Vision 2020 e-resource
- for eyecare management worldwide

REFRACTION

VISION 2020
THE RIGHT TO SIGHT

ARAVIND EYE CARE SYSTEM

Refractive errors

Introduction

An easily detectable and correctable condition like REFRACTIVE ERRORS still remains a significant cause of avoidable visual disability in our world. In developing countries, like India, it is estimated to be the second largest cause of treatable blindness, next only to cataract.

A recent survey shows an increase in the incidence of refractive errors as a cause of social blindness from 12% to 15%, whereas the burden of cataract has actually decreased from 80% to 62% (Source: National Survey of Blindness 1986-89 and 2001-02).

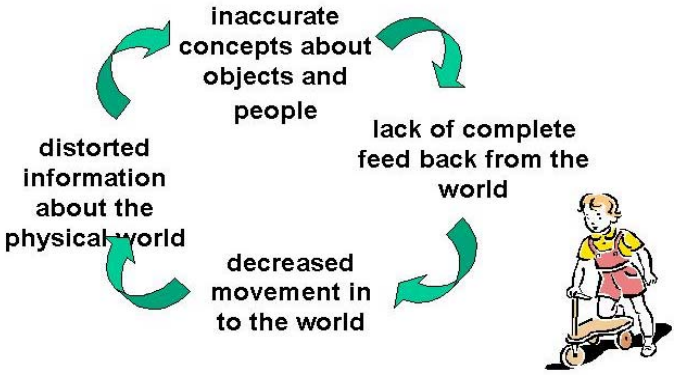
Why are Refractive Errors such a cause of concern?

A child whose refractive error is corrected by a simple pair of spectacles, stands to benefit much more than an operated patient of senile cataract – in terms of years of good vision enjoyed and in terms of overall personality development.

Refractive errors can be improved by glasses.

Refractive errors are easily corrected with spectacles. Left uncorrected, it can not only affect the mental development of the child as such but also result in irreversible diminution of vision – a condition called **Amblyopia**, or in disfiguring conditions like **Squint**.

Impact of Vision loss on Development



The frustrated child becomes an introvert, keeping away from other children of his age and avoids outdoor activities.

In an adult, whose near vision is failing –called **Presbyopia** – the uncorrected disability hampers his financial productivity and compromises his occupational skills.

Conditions like **Pathological Myopia**, if not diagnosed early and followed up regularly can result in permanent loss of vision due to retinal scarring or retinal detachment.

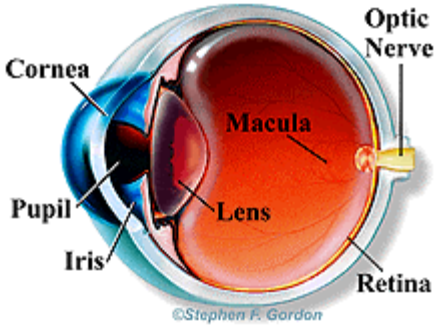
An operated patient of cataract without an intra ocular lens – **Aphakia** – is also blind for all practical purposes, unless he receives his refractive correction.

The problem of refractive errors is also grossly under documented as the definition of blindness is in terms of best corrected distance visual acuity – *which refers to the smallest letter the patient is able to read on a Snellen's visual acuity chart*.

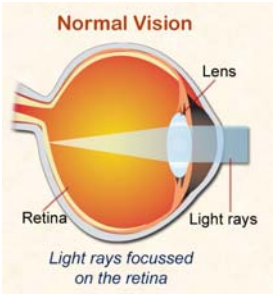
Whereas the presenting distance visual acuity – *the individual's current refractive correction* – permits assessment of blindness due to refractive errors.

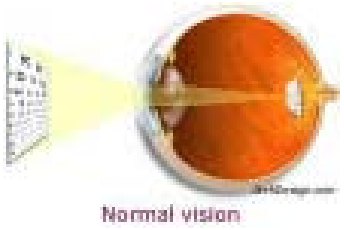
The increasing realization of this impact due to refractive errors worldwide has been the reason for prioritizing this group of disorders under **Vision 2020 – The Right to Sight**.

A working knowledge of the optics of the eye and the refractive errors helps us understand this problem better.



The human eye is a specialized camera that focuses light rays from objects as images on the light sensitive film – the retina. The focusing mechanism consists of a pliable crystalline lens, the cornea and the refracting media in the eyeball. The whole refracting system of the eye can be assumed to one whole lens, which functions as a unit.





In a camera, the focusing mechanism moves the lens forward or backwards to focus the image clearly. In the eye, the crystalline lens does this job by swelling up or thinning out.

The thinned out lens focuses distant images, while the swollen, thick lens focuses near objects – a process called **Accommodation**.

An inability to focus images clearly on the retina resulting in forming blurred images, is called a REFRACTIVE ERROR

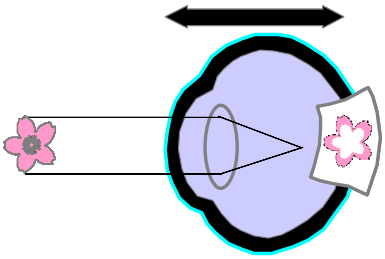
The common types of refractive errors are:

- **Myopia** or Short sightedness or near sightedness
- **Hypermetropia** or Long sightedness or Far sightedness
- **Astigmatism**

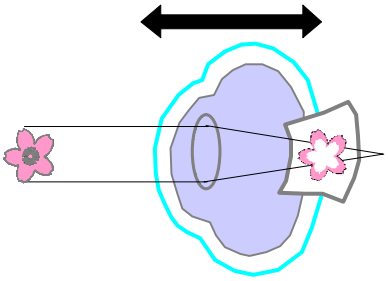
The anomalies could be because of:

The length of the eyeball being too long (in myopia) or too short (as in hypermetropia), a condition termed **Axial** Myopia and **Axial** Hypermetropia, respectively.

Myopia: too long

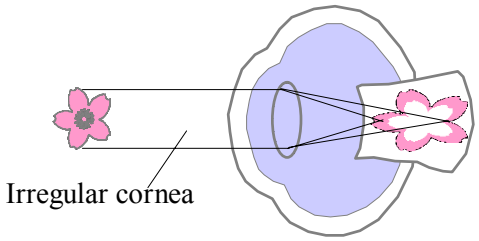


Hypermetropia: too short



The cornea maybe too steep (in myopia) or too flat (in hypermetropia) – **Curvature** myopia or **curvature** hypermetropia. The surface of the cornea maybe irregular giving rise to astigmatism.

Astigmatism



The refractive index of the media maybe too low (hypermetropia) or too high (myopia) – this is called **index** myopia and **index** hypermetropia, respectively.

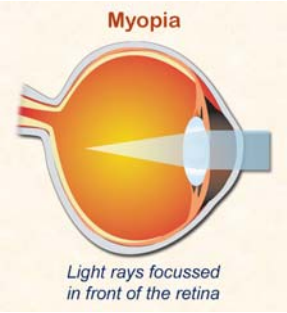
Note: Index myopia is seen in developing cataracts.

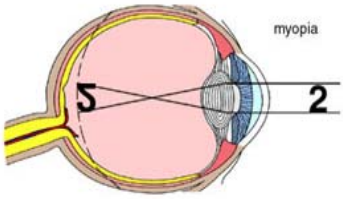
Myopia

In myopia, the person is <u>unable to see distant objects clearly,</u> but can see near objects well.

Rays of light are focused in front of the retina instead of being focused on it.

It is the commonest cause of refractive error and usually detected in the younger age group.





It consists of two main types:

Simple: is just a variant of the normal and is not a major problem

Pathological (or progressive): as the name suggests is of a more serious nature.

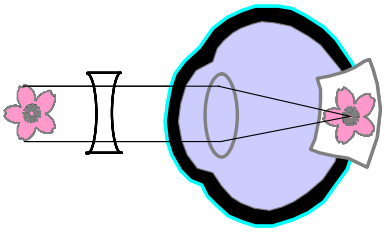
In pathological myopia the retina becomes very thin and is stretched at the periphery. The peripheral retina is at risk of developing tears or holes. This can lead to a sudden loss of vision due to the retina separating off from its base – termed **Retinal detachment**, or a progressive scarring of the retina and its underlying layers causing a chronic diminution of vision – called **Chorioretinal atrophy**.

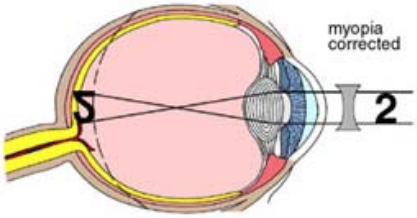
The myope's main complaint is that he doesn't see distant objects clearly.

The defect may also manifest as headache, watering from eyes and constant itching of the eyes – all these symptoms are a result of the eyestrain induced by the refractive error.

A child who is not so eloquent with his complaints would tend to read his books very close to his face and sits closer to the black board in his class.

Correction of Myopia is with lenses that bend light outward i.e., Divergent lenses or Concave lenses. They are denoted by a minus ' – ' sign.

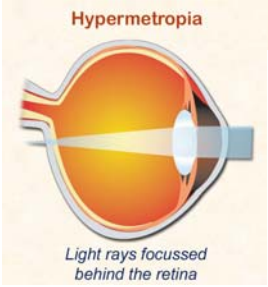


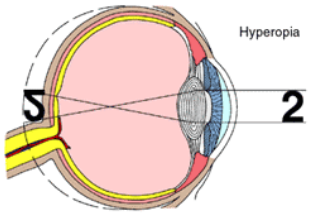


Hypermetropia

The person is <u>unable to see near objects well</u>.

The light rays are focused behind the retina instead of on the retina. The eye tries to focus the images by increasing the refractive index of the lens (by making it thicker) –the process is called **Accommodation**.

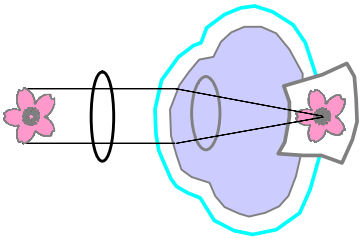


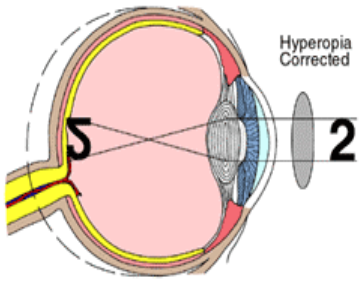


The hypermetrope's complaint is that he is unable to do near work very well. He has headache and eyestrain following any prolonged near work like desk jobs or sewing. These symptoms are collectively termed **Asthenopia**.

Although hypermetropia can be detected at any age, it generally becomes manifest more with increasing age.

Correction of hypermetropia is by giving lenses which bend light inwards to fall on the retina i.e. Converging lenses or Convex lenses, denoted by a plus '+' sign.



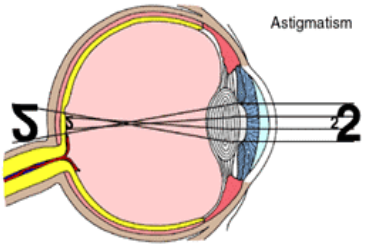


Note: Hypermetropia in children is more likely to cause a permanent diminution of vision called **Amblyopia**.

Astigmatism

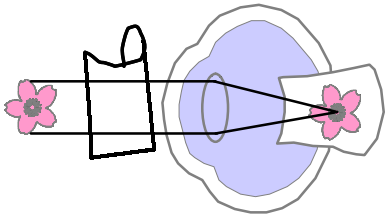
In this condition the eye is unable to form a point focus of light upon the retina.

Instead of a single focal point of the image being formed, there are two foci that are separated by a distance. *Hence the person is unable to see an image clearly in one meridian when he is focusing on another meridian*



A person with astigmatism is more likely to complain of headache or eyestrain than of blurred vision.

Correction of Astigmatism is with cylindrical lenses that correct the error in that particular meridian only.



Presbyopia

Is a disorder of aging when the eye is <u>unable to focus near objects.</u>

Presbyopes are usually people in their fourth decade, who find it increasingly difficult to read the newspaper at their usual working distance

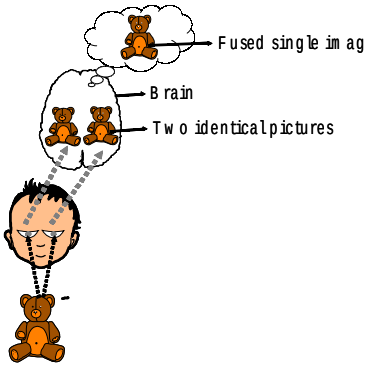
in dim light and tend to keep it at a distance to make out the letters. Simple tasks like threading a needle, putting one's signature on a document or making out the fine print on a visiting card become increasingly difficult and sometimes embarrassing.

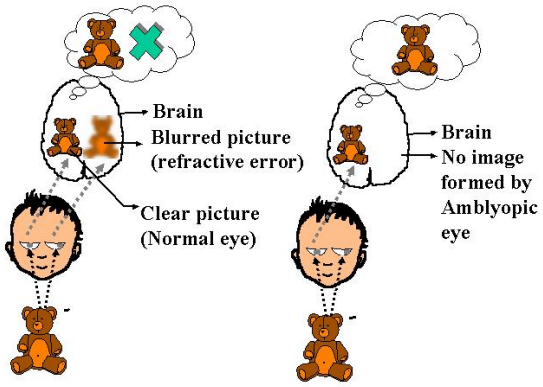
For artists and artisans who depend on their near vision for livelihood, it can even become economically crippling. Headaches and eye – strain may occur after long hours of near work.

The problem in presbyopia is the aging of the lens and the accommodating system, which fails to focus near objects on the retina.

Correction of presbyopia is with convex lenses, which can be used while reading and near work.

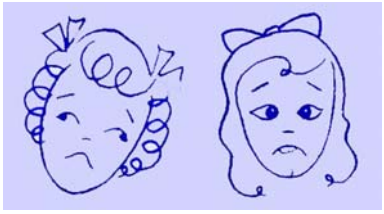
Amblyopia: Is an irreversible decrease in vision due to an uncorrected refractive error. The uncorrected eye becomes accustomed to a poor clarity of image and fails to correct even with spectacles.





Note: Hypermetropia is more commonly associated with amblyopia.

Squint: An uncorrected refractive error in an eye, which becomes amblyopic may deviate to one side because of the disuse. This results in a disfigurement called **Strabismus** or Squint.



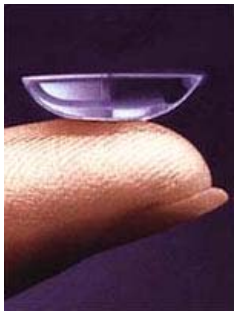
Refractive error correction

Spectacles offer the easiest and economic solution to refractive error correction. They are suitable for all ages and all types of errors.

Spectacles offer a narrow field of vision and maybe an obstacle for certain outdoor activities such as sports.

Note: It is estimated, that to address the current demand, we need a system and capacity for delivering 70 million spectacles a year, assuming that the average spectacle will last for three years on account of change in prescription or damages.

Contact lenses are thin polymers, which are placed directly on the corneal surface.

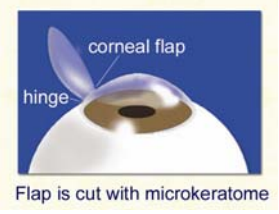


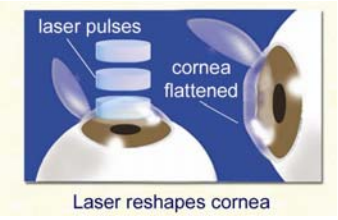
They are an aesthetically fashionable and sometimes, a necessary alternative to spectacles. In high myopes - people with a very high refractive correction – spectacles may themselves cause an image distortion that is unacceptable for clear vision and restrict the field of vision

of the person. In such individuals contact lenses offer a better quality of vision.

Contact lenses require careful handling and maintenance. They have to be changed every month or every year as per the manufacturer's instructions.

Refractive surgery: **LASIK** – Laser Assisted In-situ Keratomileusis – is a complex procedure where a laser beam is used to reshape the cornea as per the refractive error correction. Though a very modern and attractive form of permanent spectacle correction, it should be done only in deserving cases in individuals above 18 years of age.





LASIK has its own set of complications and should not be considered superior to spectacles.

To sum up, Refractive errors is a major cause of unavoidable blindness all over the world and in all age groups. There are three types of Refractive errors – Myopia, Hypermetropia and Astigmatism. Myopia is the inability to see distant objects clearly. Hypermetropia is difficulty in seeing near objects well. Astigmatism is a problem in focusing objects clearly. Presbyopia is an age related disorder causing difficulty in near work.

Refractive errors can be easily be corrected by spectacles. The alternatives are contact lens and refractive surgeries, like LASIK. If left uncorrected, refractive errors can lead to permanent complications like Amblyopia and Squint.

Suggested Reading:

1. Refractive Error Blindness – Rakhi and Lalit Dandona, Bulletin of WHO – 2001, 79(3) – pg.237.
2. Elimination of avoidable visual disability due to refractive errors – Report of an informal planning meeting, Geneva 3-5 July 2000, WHO/PBL/.0079 pg 1-22
3. Spectacles for the Millions, R D Thulasiraj et al., Health for the Millions, Aug-Sep 2002, pg 21-23.
4. Duke-Elder, Principles and Practice of Refraction.