

جامعة المستقبل / كلية التقنيات الصحة والطبية
المرحلة الثانية

المحاضرة السابعة

Department of Optics Techniques

Lecture7

Errors of refraction


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Errors of refraction


An eye that has no refractive error when viewing distant objects is said to have *emmetropia* or be *emmetropic* meaning the eye is in a state of in which can focus parallel rays of light (light from distant objects) on the retina, without using any accommodation. An eye that has refractive error when viewing distant objects is said to have *ametropia* or be *ametropic*. This eye, when not using accommodation, cannot focus parallel rays of light (light from distant objects) on the retina. The word "ametropia" can be used interchangeably with "refractive error" or "image formation defects." Types of ametropia include myopia, hyperopia and astigmatism. They are frequently categorized as [spherical errors](#) and [cylindrical errors](#):

Conditions of refractive anomalies :


1. The position of the elements of the system

 The antero-posterior diameter of the eye is too short, and the retina is too near the optical system: Axial hypermetropia.

 The antero-posterior diameter of the eye is too long, and the retina is too far away from the optical system: Axial myopia.

 Lenticular displacement. If the crystalline lens is dislocated forwards, myopia will exist; if backwards, hypermetropia.

2. Anomalies of the refractive surfaces

 The curvature of the cornea or of the lens may be too small, giving a curvature hypermetropia

 Or too great, giving a curvature myopia.

 Or be irregular, varying in different meridians, giving astigmatism.


In hypermetropic astigmatism, the curvatures of both axes are unequal and too small; in myopic astigmatism they are both unequal and too great; when the two conditions are combined so that one axis is hypermetropic and the other myopic, the condition is termed mixed astigmatism.


i. If the axes showing the greatest difference in curvature are at right angles, regular astigmatism.

ii. If they are not so related, the astigmatism may be called bioblique.


iii. If there is no symmetry about the refraction and different groups of rays form foci at different positions, as occurs in the cornea after corneal ulceration or in the lens in developing cataract, irregular astigmatism.


3. Obliquity of the elements of the system

 Lenticular obliquity. If the lens is placed obliquely or subluxated, astigmatism will result.

 Retinal obliquity. The posterior pole of the eye may be placed obliquely.

4. Anomalies of the refractive index

 If the refractive index of the aqueous humour be too low, or that of the vitreous humour too high, there will be an index hypermetropia.

 If the refractive index of the lens as a whole be too low, there will be an index hypermetropia.

5. Absence of an element of the system

Absence of the lens, a condition known as aphakia produces hypermetropia.

Myopia

Myopia (shortsightedness): is a type of refractive error in which parallel rays of light coming from infinity are focused in front of the retina when accommodation is at rest.

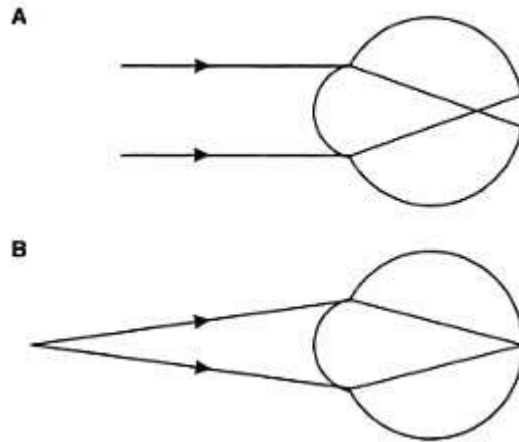


Fig. (1) optics of myopia: A. parallel rays are focused in front of retina. B. divergent rays from an object situated at the far point of the eye are focused at the retina.

Mechanism of production

1. Axial myopia results from increase in antero-posterior length of the eyeball.
2. Curvatural myopia occurs due to increase curvature of the cornea, lens or both.
3. Positional myopia is produced by anterior placement of crystalline lens in the eye.
4. Index myopia results from increase in the refractive index of the crystalline lens associated with nuclear sclerosis.
5. Myopia due to excessive accommodation occurs in patients with spasm of accommodation.

Optics of myopia

- 🕶️ Optical system of a myopic eye is too powerful for its axial length.
- 🕶️ Image of distant object on the retina is made up of the circles of diffusion formed by divergent beam, since the parallel rays of light coming from infinity are focused in front of the retina (Fig.2.A).
- 🕶️ Far point of the myopic eye is a finite point in front of the eye. Therefore, a near object situated at the far point is focused without an effort of accommodation (Fig.2.B).
- 🕶️ Nodal point in a myopic eye is further away from the retina. Therefore, the image formed will be appreciably larger than it would be in the emmetropic eye and in spectacle corrected eye.
- 🕶️ Angle alpha of the eye may be negative, resulting in the apparent convergent squint.
- 🕶️ Accommodation in uncorrected myopes is not developed normally. Since they need not accommodate to see the near objects clearly.

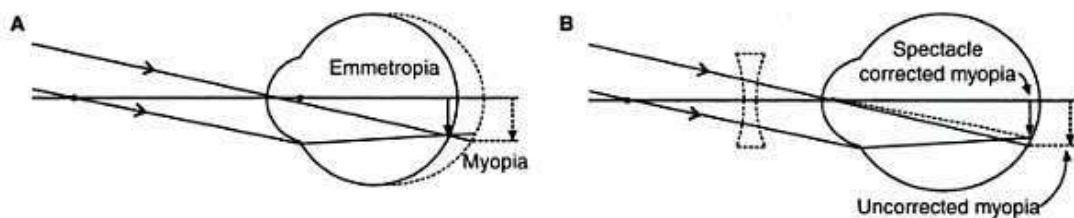


Fig. (2) : image formed in an uncorrected myopia is larger than formed by an emmetropic eye (A) and spectacle-corrected myopia (B).

Clinical varieties of myopia

1. Congenital myopia
2. Simple or developmental myopia

3. Pathological or degenerative or progressive myopia
4. Acquired myopia
 1. Congenital myopia

Is present since birth, it is usually diagnosed by the age of 2-3 years. It is seen more frequently in children who were born prematurely or with various birth defects, such as Marfan's syndrome and homocystinuria. Most of the time, the error is unilateral and manifests as anisometropia. rarely, it may be bilateral. It is usually associated with an increase in axial length and overall globe size. It may be associated with congenital convergent squint. Usually the error is of about 8-10 D, which mostly remains constant. Congenital myopia may sometimes be associated also with cataract, microphthalmos, aniridia, megalocornea and congenital separation of retina.

Simple (physiological, school) myopia




Simple or developmental myopia. About 29% of general population have low myopia (2 D) and about 7% have moderate myopia (2-6 D).

Aetiology

Simple myopia results from normal biological variation in the development of eye. Inheritance is considered to be autosomal dominant. The factors associated with simple myopia are as follows:





Axial type of simple myopia may signify just a physiological variation in the length of the eyeball or it may be associated with precocious neurological growth during childhood.

-  Curvature type of simple myopia is considered to be due to under development of the eyeball.
-  Role of diet in early childhood
-  Theory of excessive near work in childhood.

symptoms

1. Poor vision for distance (shortsightedness) is the main symptom of myopia. The visual acuity beyond the point of maximum remoteness is severely.
2. Asthenopic symptom may occur in patients with small degree of myopia. Symptom of the eye strain develops due to dissociation between convergence and accommodation. Any of the two situations may arise:

-  For near vision myopes need accommodate, so they may develop convergence weakness and exophoria and suppression in one eye.

-  Alternately, while focusing at near objects the patients converge and so there may occur associated excessive accommodation.

1. Change in psychological outlook of the uncorrected myopic children is very common.

Signs

1. The myopic eyes typically are large and somewhat prominent.
2. Anterior chamber is slightly deeper than normal.
3. Pupils are somewhat large and a bit sluggishly reacting.
4. Fundus is normal; rarely temporal myopic crescent may be seen.
5. In simple myopia, usually the error does not exceed 6-8 D.

3. Pathological myopia

It is a rapidly progressive error resulting in high myopia during early adult life which is usually associated with degenerative changes in the eye. Prevalence of pathological myopia in general population is about 2-3%.