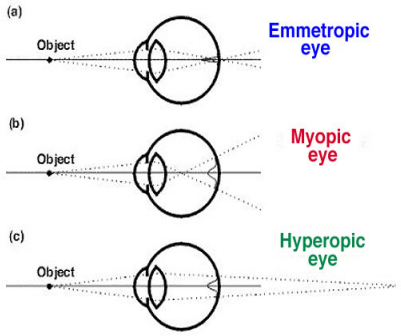
Emmetropia x Ametrobia

Adequate correlation OR matching between axial length and refractive power of the eye
Rays of light from a distant object are brought to a pin-point sharp focus on the retina (no accommodation).
In ametropia, parallel rays of light are not brought to a focus on the retina
in an eye at rest. A change in refraction is required to achieve sharp vision.
Ametropia may be divided into:

Myopia | Hyperopia | Astigmatism

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, myopia is commonly known as "short-sightedness"

Most prevalent among Asians (80-90%) followed by 25% of African Americans and 13% of Caucasians.

•Average age of onset: 8 years. from the onset of the condition up to age of 18 is the (changing period). above 18 the degree of the condition will be constant.

•**Etiology** : not clear, genetic factor.

How does it happen?

there are 2 elements effecting the light here. the refractive power and the length of the medium. any changes in any of these elements will cause deviation from normal.

Images in Myopic Eye

A) refractive myopia: if the problem caused by higher refractive power of the lens. this could be essential or secondary to other disorders listed below:

1) **changes in lens nucleus or shape**:

cataract: increase substance in the lens> increase density> higher refractive power

spherophakia: congenital anomaly of lens, the patient born with high myopia.

diabetes: Fluctuating vision in response to changing blood glucose levels; vision can change from day-to-day, or from morning to evening.

2)**lens repositioning**: ex/ trauma causes anterior lens dislocation so it pulls the image with it outward.

3**) cillary muscle tone** (exicive acomidation): ex/ medical student!

4) **increase corneal power**/

- Keratoconus: structural changes within the cornea cause it to thin and change to a more conical shape> more curveted> more power
- Conginital glocoma

B) axial myopia: the eye length doesn't match with the refractive power (long globe in big eyes). more common.

1) conginital glucoma 2) posterior staphyloma

Myopia Forms:

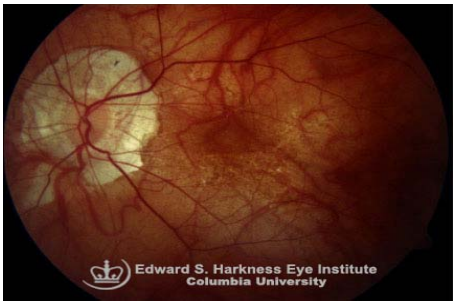
– **Benign myopia** (school age myopia): onset 10-12 years , myopia increase until the child stops growing in height and generally tapers off at about 20 years of age
– **Progressive or malignant myopia**
• myopia increases rapidly each year and is associated with , fluidity of vitreous and chorioretinal change

symptoms:

– Blurred distance vision
– Squint in an attempt to improve uncorrected visual acuity when gazing into the distance and diplopia (especially in pediatrics)
– Headache

Morphology changes in myopia:

- 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 , retinal degeneration-->hole-->increase risk of RD



Notes: congenital glaucoma causes both refractive and axial myopia, sometimes it's considered the third type of myopia!

Hyperopia

Parallel rays converge at a focal point posterior to 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"

Images in Hyperopic eye

• **Etiology** : not clear , inherited

• **Causes**

A) insufficient refractive power (refractive hyperopia)

1) absent (aphakia) or posteriorly repositioned lens: ex: in trauma when the eye ball bushed inward and pulls the image with it

2) weak accommodation : ex: trauma, marijuana smoking.

B) Decreased effective axial length(retina pushed forward): tumor, orbital mass that pushes retina backward.

Symptoms :

-Visual acuity at near tends to blur relatively early ''inability to read fine print''

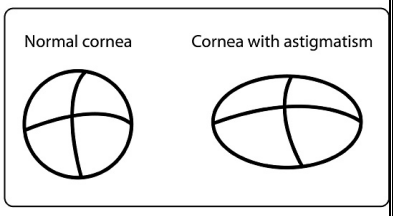
– Asthenopic symptoms : eye pain, headache in frontal region

– Accommodative esotropia (eye crossing that is caused by the focusing efforts of the eyes as they try to see clearly) : because accommodation is linked to convergence

– Amblyopia – uncorrected hyperopia > +5D

Astigmatism

Normally, the cornea surface is perfectly spherical like the surface of basketball. However, many patients have some degree of astigmatism, where the corneal surface is shaped more like an (americal football) oval-shaped. Thus, one axis of the cornea is steeper than the other.



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

•**Etiology** : hereditry

•**Cause** : refractive media is not spherical-->refract differently along one meridian than along meridian perpendicular to it-->2 focal

they could be anywhere in relation to retina. because the curvatures are different.

to understand the concept: press over your eyelid and notice the change in your vision. this happened because you manipulated the axis of your cornea

Classification

– **Regular astigmatism**: power and orientation of principle meridians are constant :With the rule astigmatism , Against the rule astigmatism , Oblique astigmatism

– **Irregular astigmatism** : power and orientation of principle meridians change across the pupil, usually due to trauma because of cut or scar formation.

Corneal causes:

a) simple corneal astigmatism

b) Keratoconus
c) Masses e.glid tumor
d) Ptosis
Lenticularcauses:
Lens dislocation, lenticonus (it works by the same concept of applying pressure over your eyelid)

Symptoms
–asthenopic symptoms (headache , eyepain)
–blurred vision
–distortion of vision (objects look taller)
–head tilting and turning

NISOMETROPIA

•A difference in refractive error between the two eyes
•Individuals can tolerates up to 2-3D of anisometropia before becoming symptomatic
•Refractive correction often leads to different image sizes on the 2retinas(aniseikonia)
•Aniseikonia depend on degree of refractive anomaly and type of correction
–Amblyopia–uncorrected astigmatism > 1.5 D

Presbyopia

when you reach 40, lens become more rigid and elasticity decreases due to Deposit of insoluble proteins in the lens with advancing age. Therefore, accommodation and zoom effect will decrease.

when reading at a distance less than 30cm, the patient can't see clearly.

accommodation become less than 3 D-->reading is possible at 40-50 cm-->

Symptoms :
difficultly reading fine print , headache , visual fatigue

How to correct Presbyopia?
the patient will need reading glasses.

how presbyopia is different than hyperboia?

	Type of the error	Onset	Management (correction)
Hyperopia	their distance vision is generally better than their near vision	At Different ages	glasses for most of day-activities
presbyopia	Their distance vision is normal.	Related to old age (40+)	Glasses only for reading

Correction of refractive errors

- Far point: a point on the visual axis conjugate to the retina when accommodation is completely relaxed
- placing theimaging 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

A•Spectacle lenses

–Monofocal lenses :

spherical lenses for both myopia and hyperopia .

cylindrical lenses for anastigmatism.

- hyperopia: plus (biconvex) lens. The convex lens converges (concentrates) light rays so that the eye's lens focuses them on the retina
- myopia: mines (biconcave) lens. Because a concave lens is thin in the center and thicker on the edges, it diverges (spreads out) light rays so that the eye's lens focuses them directly on the retina.

–Multifocal lenses

For patients who have both refractive error and prespyopia. the glasses have 2 segment, upper part for refractive errors and lower for reading.

B-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 , corneal disease

–**disadvantages**: careful daily cleaning and disinfection , expense

–**complication**: infectious keratitis , giant papillary conjunctivitis , corneal vascularization , severe chronic conjunctivitis

C-Surgical correction

- Keratorefractivesurgery :

•Refractive surgery –flattens corneal surface for myopia

•Improves unaided visual acuity but may have complications

e.gPRK, LASIK,LASEK

- Intraocular surgery :

–give best optical correction for aphakia , avoid significant magnification and distortion caused by spectacle lenses

–clear lens extraction (with or without IOL), phakicIOL

Assessment of a patient with decreased visual acuity:

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

> pinhole: is a simple way to focus light, temporarily removing the effects of refractive errors such as myopia. Because light passes only through the center of the eye's lens, defects in the shape of the lens (errors of refraction) have no effect while the pinhole is used.

if the VA has improved with the pinhole, that means the patient has refractive error.

If the VA doesn't improve with the pinhole, that means the patient has different disorder like cataract, optic nerve disease

if the VA has improved a little bit with the pinhole, that means the patient has combined refractive error with other disorder.

Different ways to measure refraction:

- auto-refraction: computer-controlled machine used during an eye examination to provide an objective measurement of a person's refractive error. can be used for initial screening.hard to measure irregular astigmatism
- Retinoscope: manual more precise and the gold standard (used in conjunction with a trial frame and trial **lenses)**

How to detect the axial disorders of refractive errors:

Retinoscope: by detecting morphological changes

Ultrasound: to detect the size and the lesions if any exist.