Ophthalmology

Refractive Errors (Ammetropia) Dr Abdulmelik shallal

Introduction:

- Axial diameter: is the distance from tip of cornea to the center of macula, which is normally 24mm.
- The most important two refractive surfaces are cornea and lens.
- The power of cornea and the lens depends on curvature of their surfaces, so if we consider the cornea as a part of a sphere, it has a diameter of 7.8mm.
- The radius of curvature of anterior capsule of lens is 10 mm.
- The radius of curvature of posterior capsule of lens is 6 mm.
- If the curvature of cornea or lens is increased, or in other word, the radius of cornea or lens is decreased, then there is increase in refractive power of these structures and vice versa.
- For rays to come parallel, their source must be at distance of six meters and more from the eye, and if the source of rays is at distance less than 6 meters, then the rays will come divergent. The more close the source of rays to the eye, the more divergent they are.

Emmetropia (normal refraction):

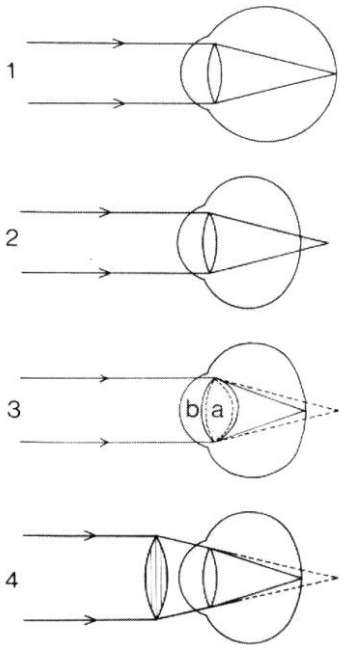
It is an eye in which *parallel* rays (i.e. from infinity, 6 meters or more) of light come to a *focus directly on the retina* when the eye is at *rest* {i.e. without accommodation = the eye is using its normal power (60D) only}.

- **Accommodation:** contraction of Ciliary muscle in order to increase curvature of lens (and so increase its refractive power more than 17D) to visualize objects closer than 6 meters (near objects).
- In order to see near objects, there will be contraction of Ciliary muscles which lead to decrease the tone of Zonule and their will be increase in the curvature of lens and increasing in the refractive power of lens (>60D).
- Amplitude of accommodation (difference between maximum contraction and complete relaxation, which depends on contraction power of Ciliary muscles and elasticity of capsule, and both of them decrease with advancing in age). Amplitude of accommodation decrease with advancing age as the following:
  * **Early in life**: it is 14D, so children can focus on objects 7cm away from their eyes, so the range of lens refractive power can be increase from 17D to 31D.
  * **At age of 36y:** due to atrophy of muscles and loss of lens elasticity (sclerosis), amplitude of accommodation will be 6D only, so the nearest object to the person which can be focused is at a distance of about 15cm away from eye.

*** At age of 45y:** amplitude of accommodation is 4D only, and the nearest focus point is 25cm away from eye.

*** At age of 60y:** amplitude of accommodation is 1D only, and the nearest focus point is 1m.

- Presbyopia: is a recession of near point due to decreased amplitude of accommodation.



Ammetropia: → Hypermetropia
→ Myopia
→ Astigmatism

Hypermetropia (hyperopia), far-sightedness: ⇨

Is a type of refractive errors in which parallel rays of light are brought to a *focus some distance behind the retina* when the eye is at rest.

Etiological classification:

1- Axial Hypermetropia: shorter antero-posterior axial length, i.e. the eye has normal converging power (60D) but its axial length is less than 24 mm.

2- Curvature Hypermetropia: due to decreased curvature (flattening) of the cornea congenitally or as a result of trauma or disease e.g. corneal ulcer, microbial keratitis.

3- Index Hypermetropia: decrease in effective refractivity of the lens.

***** power of lens depends on difference between refractive indices of the nucleus and cortex, so the more the difference the more converging power and vise versa. In index Hypermetropia, there is decrement of the difference.

Clinical classification:

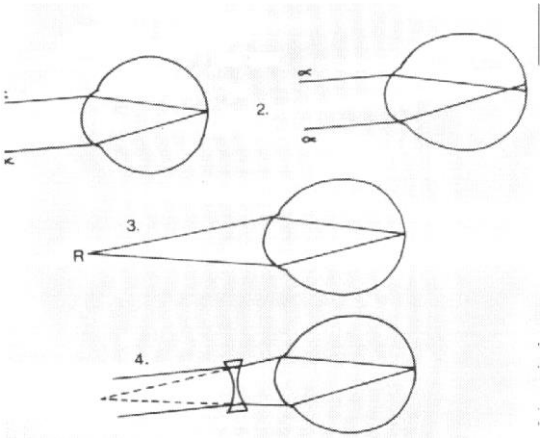
1- Facultative hypermetropia: hypermetropia corrected by accommodation (depends on age and degree of refractive error).

2- Absolute hypermetropia: hypermetropia out of amplitude of accommodation and corrected by glasses.

3- Manifest hypermetropia: maximum hypermetropia that can be corrected with a convex lens with accommodation active, i.e. = **Facultative + Absolute.**

4- Latent hypermetropia: hypermetropia hidden behind ciliary body tone which equal to the difference between total and manifest hypermetropia. The refractive power of the ciliary body is about 1-1.5D (usually it considered as part of the refractive power of lens, i.e. 17D of lens = 16D + 1D (of the ciliary body tone), it also decreases with age.

5- Total hypermetropia: amount of hypermetropia present with all accommodation suspended (with cycloplegic drugs, to exclude accommodation and tone of ciliary body) Manifest + Latent.



***** With advancing in age, the facultative will decrease and the manifest will be represented by absolute only, and at the same time, the latent will also decrease and the total will be represented by manifest only, so in old people the total is made of the absolute only.

Symptoms:

1- Blurred vision: for near work (as it needs more power) and even far vision if the degree (of hypermetropia) beyond amplitude of accommodation.

2- Eye strain: headache due to excessive accommodation and dissociation between Accommodative Convergence and Accommodation "AC/A: Accommodative Convergence to Accommodation ratio" (due to continuous contraction of ciliary muscle without interruption).

***** To see the near objects, the eye will show the near reflex, which consists of accommodation, convergence and miosis. When one of these processes occurs, it will stimulate the other two. Here we are concerned with accommodation and convergence. Normally, for each 1D of accommodation, there will be associating 4 prism D convergence (i.e. AC/A=4 prism D/1D). Therefore, in hypermetropia where we have dissociation or disorganization between accommodation and convergence causing headache and eye strain as in the following example:

A normal eye to see an object at distance of 50 cm needs 2D and this in turn will produce 8 prism D convergence, while an eye with 7D hypermetropia has at rest 28 prism D convergence, so to see an object at 50cm distance the 2D needed will produce 8 prism D more, so totally we have 36 prism D.

3- General symptoms like nausea and fatigue.

Treatment:

- Convex lens in spectacles (+ve lenses to increase refractive power).
- Contact lenses.
- Excimer laser photorefractive keratectomy: reshaping of the cornea to increase the refractive power, each 1mm decrease in radius of curvature increases the refractive power about 6D.
- Laser in situ keratomileusis (Lasik): it is needed for patients with high degree of hypermetropia (e.g. 20D, 25D).
- Non-contact laser thermal keratoplasty (Holmium laser spots): to change the coneal curvature.
- Phakic intraocular lens (IOL).

Diopter: the reciprocal of the distance in meters from the reference light source in air or vacuum, such that **D= 1/(distance in meters)**.

Myopia or short-sightedness:⇨

That form of a refractive error where parallel rays of light come to a focus in front of the retina when the eye is at rest.

- As there is increase in the refractive power of the eye, the near objects (closer than 6m) will be seen normally, while far objects (whom rays come parallel) will be focused in front of retina.

Aetiological classification:

1- Axial myopia: anteroposterior length is longer than normal.

2- Curvature myopia: increased curvature of cornea, or one or both surfaces of lens.

3- Index myopia: increased refractivity of lens, e.g. nuclear sclerosis (stage before nuclear cataract), due increase the difference between refractive indices of nucleus and cortex.

Clinical classification:

1- Simple (stationary): <6D, after the age of 4y, stationary (stops before 20y), normal physiological process and can be corrected.

2- Pathological (progressive): >6D, before the age of 4y, progress even after age of 20y, real pathological process and cannot be corrected as the real pathological process still found **(**if the patient has myopia of 20D, then even if we give glasses with -20D, he will still having refractive error).

Symptoms:

1- Distance object "Blurred", near objects clear.

2- Headache due to sustained contraction of occipito-frontalis muscle, eye strain due to dissociation of AC/A.

***** A normal eye to see an object at distance of 50 cm needs 2D (1/0.5m=2D) and this in turn will produce 8 prism D convergence, while a eye with 2D myopia will not need any accommodation to see this object, but there will convergence 8 prism D to see this near object. Thus is in turn will produce 2 D accommodation which is not needed by myopic patient. So any myopic should wear glasses for near to create normal relation between accommodative convergence and accommodation.

3- general symptoms like fatigue and nausea.

Treatment:

- Concave lenses in spectacles.
- Contact lens.

- Radial keratotomy
- Excimer laser photorefractive keratectomy. - Lasik.
- Pkakic IOL.
- Normal Lens extraction:

Astigmatism

Astigmatism is that condition of refraction in which a point of focus of light cannot be formed upon the retina. The optical condition is that instead of a single focal point, there are two or more focal lines (depending on the type of astigmatism), separated from each other by a focal interval.

Etiological classification:

1- Curvature astigmatism: Most commonly, it is corneal, where vertical curvature is more than horizontal curvature (due to pressure of the upper eyelid), less commonly it is lenticular (induced by lens).

2- Decentering astigmatism: subluxation of lens.

3- Index astigmatism: due to cataract in one meridian.

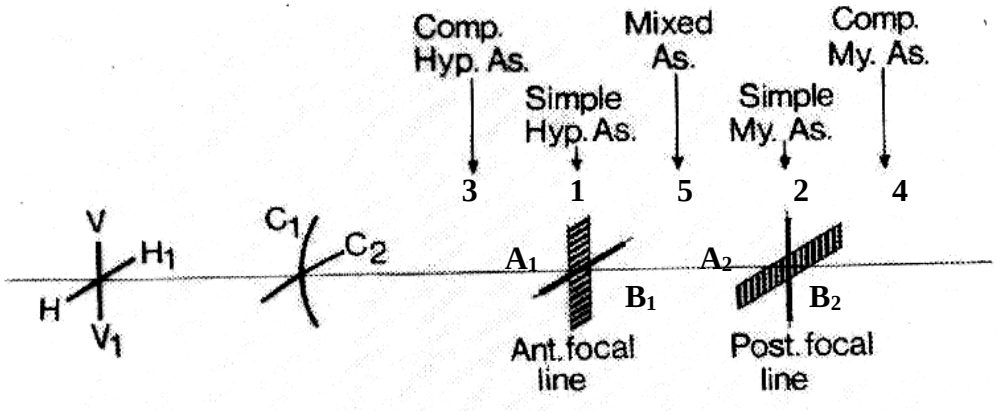
Clinical classification:

1- Regular: two principle meridians at right angle are involved (i.e. there is difference in the refractive power of two meridians 90° in between):

a- Simple astigmatism: myopic or hypermetropic; one of the foci falls on retina, other in front or behind it.

b- Compound astigmatism: neither of the two foci lies upon retina, but are both placed in front or behind retina (myopic or hypermetropic respectively).

c- Mixed astigmatism: one focus in front and other behind retina.



***** This figure represents the appearance of the image in astigmatism (regular), we have two perpendicular meridians; vertical (V-V_1) and horizontal (H-H_1), we see that the refractive power of the vertical meridian is larger than that of horizontal one as the curvature of the vertical meridian (C_1) is larger than the curvature of the horizontal meridian (C_2).

So as we see in (1), the image of vertical meridian is focused as (A_1) line on the retina (normal), while the horizontal meridian image focused behind the retina (hypermetropic) and blurred on retina as (B_1) line, so it is called **"Simple hypermetropic astigmatism"**. In (2), vertical meridian image is focused in front of the retina (myopic) and its image on retina is blurred (A_2), while horizontal meridian image (B_2) is focused on the retina (normal), so it is called **"Simple myopic astigmatism"**. In (3) and (4) both image are focused behind or in front of retina respectively and called **"Compound hypermetropic or myopic astigmatism"**. While in (5), one image focused in front of and the other behind the retina and so it is called **"Mixed astigmatism"**.

2- Irregular astigmatism: refraction in different meridians is quite irregular. Found in pathological condition of cornea; irregular healing after trauma or inflammations or keratoconus.

Treatment:

- Cylindrical lenses in spectacles: only for simple astigmatism.

-Contact lenses: used for compound and mixed astigmatism, where we correct one of the meridians by them, and then correct the other meridian by cylindrical lenses (i.e. we switch it to simple and correct it accordingly).

- Photorefractive Excimer laser surgery: Also we correct one meridian.

-LASIK: like photorefractive Excimer laser surgery, but used for higher refractive error.

- Phakic Toric IOL.

- Keratoplasty (corneal graft): for more than two meridians and central corneal opacity.