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First Year

Ophthalmic Technician

Paper I : Anatomy, Physiology and Pharmacology
Paper II : Physical & Physiological Aspects of Spectacles
Paper III : Community Ophthalmology and Health Education

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Paper III : Community Ophthalmology and Health Education

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Paper I : Anatomy, Physiology & Pharmacology

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UNIT 1

Anatomy of the Eye

Structure

1.0 Introduction

Human eye lies in the cone shaped cavity of the orbit and has a diameter of 24mm , approximate measurement specification and the distance between the midpoint of two pupils lie about 60mm.

If the length of the eye ball is too short in relation to the lens, near objects are focused behind the retina (hypermetropia: farsightedness or longsightedness). In contrast, if the length of the eye ball is too long in relation to the lens, distant

objects are focused in front of the retina (myopia: nearsightedness or shortsightedness) The development of the eye is summarized in figure . The retina, which may be regarded as an extension of the wall of the brain, develops from neural ectoderm, whereas the lens and the anterior epithelium of the cornea are derived from somatic ectoderm. Which actively participate in ocular development.

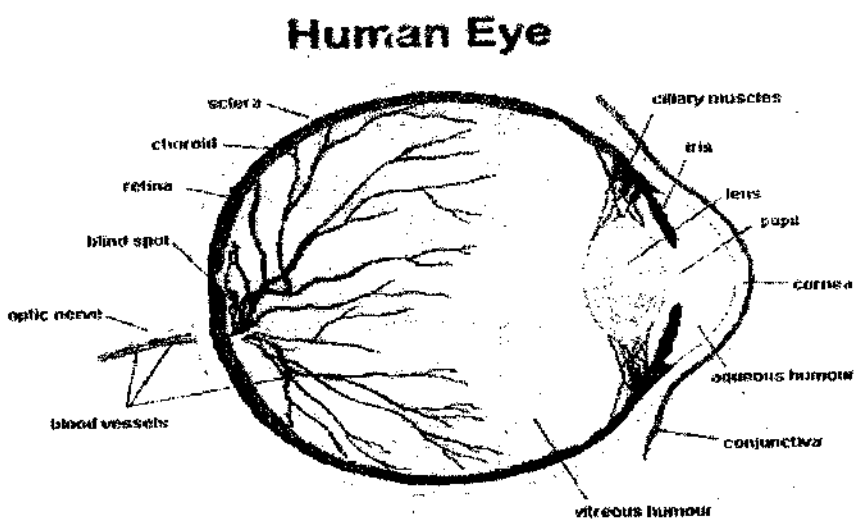

Fig 1.1 Human Eye

Layers of Eye Ball

The eyeball (globe or bulb) has three concentric coverings:

(1) An external, fibrous tunic comprising the cornea and sclera;

(2) A middle, vascular tunic comprising the iris, ciliary body, and choroid; and

(3) An internal, nervous tunic, or retina.

1.1 External fibrous Layer (Conjunctiva Cornea & Selera)

The cornea is the anterior, transparent part of the eye, and it forms about one-sixth of the circumference of the fibrous coat. Most of the refraction by the eye takes place not in the lens but at the surface of the cornea. The cornea is continuous with the conjunctiva and the junctional region is known as the limbus. The cornea is supplied by the ophthalmic nerve (from the fifth cranial nerve) by means of its ciliary branches. The eyelids close on stimulation of the

cornea (corneal reflex,). The cornea is avascular and consists of five layers histologically: a largely collagenous substantia propria enclosed by anterior and posterior epithelia and limiting laminae.

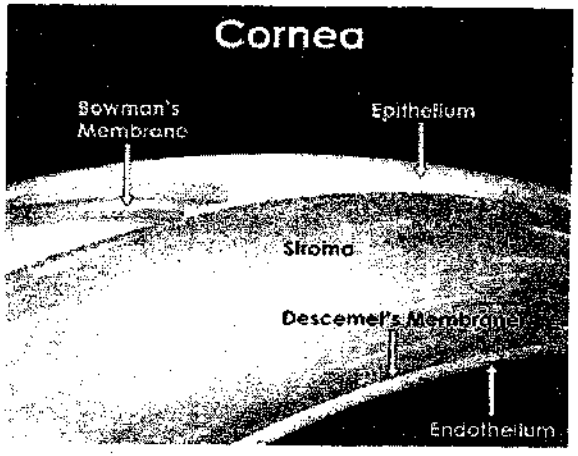

Fig 1.2 Cornea

When the cornea does not conform to a sphere but is more curved in one axis than in another, the condition is termed astigmatism.

Irritation of the eye, e.g., from a foreign body, causes hyperemia of the conjunctiva, which may also result from infection or allergic conditions (conjunctivitis). The posterior conjunctival arteries (from the palpebral arcades, become dilated and give a brick-red color to the conjunctiva.

Inflammation of the cornea (keratitis) or of the iris and ciliary body (iridocyclitis) causes dilation of the anterior ciliary arteries (from muscular branches of the ophthalmic, resulting in a rose-pink band of "ciliary injection". These vessels, unlike those of the conjunctiva, do not move when the conjunctiva is moved.

The sclera is the posterior, opaque part of the external layer. Its anterior part can be seen through the conjunctiva as "the white of the eye". The sclera consists of fibrous tissue, and it receives the tendons of the muscles of the eyeball. Posteriorly, the fibers of the optic nerve pierce the sclera through a weak plate termed the lamina cribrosa .External to the sclera, the eyeball is enveloped by a thin fascial sheath (so-called Tenon's capsule) that extends from the optic nerve to the sclerocorneal junction The sheath separates the globe from the orbital fat and acts as a socket in which the eye moves as in a ball-and-socket joint. It blends with the sheaths of the muscles of the globe.

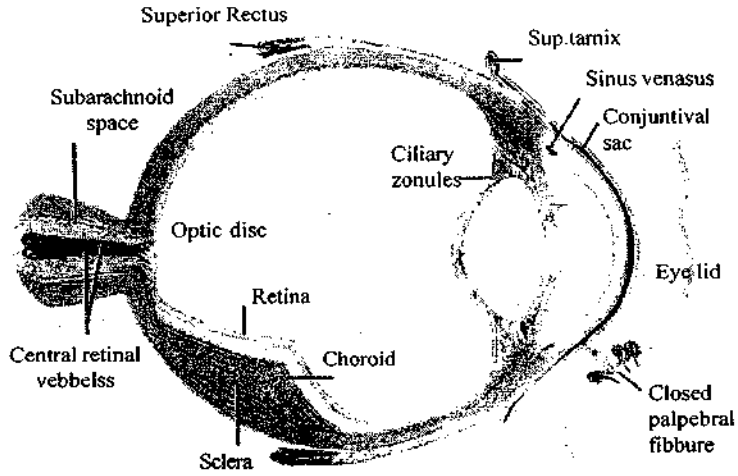

Fig 1.3

Hormonal disturbances (especially hyperthyroidism) may result in swelling of the orbital fat and extra-ocular muscles, causing protrusion of the eyes (exophthalmos).

An important, circular canal termed the scleral venous sinus (known to ophthalmologists as the canal of Schlemm) is situated at the sclerocorneal junction, anterior to a projection termed the scleral spur. The aqueous humor, formed by the ciliary processes, filters through intercellular channels leading from the anterior chamber to the venous sinus and drains by means of aqueous veins into scleral plexuses. The iridocorneal angle (between the iris and the cornea), also known as the angle of the anterior chamber or as the filtration angle, is very important physiologically (for the circulation of aqueous humor) and pathologically (in glaucoma).

1.2 Middle vascular Layer(Uvea Iris And Ciliary body)

The middle layer, frequently termed the uvea, comprises the choroid, the ciliary body, and the iris, from posterior to anterior.

(a) The choroid is a vascular, highly pigmented coat that lines most of the sclera.

(b) The ciliary body connects the choroid with the iris. The part near the choroid is a smooth ciliary ring (pars plana), whereas that near the iris is a ridged crown (pars plicata). The ciliary body contains the ciliary muscle and the ciliary processes, and is lined by the ciliary part of the retina.

The ciliary muscle comprises two main sets of smooth-muscle fibers :

(1) longitudinal fibers connect the sclera (anterior) to the choroid (posterior), and

(2) oblique fibers enter the base of the ciliary processes. The ciliary muscle is supplied by parasympathetic fibers by way of the ciliary nerves. On contraction, the ciliary body moves anteriorward. This decreases the tension on the fibers of the ciliary zonule so that the central part of the lens assumes a more globular, curved shape to permit the eye to focus on near objects, a process known as accommodation .

The ciliary processes, about 70 in number, are arranged in a circle posterior to the iris. They are the site of secretion of the aqueous humor.

The iris is a circular, pigmented diaphragm that lies anteiro to the lens in a more or less coronal plane. It is anchored peripherally to the ciliary body, whereas its central border is free and bounds the aperture known as the pupil. The iris divides the space between the cornea and the lens into two chambers. The anterior chamber is bounded largely by the cornea and iris. It communicates through the pupil with the posterior chamber, which is bounded by the iris, ciliary processes and zonule, and lens. Both chambers are filled with aqueous humor.

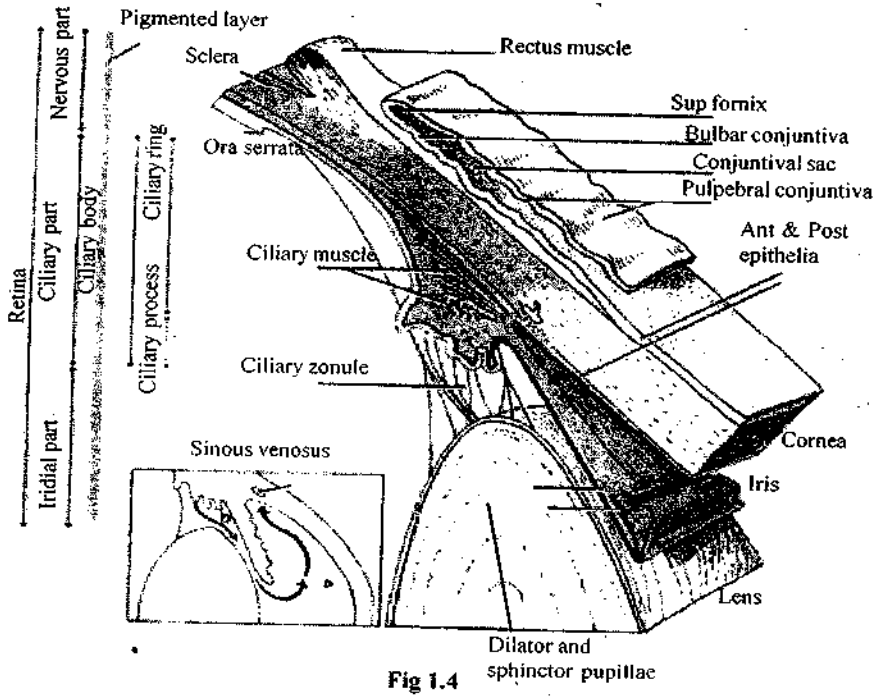

Fig 1.4

The anterior surface of the iris presents a fringe known as the collarette. The pattern of radial striations in the iris is unique from one individual to another and, like fingerprints, can be used for identification. The stroma of the iris normally contains melanin pigment. and the amount, which is low in blue eyes. is considerable in brown irides. A congenital, radial defect of the iris is termed a coloboma.

The sphincter pupillae is situated in the posterior part of the iris, near the pupil, and consists of smooth muscle. The sphincter pupillae is supplied by parasympathetic fibers by way of the short ciliary nerves, and its contraction results in constriction of the pupil (miosis). The iris contracts reflexly when light reaches the retina (the light reflex) and when focusing on a near object (part of the accommodation reaction). A drop of an atropine-like drug placed on the eye annuls the action of the ciliary muscle and the sphincter pupillae, both of which are under parasympathetic control. The resultant dilatation of the pupil (caused by overaction of the dilator) is of use in the examination of the eye.

The dilator pupillae consists of smooth muscle anterior to the pigmented epithelium on the posterior aspect of the iris, which constitutes the iridial part of the retina. The dilator pupillae is supplied by sympathetic fibers. and its contraction results in dilatation of the pupil (mydriasis). This sympathetic innervation arises as preganglionic nerve fibers leaving the spinal cord in the upper 4 thoracic ventral roots. White rami communicans transmit the sympathetics to the gangliated chain and the preganglionic fibers enter and ascend the cervical sympathetic chain. These sympathetic preganglionic fibers synapse in the superior cervical ganglion. Postganglionic sympathetic nerve fibers originating from this ganglion join the carotid artery and comprise a dense plexus of nerves surrounding the branches of this artery. The nerve fibers follow the internal carotid and ophthalmic arteries to reach the eye. Damage to sympathetic nerve fibers anywhere along this pathway can result in Horner syndrome, with a small (meiotic) pupil and slight drooping of the upper eyelid due to paralysis of the superior tarsal muscle.

The autonomic innervation.

- The autonomic innervation of the eye may be summarized in the following manner.
- Parasympathetic (synapses in ciliary ganglion) - sphincter pupillae, ciliary muscle.
- Sympathetic (synapses in superior cervical ganglion) - dilator pupillae, orbitalis (smooth muscle of inferior orbital fissure), superior tarsal muscle (smooth muscle in eyelid), blood vessels of choroid and retina.

1.3 Internal nervous tunic (retina & Choriod)

The retina contains special receptors on which is projected an inverted image of objects seen. Because of the partial crossing of nerve fibers at the optic chiasma, the retina of each eye is connected with both right and left visual areas of the forebrain. The retina is shaped like a sphere that has had its anterior segment removed, leaving an irregular margin termed the ora serrata . The sensory elements of the retina end at the ora. but a pigmented continuation lines the ciliary body and the posterior part of the iris as the ciliary and iridial parts of the retina. In other words, the ciliary body and the posterior iris are lined by retinal epithelium (a double layer), which, however, is insensitive to light.

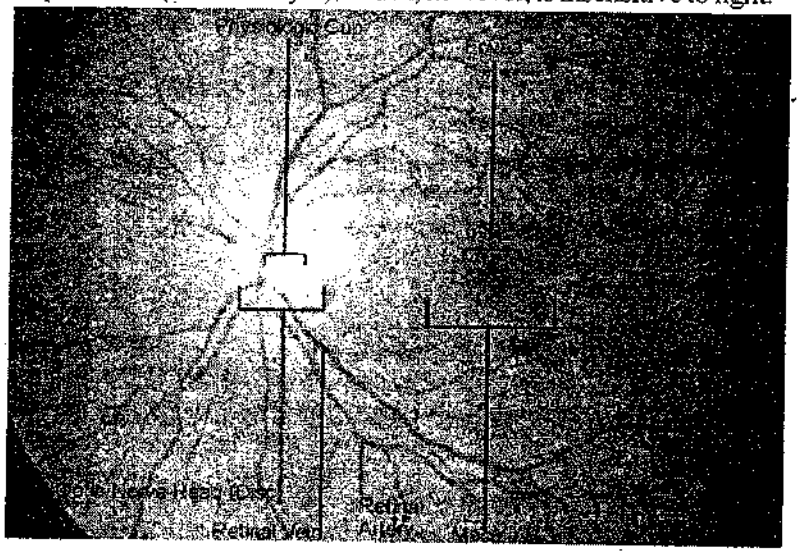

Fig 1.5

Basically, the retina comprises two main strata: (1) an external, pigmented stratum derived from the external lamina of the embryonic optic cup and (2) an internal, transparent, nervous stratum derived from the inverted lamina of the optic cup. A separation of the nervous from the pigmented stratum may occur along a plane that represents the residual cavity of the embryonic optic vesicle. This is commonly called detachment of the retina, and it may arise from an accumulation of fluid caused by a hole or a tear in the retina. Methods for repair include the use of a cryoprobe or a laser to produce an adhesive scar between these layers, preventing further separation.

The macula is a small, yellowish area of the retina on the temporal side of the optic disc .It contains a pit, the fovea centralis, which in turn presents a

depression, the foveola. The foveola contains only cone photoreceptor cells and functions in detailed color vision, when an object is looked at directly.

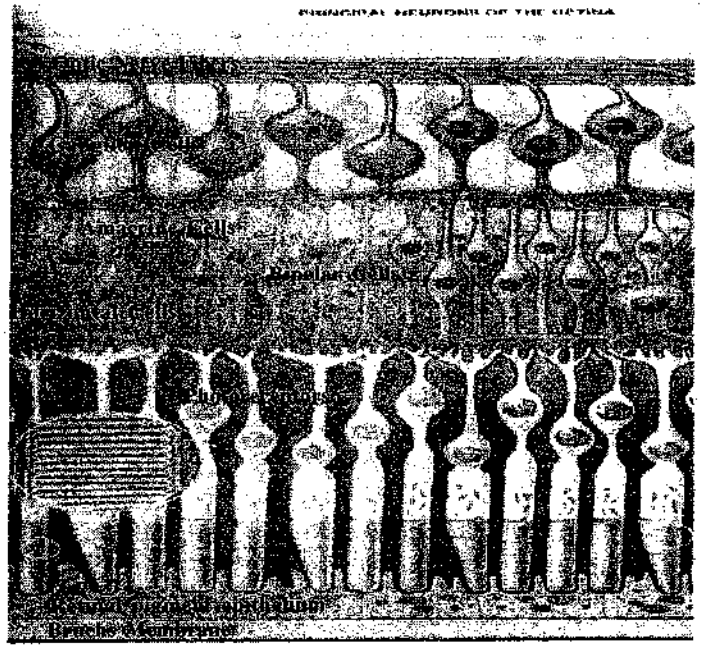

Fig 1.6

The entering optic nerve fibers form the optic disc. This is the "blind spot", insensitive to light because photoreceptor cells are absent there. It is situated nasal to the posterior pole of the eye and to the fovea centralis. Normally the optic disc is flat and does not form a papilla, but, near its center, where vessels enter and leave, a variable depression, the "physiological cup", is present.

The optic nerve is surrounded by meningeal sheaths and the subarachnoid space, so that an abnormal rise in intracranial pressure (e.g., caused by an intracranial tumor or hemorrhage) also places pressure on the optic nerve. This may result in a hydrostatic phenomenon that can be detected by ophthalmoscopy as a blurring of the margins of the optic disc ("choked disc" or papilledema) and loss of the physiological cup. Compression of the central vein of the retina, which courses inside of the optic nerve, may be a factor in the production of this swelling of the optic nerve head.

The retina is nourished externally by the choroid and internally by the central artery of the retina, a branch of the ophthalmic artery. The central artery travels in the optic nerve and divides at the optic disc. The branches of the central

artery of the retina are endarteries, so that an occlusion causes loss of vision in the corresponding part of the visual field. The fundus oculi is the posterior part of the interior of the eye as seen on ophthalmoscopy .

1.4 Lens And The Vitreous

The refractive apparatus of the eye are collectively termed the dioptric media and consist of the cornea (which contributes most of the optical power), aqueous humor, lens, and vitreous body.

The aqueous humor, formed by the ciliary processes, circulates through the posterior chamber, pupil, anterior chamber, iridocorneal angle, trabecular meshwork, and scleral venous sinus, thereby reaching the ciliary veins. The intra-ocular pressure depends chiefly on the ease of drainage of the aqueous humor. The scleral venous sinus (known to ophthalmologists as the canal of Schlemm) is an annular, endothelial channel at the sclerocorneal junction.

Glaucoma is a disorder generally (although not always) characterized by increased intra-ocular pressure. In the angle-closure (narrow-angle) type the iris blocks either the trabecular meshwork or the pupil, thereby hindering drainage of aqueous humor to the scleral venous sinus. In the open-angle type no grossly visible obstruction is seen, but abnormalities within the trabecular meshwork, for example, may be present. As a result of pressure, excavation (cupping)

Of the optic disc may occur, as well as a diminution of the visual field. In one type of operation, a small segment of the iris is excised (peripheral iridectomy), thereby re-establishing adequate humoral communication between the posterior and anterior chambers.

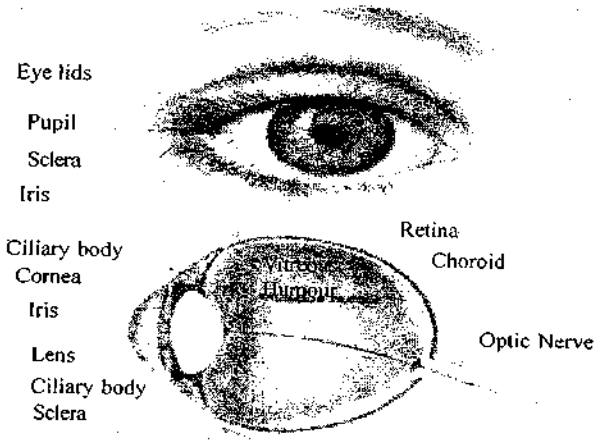

Fig 1.7

The lens, biconvex and 1 cm in diameter, is covered by a capsule and consists of cellular lens fibers. The lens capsule is anchored to the ciliary body by its suspensory ligaments, or ciliary zonule. When distant objects are being looked at, the ciliary muscle is relaxed and elastic fibers in the choroid pull on the ciliary body, which, in turn, keeps the zonular fibers and also the lens capsule under tension. This pull results in flattening of the lens .The lens, in addition to becoming increasingly yellow with age, also becomes harder and less elastic, as a result of which the power of accommodation is lessened (presbyopia) and convex spectacles may be required for reading.

An opacity of the lens is termed a cataract. It is commonly age-related and it may interfere with vision. The lens can be removed by either intracapsular extraction (removal of the entire lens and its capsule) or extracapsular extraction (retaining the posterior part of the capsule and the zonule to support a plastic lens implanted in the posterior chamber). "Couching" for cataract, i.e., a mere displacement of the lens by a needle introduced into the eye, is one of the oldest of surgical operations (it was performed in Roman times).

The vitreous body is a transparent, gelatinous mass that fills the eyeball posterior to the lens. The movement of specks in the vitreous body is sometimes seen as muscae volitantes (L., flitting flies), or "floaters".

General sensory innervation and blood supply of eye

Sensory fibers from the cornea and uvea reach the nasociliary nerve (of the ophthalmic nerve) by way of the short and long ciliary nerves. The eye receives its blood supply from the ophthalmic artery by way of the central artery of the retina, short and long posterior ciliary arteries, and the anterior ciliary arteries (from muscular branches of the ophthalmic artery). Most of the veins from the eye accompany the arteries and drain into the cavernous sinus by way of the ophthalmic veins.

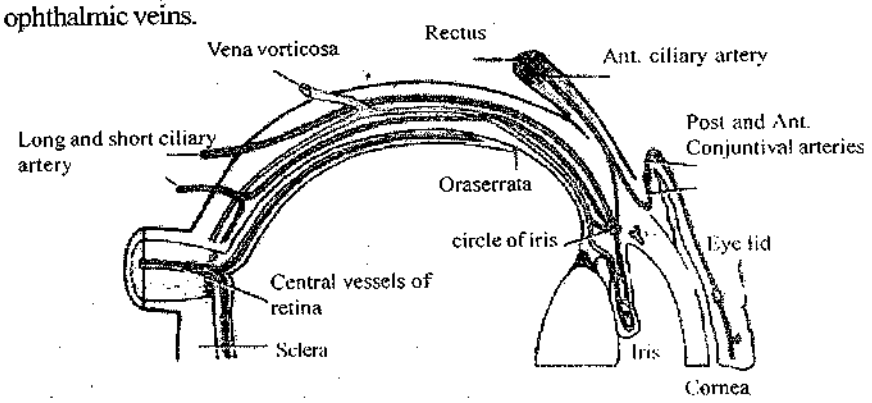

Fig 1.8

1.5 Anatomy of Eye Lids

An eyelid is a thin fold of skin that covers and protects the eye. With the exception of the prepuce and the labia minora, it has the thinnest skin of the whole body. The levator palpebrae superioris muscle retracts the eyelid to "open" the eye. This can be either voluntarily or involuntarily.

The human eyelid features a row of eyelashes which serve to heighten the protection of the eye from dust and foreign debris, as well as from perspiration. "Palpebral" (and "blepharo") means relating to the eyelids. Its key function is to regularly spread the tears and other secretions on the eye surface to keep it moist, since the cornea must be continuously moist.

They keep the eyes from drying out when asleep. Moreover, the blink reflex protects the eye from foreign bodies.In closed eye conditions cornea gets its oxygen supply from small open blood vessels from superior and inferior tarsal plate of upper eye lids but in low ratio.

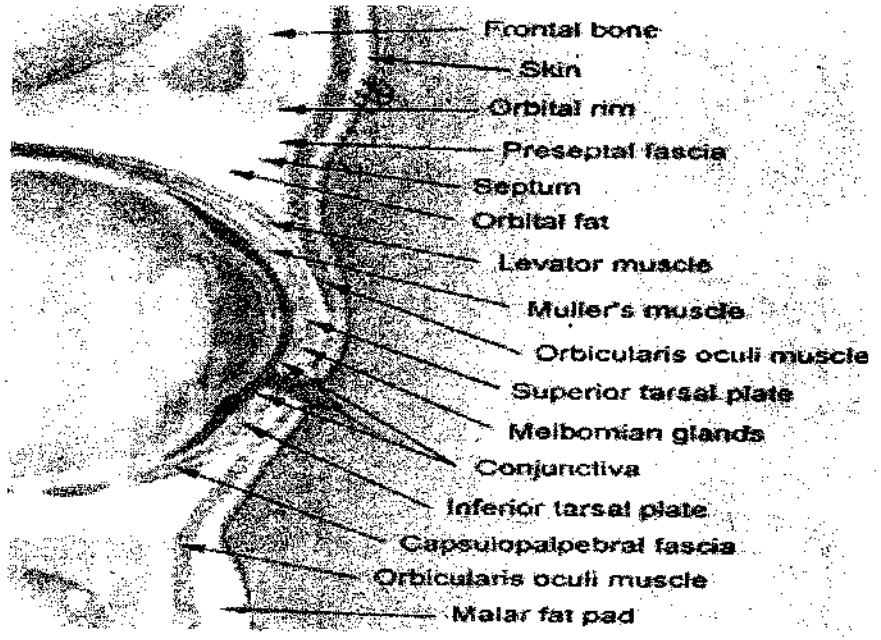

Fig 1.9

Anatomy

Layers

The eyelid is made up of several layers; from superficial to deep, these are: skin, subcutaneous tissue, orbicularis oculi, orbital septum& tarsal plates, and palpebral conjunctiva. The meibomian glands lie within the eyelid and secrete the lipid part of the tearfilm.

Skin

The skin is similar to areas elsewhere, but has more pigment cells. In diseased persons these may wander and cause a discoloration of the lids. It contains sweat glands and hairs, the latter becoming eyelashes as the border of the eyelid is met.

Innervation

In humans, the sensory nerve supply to the upper eyelids is from the infratrochlear, supratrochlear, supraorbital and the lacrimal nervesfrom the ophthalmic branch (V1) of the trigeminal nerve (CN V).

The skin of the lower eyelid is supplied by branches of the infratrochlearat the medial angle, the rest is supplied by branches of the infraorbital nerve of the maxillary branch (V2) of the trigeminal nerve.

Blood supply

In humans, the eyelids are supplied with blood by two arches on each upper and lower lid. The arches are formed by anastamoses of the lateral palpebral arteries and medial palpebral arteries; branching off from the lacrimal artery and ophthalmic artery, respectively.

Eyelid surgeries

- The eyelid surgeries are called blepharoplasties and are performed either for medical reasons or to improve one's facial appearance.
- Most of the cosmetic eyelid surgeries are aimed to enhance the look of the face and to boost one's self-confidence by restoring a youthful eyelid appearance. They are intended to remove fat and excess skin that may be found on the eyelids after a certain age. Cosmetic eyelid surgeries are mostly used to regain a younger and refreshed look but the costs are quite high, so not everyone can afford them.

- Eyelid surgeries are also performed to improve one's peripheral vision or to treat chalazion, eyelid tumors, ptosis, trichiasis, and other eyelid-related conditions.
- Eyelid surgeries are overall safe procedures but they carry certain risks since the area on which the operation is performed is so close to the eye.

1.6 Cranial Nerves

Cranial nerves are nerves that emerge directly from the brain, in contrast to spinal nerves, which emerge from segments of the spinal cord. In humans, there are traditionally twelve pairs of cranial nerves. Only the first and the second pair emerge from the cerebrum; the remaining ten pairs emerge from the brainstem.

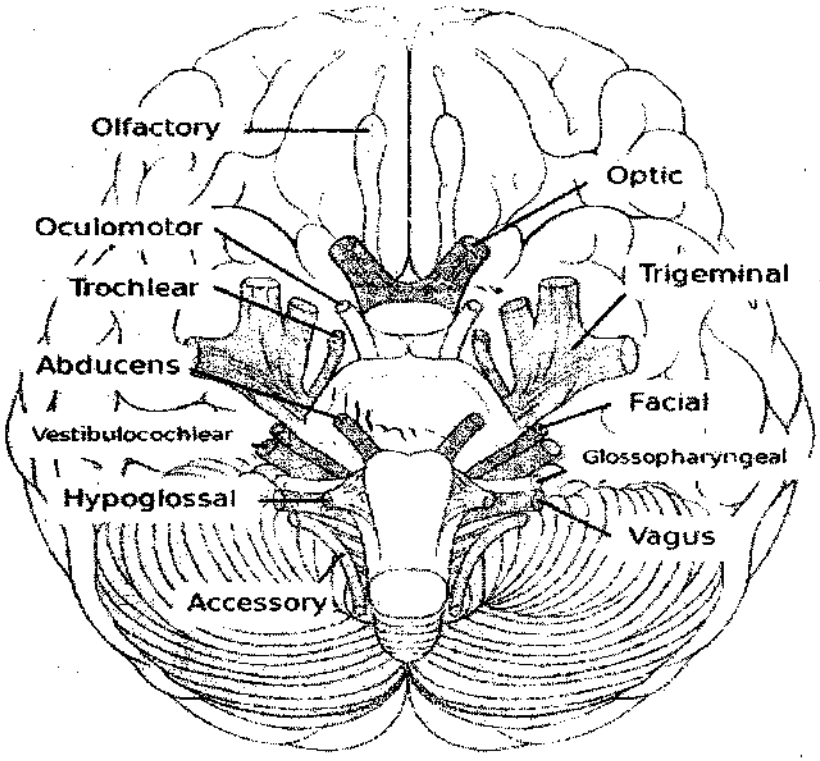

Fig 1.10

List of cranial nerves

Number	Name	Sensory,Motor or Both	Origin	Nuclei	Function
I	Olfactory	Purely Sensory	Telencephalon	Anterior olfactory nucleu.	Transmits the sense of smell from the nasal cavity. Located in olfactory foramina in the cribriform plate of ethmoid.
II	Optic	Purely Sensory	Diencephalon	Ganglion cells of retina	Transmits visua signals from the retina of the eye to the brain. Located in the optic canal.
III	Oculomo-tor	Mainly Motor	Anterior aspect of midbrain	Oculomotor nucleus,Edinger-Westphal nucleus.	Innervates the levator palpebrae superioris, superior rectus,medial rectus, inferior rectus, and inferior oblique, which collectively perform most eye movements. Also innervates the sphincter pupillae and the muscles of the ciliary body. Located in the superior orbital fissure.
IV	Trochlear	Mainly Motor	Dorsal aspect of midbrain	Trochlear nucleus	Innervates the superior oblique muscle, which depresses, rotates , laterally, and intorts the eyeball. Located in thesuperior orbital fissure.

V	Trigeminal	Both Sensory and Motor	Pons	Principal sensory trigeminal nucleus,Spinal trigeminal nucleus, Mesencephalic trigeminal nucleus,Trigeminal	Receives sensation from the face and innervates themuscles of mastication. Located in the superior orbital fissure (ophthalmic nerve - V_1), foramen rotundum (maxillary nerve - V_2), and foramen ovale (mandibular nerve - V_3).
VI	Abducens	Mainly Motor	Anterior margin of pons	motor nucleus Abducens nucleus	Innervates the lateral rectus, which abducts the eye. Located in the superior orbital fissure
VII	Facial	Both Sensory and Motor	Pons (cerebello pontine angle) above olive	Facial nucleus,Solitary nucleus,Superior salivary nucleus	Provides motor innervation to the muscles of facial expression, posterior belly of the digastric muscle, andstapedius muscle. Also receives the special sense of taste from the anterior 2/3 of the tongue and provides secreto motor innervationtothe salivary glands (except parotid) and the lacrimal gland. Located in and runs through the internal acoustic canal to the facial canal and exits at the stylomastoid foramen.
VIII	Acoustic or Vestibuloco chlear (or auditory-vestibular nerveor acoustic nerve)	Mostly sensory	Lateral to CN VII (cerebello pontine angle)	Vestibular nuclei,Cochlear nuclei	Senses sound, rotation, and gravity (essential for balance and movement). More specifically, the vestibular branch carries impulses for equilibrium and the cochlear branch carries impulses for hearing. Located in the internal acoustic canal.

IX	Glossopharyn-geal	Both sensory and motor	Medulla	Nucleus ambiguus, Inferior salivary nucleus, Solitary nucleus	Receives taste from the posterior 1/3 of the tongue, provides secretomotor innerva-tion to the parotid gland, and provides motor innervation to the stylopharyngeus. Some sensation is also relayed to the brain from the palatine tonsils. Located in the jugular foramen.
X	Vagus,	Both sensory and Motor	Posterolateral sulcus of medulla	Nucleus ambiguus,Dorsal motor vagal nucleus,Solitary nucleus	Supplies branchiomotor innervation to most laryngeal and pharyngeal muscles (except the stylopharyngeus, which is innervated by the glossopharyn-geal). Also provides parasympathetic fibers to nearly all thoracic and abdominal viscera down to the splenic flexure. Receives the special sense of taste from the epiglottis. A major function: controls muscles for voice and resonance and the soft palate. Symptoms of damage: dysph-agia (swallowing problems), velopharyngeal insufficiency. Located in the jugular foramen

XI	Accessory (orcranial accessory nerve or spinal accessory nerve)	Mainly Motor	Cranial and Spinal Roots Medulla	Nucleus ambiguus,Spinal accessory nucleus	Controls the sternocleidomas-toid and trapezius muscles, and overlaps with functions of the vagus nerve (CN X). Symptoms of damage: inability to shrug, weak head movement. Located in the jugular foramen
XII	Hypoglos-sal.	Mainly Motor		Hypoglossal nuclesus	Provides motor innervation to the muscles of the tongue (except for the palatoglossus, which is innervated by the vagus nerve) and other glossal muscles. Important for swallowing (bolus formation) and speech articulation. Located in the hypoglossal canal.

1.7 Lacrimal Apparatus

The lacrimal apparatus is the physiologic system containing the orbital structures for tear production and drainage.

It consists of

(a) The lacrimal gland, which secretes the tears, and its excretory ducts, which convey the fluid to the surface of the eye;

(b) The lacrimal canaliculi, the lacrimal sac, and the nasolacrimal duct, by which the fluid is conveyed into the cavity of the nose, emptying anterioinferiorly to the inferior nasal conchae from the nasolacrimal duct.

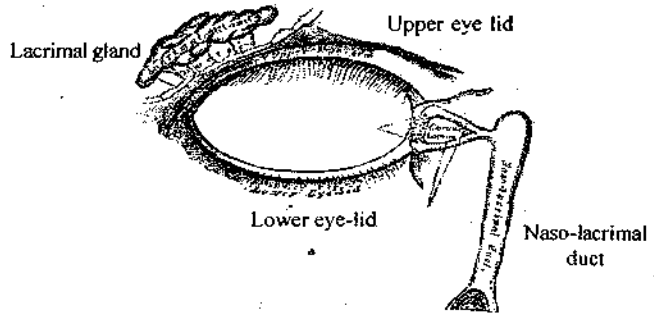

Fig 1.11

(c) The nerve supply of lacrimal apparatus done by carotid plexuse of nerves along artery internal and external sympathetically but parasympathetic from lacimal necleus of the facial nerve.

The lacrimal apparatus is the system in the body that produces and drains tears. The lacrimal apparatus is made up of many parts, described below.

Parts that make up the Lacrimal Apparatus

The lacrimal apparatus is comprised of many parts. Here is a brief description.

Lacrimal Glands: Small organs that excrete (release) tears. There are two types of lacrimal glands, known as main and accessory lacrimal glands. The main lacrimal glands (located in the upper and outer part of the eye sockets) release extra tears, such as when the eye is irritated and during crying. The main lacrimal glands drain tears into the conjunctiva. The conjunctiva is a layer that covers and protects the inside of the eyelids and the front part of the sclera (the white part of the eyes). The accessory lacrimal glands (located within the conjunctiva) maintain a normal amount of tears on the surface of the conjunctiva. This helps overcome the effect of tears evaporating (changing from a liquid to a gas).

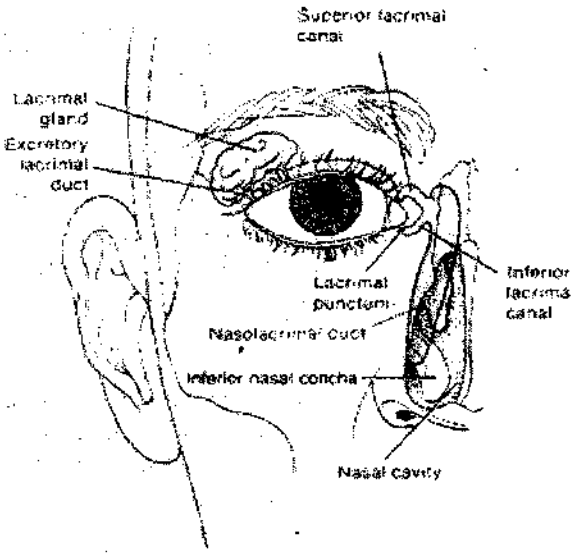

Fig 1.12

Lacrimal Lake: A small open area of the conjunctiva of the eye where tears collect after bathing in the front part of the eyeball and in a slit-like space known as the conjunctival sac. The conjunctival sac is located between the eyelids and the conjunctiva-covered eyeball.

Excretory Lacrimal Ducts: Tube shaped areas that release tears from the lacrimal gland into the top part of the conjunctiva sac.

Lacrimal Puncta: Tiny openings towards the inner part of each eyelid, that tears drain through. Picture the lacrimal puncta as being like a drain in a kitchen sink. The lacrimal puncta connect and send tears to narrow tubes, known as lacrimal canals.

Lacrimal Canals (Superior and Inferior) : Curved, tube shaped structures connected to the lacrimal puncta that tears coming from the lacrimal lake drain into. As you can see in the picture, the superior (above)lacrimal canal is on the top and the inferior (below) lacrimal canal is on the bottom. Tears travel from the lacrimal canals to the lacrimal sacs. The lacrimal canals are also known as the lacrimal ducts and lacrimal canaliculi.

Lacrimal Sacs : Hollow spaces that the lacrimal canals drain tears into. Each eye has a lacrimal sac for tears to drain into. The yellow structure pictured above, next to the lacrimal canals, is the lacrimal sac. Flat muscles that cover the lacrimal sac, squeeze and release it during blinking. This helps produce a suction effect that draws away extra tears when blinking. This is why people blink when they cry.

Lacrimal Bones : The bones that surround the lacrimal sac. They are located on each side of the nose, within the inner part of the eye socket.

Nasolacrimal Ducts: Tube shaped areas that are below the lacrimal sac and carry tears down through the bone, leading to an opening in the nose. The nasal cavity is an opening on each side of the nose. The inferior nasal conchae are thin, spongy, bony plates in the nose.

1.8 Orbit And It's Relations

In anatomy, the orbit is the cavity or socket of the skull in which the eye and its appendages are situated. "Orbit" can refer to the bony socket, or it can also be used to imply the contents. In the adult human, the volume of the orbit is 30 ml, of which the eye occupies 6.5 ml.

Definition

The orbits are conical or four-sided pyramidal cavities, which open into the midline of the face and point back into the head. Each consists of a base, an

apex and four walls. They protect the eye from mechanical injury. The base, which opens in the face, has four borders. The following bones take part in their formation·

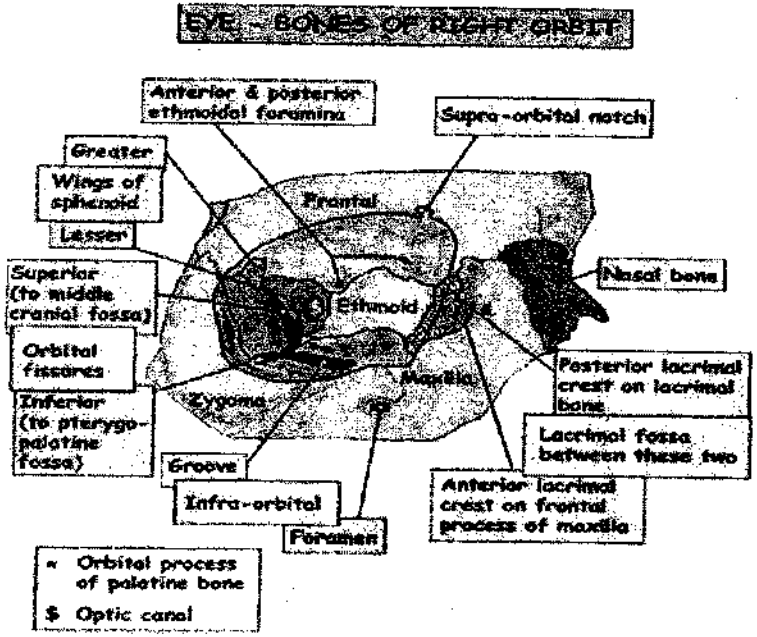

Fig 1.13

Superior margin: frontal bone

Inferior margin: maxilla and zygomatic

Medial margin: frontal, lacrimal and maxilla

Lateral margin: zygomatic and frontal

The apex lies near the medial end of superior orbital fissure and contains the optic canal(containing the optic nerve and ophthalmic artery), which communicates with middle cranial fossa. The roof (superior wall) is formed primarily by the orbital plate frontal bone, and also the lesser wing of sphenoid near the apex of the orbit. The orbital surface presents medially by trochlear fovea and laterally by lacrimal fossa.

The floor (inferior wall) is formed by the orbital surface of maxilla, the orbital surface of zygomatic bone and the minute orbital process ofpalatine bone. Medially, near the orbital margin, is located the groove for nasolacrimal duct.

Near the middle of the floor, located infraorbital groove, which leads to the infraorbital foramen. The floor is separated from the lateral wall by inferior orbital fissure, which connects the orbit to pterygopalatine and infratemporal fossa.

The medial wall is formed primarily by the orbital plate of ethmoid, as well as contributions from the frontal process of maxilla, thelacrimal bone, and a small part of the body of the sphenoid. It is the thinnest wall of the orbit, evidenced by pneumatized ethmoidal cells. The lateral wall is formed by the frontal process of zygomatic and more posteriorly by the orbital plate of the greater wing of sphenoid. The bones meet at the zygomaticosphenoid suture. The lateral wall is the thickest wall of the orbit, important because it is the most exposed surface, highly vulnerable to blunt force trauma.

Protrusion

. In the orbit. fat tissue, which surrounds the eyeball and its muscles, keeps the rotation smooth with respect to the center of the eye. If excess liquid is collected in the fat cushion tissue, the eye may protrude (known also as exophthalmos). Alternately, the eye may make an illusion of protrusion in extreme fear, not from the contraction of smooth muscle of the orbit, but based on the widening of the eyelids and dilation of the pupil (all commanded by the sympathetic nervous system.

Enlargement of the lacrimal gland, located superotemporally within the orbit, produces protrusion of the eye inferiorly and medially (away from the location of the lacrimal gland). Lacrimal gland may be enlarged from inflammation (e.g. sarcoid) or neoplasm (e.g. lymphoma or adenoid cystic carcinoma).

Tumors (e.g. glioma and meningioma of the optic nerve) within the cone formed by the horizontal rectus muscles produce axial protrusion (bulging forward) of the eye.

Graves disease may also cause axial protrusion of the eye, known as Graves' ophthalmopathy, due to buildup of extracellular matrix proteins and fibrosis in the rectus muscles. Development of Graves' ophthalmopathy may be independent of thyroid function.

Extra Ocular Muscles

The extraocular muscles are the seven muscles that control the movements of the (human) eye . The actions of the extraocular muscles depend on the position of the eye at the time of muscle contraction.

Extraocular muscle function:The muscles of the eye are designed to stabilize and move the eyes. All eye muscles have a resting muscle tone that is designed to stabilize eye position. During movements, certain muscles increase their activity while others decrease it. The movements of the eye include: adduction (the pupil directing toward the nose); abduction (the pupil directed laterally); elevation (the pupil directed up); depression (the pupil directed down); intorsion (the top of the eye moving toward the nose); and extorsion (the superior aspect of the eye moving away from the nose). Horizontal eye movements are rather simple. Increased activity of the lateral rectus will direct the pupil laterally, while increased activity of the medial rectus will direct it medially. However, movements of the eyes above or below the horizontal plane are complicated and require, at the minimum, activation of pairs of muscles. This is because the obit is not directed straight forward in the head and, therefore, there is no one muscle positioned to direct the eye straight up or down without the simultaneous occurence of unwanted movements. Because of this, the protocol for testing eye movements is somewhat more complicated than might be expected.

- Medial rectus moves the eye towards the nose
- Lateral rectus moves the eye away from the nose
- Superior rectus moves the eye up
- Inferior rectus moves the eye down
- Superior oblique rotates the eye so that the top of the eye moves towards the nose.
- Inferior oblique rotates the eye so that the top of the eye moves away from the nose.

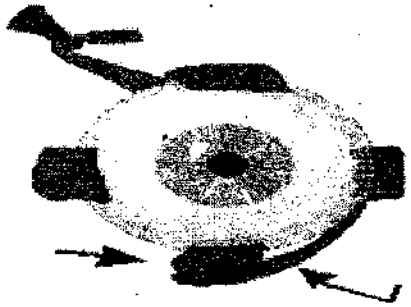

Fig. 1.14 The Left eye

Table of muscles of human body # Extraocular

Muscle	Innervation	Origin	Insertion	Primary Function	Secondary Function	Teritory Function	Distance inserted into the sclera
Superior rectus	Superior branch of oculomotor nerve	Annulus of Zinn	eye (anterior, superior surface)	Elevation	Intorsion	Adduction	7.9mm
Inferior rectus	Inferior branch of oculomotor nerve	Annulus of Zinn	eye (anterior, inferior surface)	Depression	Extorsion	Adduction	6.6mm
Lateral rectus	Abducens nerve	Annulus of Zinn	eye (anterior, lateral surface)	Abduction			7.0mm
Medial rectus	Inferior branch of oculomotor nerve	Annulus of Zinn	eye (anterior, medial surface)	Adduction			5.8mm
Superior oblique	Trochlear nerve	Annulus of Zinn via theTrochlea of superior oblique	eye (posterior, superior, lateral surface)	Intorsion	Depression	Abduction	
Inferior oblique	Inferior branch of oculomotor nerve	Maxillary bone	eye (posterior, inferior, lateral surface)	Extorsion	Elevation	Abduction	

Summary

Summary of the early development of the eye.

1. A, an embryo of 4 weeks showing the optic vesicle.
2. A section through the head including the diencephalon (Di) and both optic vesicles.
3. The optic vesicle presents retinal and lens discs. the retinal and lens discs have become indented to form the optic cup and the lens pit respectively.
4. The lens pit has become closed from the surface to form the lens vesicle.
5. The optic stalk (future optic nerve) and cup, showing the retinal fissure and the lens.
6. Section of the eye at the end of the embryonic period (8 postfertilization weeks). The pigmented and inverted strata of the retina are evident. The rim of the optic cup will give rise to the ciliary and iridial parts of the retina.

Short Answer Type Questions

1. Where is most of the optical power of the eye concentrated?
2. Is the cornea covered by conjunctiva?
3. Where does the retina terminate anteriorly?
4. Into which channel does the aqueous humor in the anterior chamber drain?
5. When "drops" are used in the examination of the eye, which muscles are removed from action?
6. Where do the posterior and anterior chambers communicate?
7. Which disease is generally characterized by increased intra-ocular pressure?
8. In obstruction of the aqueous pathway, what effect would excision of a portion of the iris have?
9. Define eye lids?
10. What is the use of eye lids?
11. How does metabolism take place in cornea?

12. In closed eye conditions, from where does cornea get oxygen?
13. What do you mean by lacrimal apparatus?
14. Draw a neat labeled diagram of lacrimal apparatus?
15. Lacrimal lake in eye means?
16. How does lacrimal sacs works?
17. Where are lacrimal bones located?
18. What do you mean by eye orbit?
19. How many borders does eye orbit have?
20. Name the main walls of the eye orbit?
21. Which wall is the thickest in eye orbit?
22. What is the importance of lateral wall?
23. What do you mean by eye orbit?

Long Answer Type Questions

1. Which muscle and nerve are involved in accommodation?
2. What is the autonomic innervation of the muscles of the eye?
3. Where does detachment of the retina occur?
4. On which side of the optic disc is the macula?
5. Explain the antomy of eye lids?
6. Draw a neat labeled diagram of eye lids and explain?
7. Describe briefly lacrimal apparatus?
8. What parts make up the lacrimal apparatus?
9. Importance of lacrimal apparatus?
10. Define briefly eye orbit?
11. Give specifications of eye orbit, with diagram?
12. Name the walls of eye orbit and their importance?
13. What do you mean by protrusion of eye ball when does it happen?

UNIT 2

Physiology

Structure

2.1 General Physiology of the Eye

The human eye is the organ which gives us the sense of sight, allowing us to learn more about the surrounding world than we do with any of the other four senses. We use our eyes in almost every activity we perform, whether reading, working, watching television, writing a letter, driving a car, and in countless other ways. Most people probably would agree that sight is the sense they value more than all the rest.

The eye allows us to see and interpret the shapes, colors, and dimensions of objects in the world by processing the light they reflect or emit. The eye is able to detect bright light or dim light, but it cannot sense objects when light is absent.

Light waves from an object (such as a candle) enter the eye first through the cornea, which is the clear dome at the front of the eye. The light then progresses through the pupil, the circular opening in the center of the colored iris.

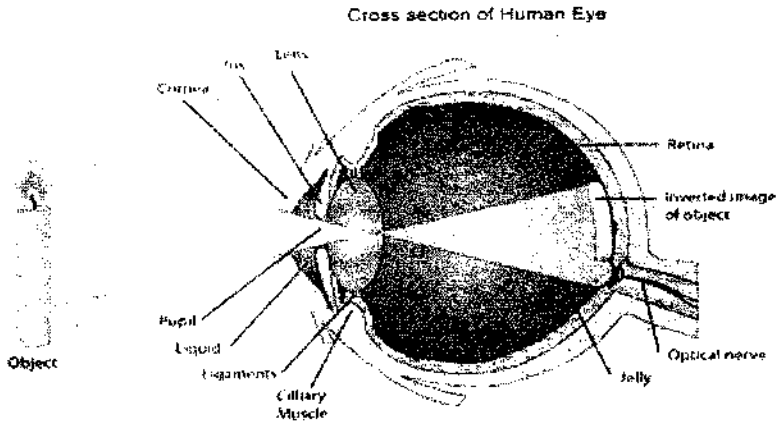

Fig 2.1

Fluctuations in incoming light change the size of the eye's pupil. When the light entering the eye is bright enough, the pupil will constrict (get smaller), due to the pupillary light response. Initially, the light waves are bent or converged first by the cornea, and then further by the crystalline lens (located immediately behind the iris and the pupil), to a nodal point (N) located immediately behind the back surface of the lens. At that point, the image becomes reversed (turned backwards) and inverted (turned upside-down).

The light continues through the vitreous humor, the clear gel that makes up about 80% of the eye's volume, and then, ideally, back to a clear focus on the retina, behind the vitreous. The small central area of the retina is the macula, which provides the best vision of any location in the retina. If the eye is considered to be a type of camera, the retina is equivalent to the film inside of the camera, registering the tiny photons of light interacting with it.

Within the layers of the retina, light impulses are changed into electrical signals. Then they are sent through the optic nerve, along the visual pathway, to the occipital cortex at the posterior (back) of the brain. Here, the electrical signals are interpreted or "seen" by the brain as a visual image. Actually, then, we do not "see" with our eyes but, rather, with our brains. Our eyes merely are the beginnings of the visual process.

2.2 Pupillary Reflexes

The **pupillary light reflex** is a reflex that controls the diameter of the pupil, in response to the intensity (luminance) of light that falls on the retina of the eye, thereby assisting in adaptation to various levels of darkness and light, in addition to retinal sensitivity. Greater intensity light causes the pupil to become smaller (allowing less light in), whereas lower intensity light causes the pupil to become larger (allowing more light in). Thus, the pupillary light reflex regulates the intensity of light entering the eye.

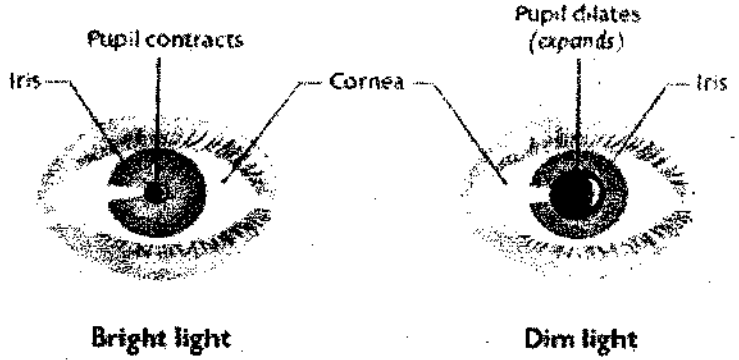

Fig 2.2

Mechanism

The optic nerve, or more precisely, the photosensitive ganglion cells through the retinohypothalamic tract, is responsible for the afferent limb of the pupillary reflex - it senses the incoming light. The oculomotor nerve is responsible for the efferent limb of the pupillary reflex - it drives the muscles that constrict the pupil.

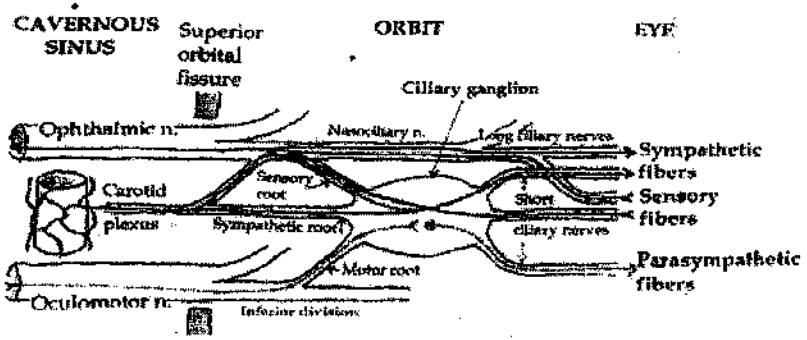

Fig 2.3

Neuron 1

The pupillary reflex pathway begins with the photosensitive retinal ganglion cells, which convey information to the optic nerve (via the optic disc). The optic nerve connects to the pretectal nucleus of the upper midbrain, bypassing the lateral geniculate nucleus and the primary visual cortex.

These "intrinsic photosensitive ganglion cells" are also referred to as "melanopsin-containing" cells, and they influence the circadian rhythms and the pupillary light reflex.

Neuron 2

From the pretectal nucleus, axons connect to neurons in the Edinger-Westphal nucleus, whose axons run along both the left and rightoculomotor nerves.

Neuron 3

Oculomotor nerve axons synapse on ciliary ganglion neurons.

Neuron 4

Neuron #4 innervates the constrictor muscle of the iris.

Clinical significance

In addition to controlling the amount of light that enters the eye, the pupillary light reflex provides a useful diagnostic tool. It allows for testing the integrity of the sensory and motor functions of the eye.

Under normal conditions, the pupils of both eyes respond identically to a light stimulus, regardless of which eye is being stimulated. Light entering one eye produces a constriction of the pupil of that eye, the direct response, as well as a constriction of the pupil of the unstimulated eye, the consensual response. Comparing these two responses in both eyes is helpful in locating a lesion.

For example, a direct response in the right pupil without a consensual response in the left pupil suggests a problem with the motor connection to the left pupil (perhaps as a result of damage to the oculomotor nerve or Edinger-Westphal nucleus of the brainstem). Lack of response to light stimulation of the right eye if both eyes respond normally to stimulation of the left eye indicates damage to the sensory input from the right eye (perhaps to the right retina or optic nerve).

Emergency room physicians routinely assess the pupillary reflex because it is useful for gauging brain stem function. Normally, pupils react (i.e. constrict)

equally. Lack of the pupillary reflex or an abnormal pupillary reflex can be caused by optic nerve damage, oculomotor nerve damage, brain stem death and depressant drugs.

Normally, both pupils should constrict with light shone into either eye alone. On testing each reflex for each eye, several patterns are possible.

- Optic nerve damage on one side: (Example in parens.: Left optic nerve lesion).
- The ipsilateral direct reflex is lost (Example: when the left eye is stimulated, neither pupil constricts, as no signals reach the brain from the left eye due to its damaged optic nerve)
- The ipsilateral consensual reflex is INTACT (because light shone into the right eye can signal to the brain, causing constriction of both pupils via the normal oculomotor nerves)
- The contralateral direct reflex is intact (because light shone into the right eye can signal to the brain, causing constriction of both pupils via the normal oculomotor nerves)
- The contralateral consensual reflex is lost (because light shone into the eye on the damaged side cannot signal to the brain; therefore, despite the right eye's motor pathway (oculomotor nerve) being intact, no signals from the left eye are able to stimulate it due to the damage to the sensory pathway (optic nerve) of the left eye)
- Oculomotor nerve damage on one side: (Example in parens: Left oculomotor lesion)
- The ipsilateral direct reflex is lost (Example: when the left eye is stimulated, only the right pupil constricts)
- The ipsilateral consensual reflex is lost (Example: when the right eye is stimulated, only the right pupil constricts)
- The contralateral direct reflex is intact (because light shone into both eyes can still signal to the brain, and the pupil on the undamaged side will still be able to constrict via its normal oculomotor nerve)
- The contralateral consensual reflex is intact (because light shone into the left eye can still signal to the brain via the normal optic nerve, causing attempted constriction of both pupils; the contralateral pupil constricts via its normal oculomotor nerve, but the ipsilateral pupil is unable to constrict due to its damaged oculomotor nerve)

2.3 Colour Vision

Color vision is the ability of an individual to distinguish objects based on the wavelengths (or frequencies) of the light they reflect, emit, or transmit. Colors can be measured and quantified in various ways; indeed, a human's perception of colors is a subjective process whereby the brain responds to the stimuli that are produced when incoming light reacts with the several types of cone photoreceptors in the eye.

White light shone onto a green surface is perceived as green by the human eye, and processed as such in the brain's visual cortex.

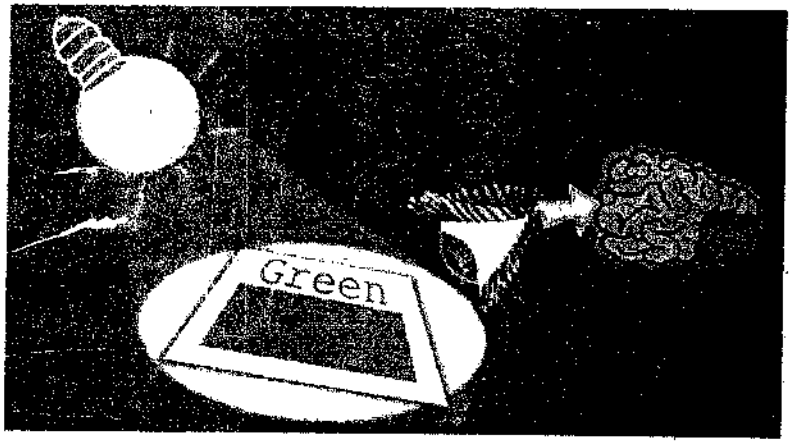

Fig 2.4

Physiology of color perception

Perception of color begins with specialized retinal cells containing pigments with different spectral sensitivities, known as cone cells. In humans, there are three types of cones sensitive to three different spectra, resulting in trichromatic color vision.

Each individual cone contains pigments composed of opsin apoprotein, which is covalently linked to either 11-cis-hydroretinal or more rarely 11-cis-dehydroretinal.

The cones are conventionally labeled according to the ordering of the wavelengths of the peaks of their spectral sensitivities:

short (S),

medium (M), and

long (L) cone types.

These three types do not correspond well to particular colors as we know them. Rather, the perception of color is achieved by a complex process that starts with the differential output of these cells in the retina and it will be finalized in the visual cortex and associative areas of the brain.

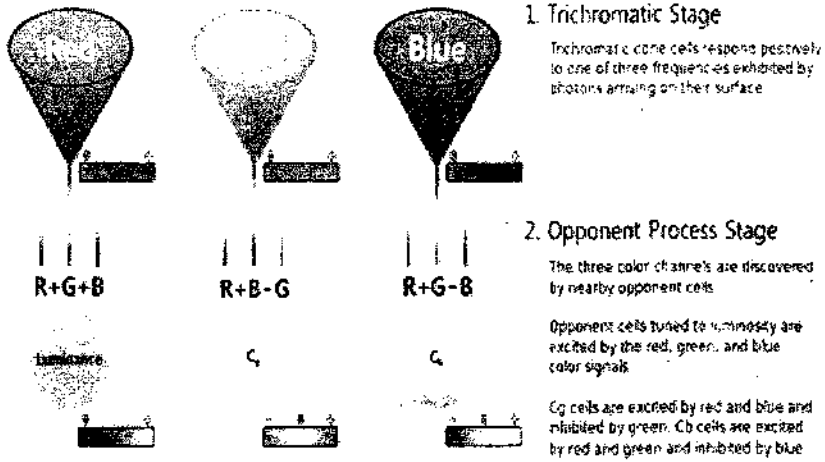

Fig 2.5

For example, while the L cones have been referred to simply as red receptors, microspectrophotometry has shown that their peak sensitivity is in the greenish-yellow region of the spectrum. Similarly, the S- and M-cones do not directly correspond to blue and green, although they are often depicted as such. It is important to note that the RGB color model is merely a convenient means for representing color, and is not directly based on the types of cones in the human eye.

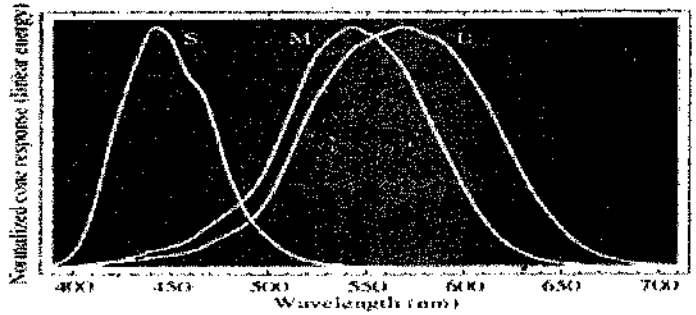

Fig 2.6

Normalized response spectra of human cones, S, M, and L types, to monochromatic spectral stimuli, with wavelength given in nanometers.

The peak response of human cone cells varies, even among individuals with 'normal' color vision; in some non-human species this polymorphic variation is even greater, and it may well be adaptive.

Cone cells in the human eye

Cone type	Name	Range	Peak wavelength
S	β	400–500 nm	420–440 nm
M	γ	450–630 nm	534–555 nm
L	ρ	500–700 nm	564–580 nm

2.4 Visual Field

The term visual field is sometimes used as a synonym to field of view, though they do not designate the same thing. The visual field is the "spatial array of visual sensations available to observation in introspectionist psychological experiments",while 'field of view' "refers to the physical objects and light sources in the external world that impinge the retina". In other words, field of view is everything that (at a given time) causes light to fall onto the retina. This input is processed by the visual system, which computes the visual field as the output.

The term is often used in optometry and ophthalmology, where a visual field test is used to determine whether the visual field is affected by diseases that cause local scotoma or a more extensive loss of vision or a reduction in sensitivity (threshold).

Normal limits

The normal human visual field extends to approximately 60 degrees nasally (toward the nose, or inward) from the vertical meridian in each eye, to 100 degrees temporally (away from the nose, or outwards) from the vertical meridian, and approximately 60 degrees above and 75 below the horizontal meridian. In the United Kingdom, the minimum field requirement for driving is 60 degrees either side of the vertical meridian, and 20 degrees above and below horizontal. The macula corresponds to the central 13 degrees of the visual field; the fovea to the central 3 degrees.

Measuring the visual field

The visual field is measured by perimetry. This may be kinetic, where points of light are moved inwards until the observer sees them, or static, where points

of light are flashed onto a white screen and the observer is asked to press a button if he or she sees it. The most common perimeter used is the automated Humphrey Field Analyzer.

Another method is to use a campimeter, a small device designed to measure the visual field. Patterns testing the central 24 degrees or 30 degrees of the visual field, are most commonly used. Most perimeters are also capable of testing the full field of vision.

Another method is for the practitioner to hold up 1,2, or 5 fingers in the four quadrants and center of a patient's visual field (with the other eye covered). If the patient is able to report the number of fingers properly as compared with the visual field of the practitioner, the normal result is recorded as "full to count fingers" (often abbreviated FTCF). The blind spot can also be assessed via holding a small red object between the practitioner and the patient. By comparing when the red object disappears for the practitioner, a patient's abnormally large blind spot can be identified. There are many variants of this type of exam (e.g. wiggling fingers at visual periphery in cardinal axes).

Importance of visual fields

Initially, Visual field tests help your optometrist/ophthalmologist diagnose problems with your eyes, optic nerve or brain, including:

- Loss of vision
- Glaucoma
- Disorders of your retina
- Brain tumors
- Strokes

Visual field loss

Visual field loss may occur due to disease or disorders of the eye, optic nerve, or brain. Classically, there are four types of visual field defects:

Altitudinal field defects, loss of vision above or below the horizontal – associated with ocular abnormalities. Bitemporal hemianopia, loss of vision at the sides (see below). Central scotoma, loss of central vision

Homonymous hemianopia, loss at one side in both eyes – defect behind optic chiasm (see below)

In humans, confrontational testing and other forms of perimetry are used to detect and measure visual field loss. Different neurological difficulties cause

characteristic forms of visual disturbances, including hemianopsias (shown below without macular sparing),quadrantanopsia, and others.

Fig 2.7 View as seen with full visual fields

Fig 2.8 View as seen with bitemporal hemianopsia

Fig 2.9Vision as seen with binasal hemianopsia

Fig 2.10 Vision as seen with left homonymous hemianopsia

Fig 2.11 Vision as seen with right homonymous heminopsia

2.5 Accomodation (Eye)

Accommodation is the ability of the eye to focus at various distances by altering the shape of the crystalline lens. Accommodation, we are told, is the ability to increase the refractive power of the eye beyond its static (resting) power; it is measured in dioptres.

But this definition is simple, in that it appears to consider only the physical response of the eye. Of equal importance to the refractionist is the neuromuscular effort required to generate that response, since that, too, may be responsible for ocular symptoms. An understanding of the difference between accommodative effort and accommodative response is necessary to appreciate the shifting interactions that occur between accommodation and ocular vergences, particularly the ongoing changes that occur as the lens ages.

The amplitude of accommodation (AA) is the maximum increase in dioptric power attainable by an eye.

The range of accommodation denotes the linear distance (expressed in centimeters or metres) over which the accommodative power allows an individual to maintain clear vision; it lies between near point of accommodation and far point of accommodation. Since this range determines whether an eye is actually capable of performing a given visual task, it is undoubtedly the most useful clinical measurement of accommodation. Thus, while a patient may have X diopters of accommodative amplitude, and our more interest is in whether or not his accommodative range comfortably encompasses his visual field. The key word, for refractionist, is "comfortably"

The stimulus for accommodation mechanism is the proximity of the object.

Punctum Proximum : Can be defined as the nearest point, which can see a object without blurr.

Punctum remotum : Can be defined as the farthest point, which eye can see a object without blurr

Tests of accommodation

1. Near point of accommodation
2. Prince rule
3. Spherical adds

Note; The detail procedure to perform these tests will be explained in the next text book.

The Relationship Between Accommodation And Convergence

Every individual has a fixed neuromuscular relationship between the amount of accommodation exerted and the accompanying convergence. This is the accommodative-convergence/accommodation ratio AC/A ratio. It is this tight AC/A alliance that sets the eyes into appropriate alignment on all their visual tasks. The alignment is refined by fusional vergence, which represents the elasticity available in the neurophysiologic linkage between accommodation and convergence. The amount of elasticity can be measured as relative vergence, if accommodation is kept constant, a relative accommodation, if the degree of convergence is kept constant., a relative fusional vergence.

Relative Accommodation Test

This test is done by the amount of lens power the patient can overcome while keeping the target clear is called relative accommodation: "positive" when accommodation is stimulated with minus lenses, "negative" when accommodation is relaxed with negative lenses.

2.6 Convergence

In ophthalmology, convergence is the simultaneous inward movement of both eyes toward each other, usually in an effort to maintain single binocular vision when viewing an object.

1. This is the only eye movement that is not conjugate, but instead adducts the eye.
2. In relation Divergence is a disjugate movement and abducts the eyes.
3. Convergence is one of three processes an eye does to properly focus an image on the retina. In each eye, the visual axis will point towards the object of interest in order to focus it on the fovea.

4. This action is mediated by the medial rectus muscle, which is innervated by Cranial nerve III. It is a type of vergence eye movement and is done by extrinsic muscles. Diplopia commonly referred to as double vision, can result if one of the eye's extrinsic muscles are weaker than the other. This results because the object being seen gets projected to different parts of the eye's retina, causing the brain to see two images.

5. Convergence insufficiency is a common problem with the eyes, and is the main culprit behind eyestrain, blurred vision, and headaches.

This problem is most commonly found in children.

Near point of convergence (NPC) is measured by bringing an object to the nose and observing when the patient sees double, or one eye deviates out. Normal NPC values are up to 10 cm. Any NPC value greater than 10 cm is remote, and usually due to high exophoria at near.

Relative vergence : Horizontal fusional vergence is measured with the help of relative vergence test and this method can determine the fusional vergence amplitudes in both convergent and divergent directions: "positive" for convergence and "negative" for divergence.

2.7 Aqueous Humour Dynamics

The aqueous humour is a transparent, gelatinous fluid similar to plasma, but containing low-protein concentrations. It is secreted from the ciliary epithelium, a structure supporting the lens.[It is located in the anterior and posterior chambers of the eye, the space between the lens and the cornea. It is not to be confused with vitreous humour, which is contained within the larger cavity of the eye behind the lens.

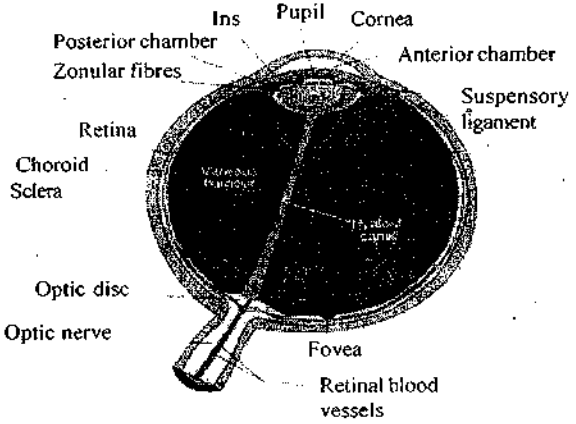

Fig 2.12

Functions

Maintains the intraocular pressure and inflates the globe of the eye. Provides nutrition (e.g. amino acids and glucose) for the avascular ocular tissues; posterior cornea, trabecular meshwork, lens, and anterior vitreous. May serve to transport ascorbate in the anterior segment to act as an anti-oxidant agent. Presence of immunoglobulins indicate a role in immune response to defend against pathogens.

Provides inflation for expansion of the cornea and thus increased protection against dust, wind, pollen grains and some pathogens.

For refractive index.

Composition

Amino acids: transported by ciliary elial cells.

With a refractive index of 1.336, the aqueous humor is a clear fluid, a very important feature because of its location in the eye. Like the cornea and the lens, the aqueous humor is part of the ocular media in the eye, meaning it must be transparent to allow light rays through. It is made up of 99.9% water. The remaining 0.1% is solid and contains:

- proteins
- some amino acids
- oxygen in a dissolved state
- glucose, urea, ascorbate, lactic acid
- ions like sodium, potassium and bicarbonate

Compared to blood plasma, aqueous humor has higher concentrations of ascorbate and lactate and lower concentrations of glucose, urea and proteins. The lower protein content, 5 to 16 mg% compared to 6 to 7 gm% in plasma, is due to the presence of the 'blood-aqueous barrier', a physiological mechanism that prevents the free exchange of materials between the anterior segment of the eye and the blood stream.

Production and drainage

Aqueous humour is secreted into the posterior chamber by the ciliary body, specifically the non-pigmented epithelium of the ciliary body (pars plicata). It flows through the narrow cleft between the front of the lens and the back of the iris, to escape through the pupil into the anterior chamber, and then to drain out of the eye via the trabecular meshwork. From here, it drains into Schlemm's

canal by one of two ways: directly, via aqueous vein to the episcleral vein, or indirectly, through collector channels to the episcleral vein by intrascleral plexus and eventually into the veins of the orbit.

Production

Filtration: As blood flows in the ciliary body's capillaries, it is coarsely filtered by the capillaries' endothelial cells. The resulting plasma is then refiltered by the pigmented and nonpigmented ciliary epithelial cells and is secreted into the posterior chamber before travelling between the lens and iris into the anterior chamber of the eye as aqueous humour.

Diamond-Bossert model: Active transport occurring in the nonpigmented cilary epithelial cells induces small osmotic pressuregradients in between the cells. A higher concentration of solutes in the proximal part of the intercellular space generates a flow of water. The concentration diminishes from the proximal part to the distal part, releasing the liquid into the posterior chamber.

Drainage

Aqueous humour is continually produced by the ciliary processes and this rate of production must be balanced by an equal rate of aqueous humour drainage. Small variations in the production or outflow of aqueous humour will have a large influence on the intraocular pressure.

The drainage route for aqueous humour flow is first through the posterior chamber, then the narrow space between the posterior iris and the anterior lens (contributes to small resistance), through the pupil to enter the anterior chamber. From there, the aqueous humour exits the eye through the trabecular meshwork into Schlemm's canal (a channel at the limbus, i.e., the joining point of the cornea and sclera, which encircles the cornea) It flows through 25–30 collector canals into the episcleral veins. The greatest resistance to aqueous flow is provided by the trabecular meshwork, and this is where most of the aqueous outflow occurs. The internal wall of the canal is very delicate and allows the fluid to filter due to high pressure of the fluid within the eye. The secondary route is the uveoscleral drainage, and is independent of the intraocular pressure, the aqueous flows through here, but to a lesser extent than through the trabecular meshwork.

The fluid is normally 15 mm (0.6 inch) Hg above atmospheric pressure, so when a syringe is injected the fluid flows easily. If the fluid is leaking, due to collapse and wilting of cornea, the hardness of the normal eye is therefore corroborated.

Summary

To summarise general physiology of the eye simply, the eye is compared with the camera and explained in much easier terminology to understand how image is formed on the retina, its charecteristics and then again transferred to the brain through electrical impulses to perceive image.

In this unit, we have briefly described about the pupillary reflexes of the pupillae of the eye, their mechanism, innervation and pathway. Related to pupillary reflex how to test and their interpretations i.e., the clinical significance of pupillary reflexes testing is also been covered.

This unit deals with the eye perception of various colours and spacial discrimination of the eye to various colours. We have also briefly described the mechanism of colour vision related to the eye and retinal cells which are responsible for distinguishing colours and recognizing them. Along with them physiology of colour perception is been explained

Your visual field refers to how much you can see around you, including objects in your peripheral (side) vision. Testing your visual field is important to the health of your eyes. Visual field tests help your optometrist/ ophthalmologist monitor any loss of vision and diagnose eye problems and disease. Visual field testing is the only way to document actual visual loss and whether the loss is progressing or remaining stable. If you are diagnosed with a particular disorder or disease, visual field tests may become a routine part of your treatment. People who have glaucoma or who are at risk for developing it take visual field tests every six months to a year to make sure their condition is stable and no vision loss has occurred.

Is it accomodation, or accommodation ? Some idea of the difficulties accommodation problems can present for patient and refractionist can be gleaned from the fact that we even have trouble spelling the word. And while accommodation may appear to be a simple physiological act, it embodies a set of complex interactions.

Accommodation is somewhat like sunshine: sometimes we have too much, sometimes not enough, but we function best when we have at least some. So in this chapter let us cast a little sunlight onto understanding the accommodation(not accommodation) and relationship between synkinetic action of accommodation associated with convergence.

Accommodation is a synkinetic action associated with convergence, these both actions of both the eyes go hand in hand and vice versa divergence. So convergence exerts accommodation and nearness of the object makes

convergence of the eyes happen and in relation divergence of the eyes relaxes accommodation, and object moving away from the eyes makes divergence happen binocularly.(i.e.. fixation of both eyes on a object)

This unit deals all details of aqueous humour. Its location in the eye, production and drainage mechanism and along with that to shortly summarise the aqueous humour, Although present in such small amounts, the aqueous humor has important functions in eye physiology:

- Provides nutrition to the lens and cornea. Both are structures without blood vessels and depend on the aqueous for oxygen and other substances
- Helps maintain normal intraocular pressure or the pressure within the eyes.
- Being transparent, it is part of the ocular media allowing light rays to pass through for good vision

To summarise general physiology of the eye simply, the eye is compared with the camera and explained in much easier terminology to understand how image is formed on the retina, its charecteristics and then again transferred to the brain through electrical impulses to perceive image.

Short Answer Type Questions

1. Define human eye.
2. What is the use of the eye?
3. Draw a neat labeled diagram of eye ball.
4. What are the properties of the image focused on the retina?
5. Define human eye.
6. What is the use of the eye?
7. Draw a neat labeled diagram of eye ball.
8. What are the properties of the image focused on the retina?
9. What do you mean by pupillary reflex?
10. How do you check papillary reflexes?
11. Which nerve is responsible for afferent reflex.
12. Efferent reflex is caused by in pupil.

13. How many neurons control papillary reflex.
14. What is the function of the pupil?
15. What is colour vision?
16. What is the difference between vision and colour vision ?
17. What do you mean by photoreceptor cells?
18. Which cells in the eye are responsible for colour vision.
19. Define visual field.
20. Normal limits of visual field in human eye uniocularly.
21. Importance of visual field tests.
22. What do you mean by Bitemporal hemianopia?
23. Define Accommodation.
24. What is amplitude of accommodation?
25. How do you measure amplitude of accommodation.
26. What is punctum remotum and punctum proximum?
27. What is relative accommodation test?
28. What is convergence?
29. What is divergence?
30. What is the stimulus for convergence and divergence of the eyes?
31. What is positive and negative vergence of the eyes?
32. What do you mean by fusional vergence amplitudes?

Long Answer Type Questions

1. Describe how our eye perceives image.
2. After image formed on the retina, how is it transferred to the brain.
3. Write about the physiology of the eye.
4. Describe how our eye perceives image.
5. Explain briefly field of vision and normal limits.
6. How do you perform visual field tests.

7. What are the four types of visual field defects?
8. Importance of papillary reflexes and how are they controlled/
9. Clinical significance of papillary reflexes.
10. How do you check papillary reflexes and conclusions.
11. Explain papillary reflexes path way along with diagram.
12. Describe briefly physiology of colour perception.
13. Write photophysiology of colour vision receptor cells in retina.
14. What is AC/A ratio?
15. Accommodation is associated with? Explain briefly.
16. What is the relationship of convergence with accommodation?
17. Explain convergence insufficiency briefly?
18. How do you measure near point of convergence (NPC)?
19. Convergence of the eyes explain briefly?
20. Importance of papillary reflexes and how are they controlled.
21. Clinical significance of papillary reflexes.
22. How do you check papillary reflexes and conclusions.
23. Explain papillary reflexes path way along with diagram.

UNIT 3

Pharmacology

Structure

3.1 Ocular Pharmacology & Mode of Therapy

The human eye can be divided into the anterior and posterior anatomical segments. Drug delivery to the anterior segment is primarily achieved through topical application, and significant success has been achieved in delivering drugs to this area.

However, the delivery of drugs to the posterior segment of the eye poses a great challenge. Currently, the posterior segment disease treatment focuses on four approaches to deliver drugs - topical, systemic, intraocular, and periocular.

Topical application of drugs for treatment of posterior eye disorders is not very effective due to the long diffusional path length, rapid precorneal elimination due to solution drainage, normal or induced lacrimation, and corneal epithelial impermeability to molecules larger than 5 kDa. Although the systemic approach can deliver drugs to the eye, systemically administered drugs have poor access to the eye tissues because of the blood-aqueous barrier (which prevents the substances from entering into the aqueous humor) and because of the blood-retinal barrier (which severely limits drug entry into the extravascular space of the retina and into the vitreous). Consequently, large systemic doses are required, and this can induce toxicity and unwanted side effects. Intravitreal injections are an effective way of delivering drugs to the vitreoretinal region. However, intravitreal injections can potentially induce retinal detachment, hemorrhage, endophthalmitis, and cataracts. Repeated intravitreal injections are often required, which might further complicate the treatment and compromise safety factors. In recent years, there is a regenerated interest in the periocular delivery of drugs.

Periocular modes of administration include subconjunctival, subtenon, and retrobulbar. In all of these modes, the drug is interfaced with sclera. There is substantial evidence indicating that drugs administered subconjunctivally can reach the vitreous effectively. The sclera does not provide an effective barrier to the entry of drugs, and even solutes of relatively large molecular weight can penetrate through it. The drugs can gain entry into the posterior segments from the subconjunctival space after entering the sclera. The subconjunctival injection approach is safer and less invasive than the intravitreal route. Systemic absorption is low with subconjunctival route, which can lower the systemic side effects while providing a localized drug effect.

Long-term administration of drugs is required for treating some vitreoretinal disorders. Sustained delivery systems can provide therapeutically effective drug levels for a long period of time. Various types of sustained delivery systems and devices are currently being developed to provide a longer duration of action and to also localize drug delivery. These include sustained-release intravitreal implants, scleral plugs, and particulate systems. These sustained delivery systems are made from either biostable (nonbiodegradable, nonerodible) or biodegradable polymers. Indeed, an intravitreal implant (Vitrasert®, Bausch & Lomb) of ganciclovir is being clinically used in the treatment of CMV retinitis. This implant delivers sustained therapeutic levels of ganciclovir for a period of approximately 7.5 months. Although it is a very effective device for sustained delivery, the implantation procedure requires surgery, and the procedure can be expensive. Hence, there is a need to explore other non-surgical ways for sustaining drug delivery to the posterior segment. In recent times, nano- and microparticulate systems have generated considerable interest for sustaining drug delivery.

Nanoparticle suspensions have been shown to improve the residence time of topicaly applied ophthalmic formulations.

Also, intravitreally administered microparticles have been shown to sustain drug delivery. Such particulate systems can be explored for sustaining the drug delivery to the posterior segments of the eye.

Subconjunctivally administered micro- and nano-particulate systems containing the drug of interest, if retained in the subconjunctival space, may be useful in delivering therapeutic amounts of the drug to the posterior segment of the eye in a sustained fashion, while minimizing the polymeric burden on the sensitive intraocular tissues. Therefore, in this study, we assessed the ocular distribution of fluorescent nano- and microparticles after subconjunctival injection. We also studied the distribution of sodium fluorescein and these particulate systems after systemic administration for comparative purposes.

3.2 Commonly Used Drugs In Ophthalmology and Antibiotics

Ophthalmic Antibiotics

Ophthalmic antibiotic agents are used to treat superficial ocular bacterial and fungal (natamycin) infections. These superficial bacterial or viral infections include conjunctivitis, blepharitis, and corneal ulcers. Acute conjunctivitis is the most common disorder of the eye seen by the primary care physician, and the term encompasses a broad group of conditions presenting as inflammation of the conjunctiva. The most common pathogen of viral or bacterial infections varies with age. In children, that pathogen is H. influenzae and S. pneumoniae, and the pathogens in adults range from Staphylococcus to Pseudomonas, usually introduced as a contagious manifestation. Most cases, usually about 80%, become bilateral, justifying bilateral treatment even when presenting unilaterally. A typical case of untreated conjunctivitis will usually resolve in about 8 days. With medication, conjunctivitis symptoms are alleviated in approximately 4 days.

Treatment of superficial ocular infections with topical agents is indicated within 4 days of the onset of symptoms. There are several therapeutic options approved for the treatment Of superficial ocular infections. The topical agents used to treat ocular infections are grouped into various classes such as aminoglycosides (gentamicin, neomycin, and tobramycin), macrolides (erythromycin), fluoroquinolones (ciprofloxacin, levofloxacin, ofloxacin, gatifloxacin, and moxifloxacin), and others including chloramphenicol and natamycin (should be reserved for fungal eye infections). Gatifloxacin and moxifloxacin are two newer fluoroquinolones. There are also combination

products including various combinations of bacitracin, neomycin sulfate, and/or polymyxin B sulfate, tobramycin and dexamethasone.

Few studies of ophthalmic antibiotics have been done that compare the efficacy of these agents. This may be due to the age of some of these products and the established use by physicians. Resistance is a concern with all antibiotics; however, there have not been any clinical trials to evaluate resistance to ophthalmic antibiotics.

The safety profiles of the ophthalmic antibiotics are very different. Neomycin is associated with a significant incidence of contact dermatitis. Gentamicin and tobramycin are associated with ocular toxicities, while chloramphenicol may cause rare aplastic anemia. The fluoroquinolones are newer, broad-spectrum (including coverage for pseudomonas) antibiotics with mild to moderate side effects; however, they are more expensive and should be reserved for severe infections.

Generic Name	Trade Name	Dosage Form	Manufacturer	Generic
Bacitracin	AK-Tracin®	Ointment	Akorn	Y
Chloramphenicol	Chloroptic ®	Ointment,Solution	Allergan	Y
Ciprofloxacin	CiloxinTM	Solution,Ointment	Alcon	Y
Erythromycin	Ilotycin®	Ointment	Various	Y
Gatifloxacin	ZymarTM	Solution	Allergan	N
Gentamicin	Garamycin®	Ointment,Solution	Various	Y
Levofloxacin	QuixinTM (0.5%),Iquix® (1.5%)	Solution	Santen	N N
Moxifloxacin	VigamoxTM	Solution	Alcon	N
Natamycin	Natacyn®	Suspension	Alcon	N
Neomycin Sulfate	Neosporin®	Ointment,solution	Various	Y
Ofloxacin	Ocuflox®	Solution	Allergan	Y
Polymyxin BSulfate &Bacitracin	Polysporin®	Ointment	Various	Y
Tobramycin	Tobrex®	Solution,Ointment	Various	Y

3.3 Anti-Inflammatory

There are four broad categories of ophthalmic anti-inflammatory preparations:

1. Corticosteroids
2. Anti-histamines

3. Mast cell stabilisers
4. Non-steroidal anti-inflammatory drugs (NSAIDs)

In the primary care setting, topical agents are most commonly used, with the marked exception of suspected giant cell arteritis (GCA) where systemic steroids may need to be initiated promptly prior to urgent specialist review. In a specialist unit, anti-inflammatory agents (typically steroids) can be injected in the sub-Tenon's space and within the globe.

Common conditions warranting anti-inflammatory treatment include allergic conjunctivitis and hypersensitivity reactions. These drugs are also very commonly used in specialist units to treat a very wide range of conditions. These include uveitis, cystoid macular oedema, scleritis and episcleritis, and certain cases of herpes simplex keratitis, during and after surgical procedures.

Topical Corticosteroids

Overview

- **Examples -** betamethasone, dexamethasone, fluoromethalone, hydrocortisone acetate,prednisolone, rimexolone, loteprednol etabonate .
- **Use** - short-term treatment of local inflammation, usually in the anterior segment of the eye. This includes inflammation post surgery.
- **Action** - decrease number and function of inflammatory cells, increase vascular permeability and inhibit chemical mediators of inflammation.
- **Contra-indications** - undiagnosed red eye; they can aggravate herpes virus and other infections.
- **Caution** - prescription and monitoring need to be done in a specialist unit.
- **Administration** - largely depends on the condition: may be as frequent as every 30 minutes in severe inflammatory states. There is then a gradual reduction over time (again, depends on condition) according to symptoms and clinical findings. Period of reduction may be weeks or even months, with a small minority of patients being kept on very low doses of weak steroids for extended periods of time (years) to prevent recurrence.
- **Ocular side-effects** - rise in intraocular pressure (may be insidious or rapid: "steroid responders"), cataract formation in long-term use, corneal

thinning, delay in corneal healing, increased susceptibility to microbial infections and a paradoxical uveitis.

- **Systemic side-effects** - theoretical but be aware of susceptible individuals (pregnancy,peptic ulcer disease, tuberculosis, active infection, psychosis).
- **Additional information** - in severe inflammatory states, a local injection of steroids around the globe can be performed by ophthalmologists.

Corticosteroids available in ointment form

- **Examples** - Betnesol® and hydrocortisone acetate.
- Use - atopic conditions involving the periocular skin; can be used as a substitute for night time steroid drop application in some cases and where there is difficulty in applying drops, e.g. due to arthritic hands.

Corticosteroid/antibiotic combinations3

- **Examples** - betamethasone + neomycin, dexamethasone 0.1% + neomycin/polymyxin B/tobramycin, dexamethasone 0.05% + framycetin/gramicidin, prednisolone 0.5% + neomycin.
- **Use** - where there is inflammation associated with a risk or actual infection, e.g. post routine cataract surgery. Initiation of these drugs is not recommended in the primary care setting.

Corticosteroids available in Minims®

- **Examples** - dexamethasone and 0.5% prednisolone.
- **Use** - these are single-use application packs used where there is preservative toxicity.

Antihistamines

- **Examples** - antazoline sulfate, azelastine hydrochloride, olopatidine, epinastine hydrochloride, ketotifen.
- **Use** - allergic conjunctivitis, seasonal and perennial conjunctivitis.
- **Action** - they inhibit histamine-mediated inflammatory responses.
- **Caution** - some agents are not licensed for young children, there can be rebound vasodilation after prolonged use, severe renal impairment, pregnancy and breast-feeding.

- **Administration** - most preparations twice-daily until cessation of symptoms.
- **Ocular side-effects** - local irritation and stinging possible, visual disturbances, keratitis, oedema, photophobia.
- **Systemic side-effects** - (rare): headache, pruritus and skin reactions, drowsiness and dry mouth reported.
- **Additional information** - these drugs act quickly but consider oral antihistamines if symptoms severe or not limited to the eye. May be used concurrently with mast cell stabiliser (ketotifen has mast cell stabilising properties too). Antazoline preparations are available over-the-counter (OTC).

Mast cell stabilisers

- **Examples** - lodoxamide, nedocromil sodium, emedastine, sodium cromoglicate.
- **Use** - allergic, seasonal and vernal conjunctivitis.
- **Action** - stabilise mast cell membranes; therefore these drugs have a more prophylactic role, as they are administered before mast cell priming with IgE and allergens.
- **Caution** - some agents not licensed for young children (check individual drug), pregnancy and breast-feeding.
- **Contra-indication** - soft contact lens wear.
- **Administration** - most preparations are applied four times daily for a maximum of 12-16 weeks.
- **Ocular side-effects** - transient local irritation and stinging possible, dry eye, keratitis, lacrimation, corneal infiltrates, staining and localised oedema.
- **Systemic side-effects** - headache, dizziness and taste disturbance.
- **Additional information** - may be used concurrently with antihistamines. Sodium cromoglicate preparations are available OTC.

Non-steroidal anti-inflammatory drugs

- **Examples** - diclofenac, ketorolac, flurbiprofen sodium.

- **Use** - postoperative inflammation in cataract surgery (e.g. macular oedema), pain after accidental or surgical corneal trauma. Diclofenac also has a role in seasonal allergic conjunctivitis.
- **Action** - inhibit the synthesis of eicosanoids (prostaglandins, thromboxanes and leukotrienes).
- **Caution** - some agents not licensed for young children (check individual medication), rebound vasodilation after prolonged use, pregnancy and breast-feeding.
- **Administration** - this varies depending on condition. May be a single stat dose.
- **Ocular side-effects** - local irritation and stinging possible.
- **Systemic side-effects** - none reported for topical drugs.

3.4 Ocular Anti-Allergic

- Symptoms of eye allergies, or allergic conjunctivitis, include watery, itchy, red, sore, swollen, and stinging eyes. Itchy eyes are the most important symptom of allergic conjunctivitis. Without itching, it's much less likely that a person is suffering from eye allergies. Both eyes are usually affected, although one eye may be more symptomatic than the other.
- Seasonal allergic conjunctivitis (SAC) is the most common form of eye allergy, with grass and ragweed pollens being the most important seasonal triggers. Perennial allergic conjunctivitis (PAC) is also very common. Animal dander, feathers, and dust mites are common triggers in PAC.
- People with SAC usually note the onset of symptoms during the spring and fall, and frequently note symptoms of allergic rhinitis. Symptoms include itchy eyes, burning of the eyes, and eye watering. In some cases, people notice sensitivity to light and blurred vision. The eyes are usually red and the eyelids may become swollen. When the inside of the eyelid (the conjunctiva) is also swollen, the eyes may have a watery, gelatinous-like appearance, this is called "chemosis".
- Prescription eye drops are available in five types, based on how the medication works. Decongestant and decongestant/anti-histamine combination drops are also available in prescription forms, which are equivalent to other-the-counter formulations. Other than decongestant forms of eye drops, none of the prescription eye drops are associated with conjunctivitis with long-term use.

Anti-histamine eye drops

This medication, currently only available as emedastine (Emadine®), works well to treat eye allergies on an "as-needed" basis. Older forms of ant-histamine eye drops have been discontinued.

Mast cell stabilizer eye drops

These medications have been around for many years and work well to prevent allergic conjunctivitis symptoms if used before allergen exposure. These are available as cromolyn (Crolom® and generics), nedocromil (Alocril® and generics), lodoxamide (Alomide®) and pemirolast (Alamast®). These medications are not as helpful when used on an "as needed" basis.

Anti-histamine/mast cell stabilizer dual-action eye drops

The newest generation of allergy eye drops is superior to either of the single action agents. This class of medication includes olopatadine (Patanol®), azelastine (Optivar®), epinastine (Elestat®) and ketotifen (Zaditor®). These medications block the effects of histamine and prevent mast cells from releasing the chemicals responsible for allergy symptoms.

Non-steroidal anti-inflammatory eye drops

Ketorolac (Acular®) is indicated for the treatment of allergic conjunctivitis and works in a similar way as aspirin and ibuprofen. Those with aspirin sensitivity or intolerance should not use this medication.

Corticosteroid eye drops

Use of steroid eye drops can lead to severe complications if not used with caution and under the close supervision of a physician. Complications can include glaucoma, cataract formation, and severe eye infections. One type of steroid eye drop, loteprednol (Alrex®), is indicated for the short-term use (typically less than 7-10 days) of allergic conjunctivitis, but should be used with caution. These medications are usually only needed in severe cases of allergic conjunctivitis, and can act as a "bridge" to another class of medication as listed above.

3.5 Mydriatics And Miotics

Mydriasis

Mydriasis is a dilation of the pupil, usually defined as when having a non-physiological cause, but sometimes defined as potentially being a physiological pupillary response. Non-physiological causes of mydriasis include disease, trauma, or the use of drugs. Normally, the pupil dilates in

the dark and constricts in the light to respectively improve vividity at night and to protect the retina from sunlight damage during the day. Amydriatic pupil will remain excessively large even in a bright environment and is sometimes colloquially referred to as a "blown pupil". More generally, mydriasis refers to the dilation of pupils, for instance in low light conditions or under sympathetic stimulation. The excitation of the radial fibres of the iris which increases the pupillary aperture is referred to as a mydriasis.

An informal term for mydriasis is blown pupil, and is used by medical providers. It is usually used to refer to a fixed, unilateral mydriasis, which could be a symptom of stroke or other type of brain dysfunction.

The opposite, constriction of the pupil, is referred to as miosis. Both mydriasis and miosis can be physiological.

Fig 3.1

Mechanism

There are two types of muscle that control the size of the iris: the iris sphincter, composed of circularly arranged muscle fibers, and the iris dilator, composed of radially arranged muscle fibers. The former is innervated by the parasympathetic nervous system; the latter by the sympathetic nervous system. Sympathetic stimulation of the adrenergic receptors causes the contraction of the radial muscle and subsequent dilation of the pupil. Conversely, parasympathetic stimulation causes contraction of the circular muscle and constriction of the pupil.

The mechanism of mydriasis depends on the agent being used. It usually involves either a disruption of the parasympathetic nerve supply to the eye (which causes contraction of the pupil) or overactivity of the sympathetic nervous system (SNS).

A mydriatic is an agent that induces dilation of the pupil. Drugs such as tropicamide are used in medicine to permit examination of the retina and other deep structures of the eye, and also to reduce painful ciliary muscle spasm (see cycloplegia). Phenylephrine (e.g. Cyclomydril) is used if strong mydriasis is needed for a surgical intervention. One effect of administration of a mydriatic is intolerance to bright light (Photophobia). Purposely-induced mydriasis via mydriatics is also used as a diagnostic test for Horner's Syndrome.

Miosis

Miosis (or myosis, from Ancient Greek mkein, "to close the eyes") is a term with various definitions, which generally include constriction of the pupil.

The opposite condition, mydriasis, is the dilation of the pupil.

Definitions of miosis include

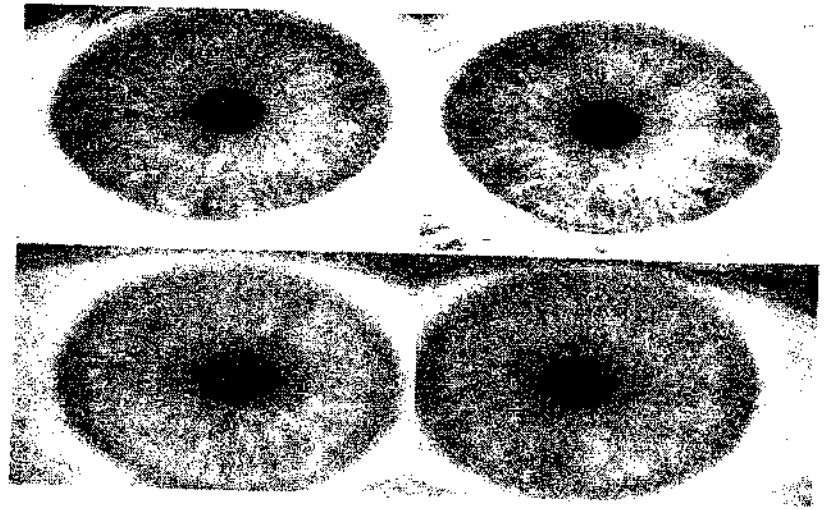

Fig 3.2

- Constriction of the pupil that is excessive which may potentially be interpreted as being relative to what would be expected by the amount of light the pupil receives
- Constriction of the pupil to a diameter of less than two millimeters
- Constriction of the pupil with causes including both abnormal and physiological ones.

Pupillary constriction by abnormal causes

Causes

Age

Diseases

- Horner's syndrome
- Hemorrhage into pons (intracranial hemorrhage)
- Cluster Headaches with ptosis
- Iridocyclitis
- Fatal familial insomnia

Drugs

- Opioids such as fentanyl, morphine, heroin and methadone (the notable exception being demerol)
- Antipsychotics, including haloperidol, thorazine, olanzapine, quetiapine and others
- Cholinergic agents such as acetylcholine
- Some cancer chemotherapy drugs, including camptothecin derivatives
- Mirtazapine, a noradrenergic and specific serotonergic antide pressant (NaSSA)
- Trazodone
- Some MAO Inhibitors.
- In some rare cases, when exposed to mustard gas.
- Organophosphates

A miotic substance causes the constriction of the pupil of the eye (or miosis). It is the opposite of a mydriatic substance, which causes dilation of the pupil.

3.6 Antiseptics

Antiseptics are chemicals which kill bacteria without harming living tissue. They are normally used to sterilize and area of skin e.g., hands before performing an operation or arm before drawing blood or clean a wound e.g., kid fallen off bicycle onto gravel. They are different from disinfectants (which would harm living tissue and so should only be used on objects) and antibiotics (which are

medicines). many antibiotics don't kill bacteria but only prevent them from multiplying.

Antiseptics are antimicrobial substances that are applied to living tissue/ skin to reduce the possibility of infection, sepsis, or putrefaction. Antiseptics are generally distinguished from antibiotics by the latter's ability to be transported through the lymphatic system to destroy bacteria within the body, and from disinfectants, which destroy microorganisms found on non-living objects.

Some antiseptics are true germicides, capable of destroying microbes (bacteriocidal), while others are bacteriostatic and only prevent or inhibit their growth. Antibacterials are antiseptics that have the proven ability to act against bacteria. Microbicides which destroy virus particles are called viricides or antivirals.

For the growth of bacteria, there must be a food supply, moisture, oxygen (if the bacteria is an obligate aerobe), and a certain minimum temperature (see bacteriology). These conditions have been studied and dealt with in food preservation and the ancient practice of embalming the dead, which is the earliest known systematic use of antiseptics.

In early inquiries before there was an understanding of microbes, much emphasis was given to the prevention of putrefaction, and procedures were carried out to determine the amount of agent that was to be added to a given solution in order to prevent the development of pus and putrefaction; however, due to a lack of a developed understanding of germ theory this method was inaccurate and, today, an antiseptic is judged by its effect on pure cultures of a defined microbe and/or their vegetative and spore forms. The standardization of antiseptics has been implemented in many instances, and a water solution of phenol of a certain fixed strength is now used as the standard to which other antiseptics are compared.

3.7 Aseptic Techniques

Aseptic technique is a general term involving practices that minimize the introduction of microorganisms to patients during patient care. There are two categories of asepsis; general asepsis which applies to patient care procedures outside the operating theatre and surgical asepsis relating to procedures/processes designed to prevent surgical site infection. This chapter will focus primarily on general aseptic procedures as insertion of intravenous catheters or urinary catheters and examples of "no-touch" technique. Aseptic techniques are used to reduce the risk of post-procedure infections and to minimize the exposure of health care providers to potentially infectious microorganisms.

Aseptic techniques include practices performed just before, during, or after any invasive procedures. Poor adherence to aseptic techniques results in considerable morbidity and mortality. Even in countries with well-established infection control programs, hospital-acquired infections (HAI) related to poor compliance with aseptic techniques is an important public health problem.

Poor adherence to aseptic techniques, such as the reuse of needles and syringes between patients has also been implicated in transmission of blood-borne pathogens (e.g., HIV and HCV).

It is important that all health care facilities establish policies regarding procedures that require aseptic techniques. Health care personnel who perform these procedures should be trained in aseptic technique and should demonstrate competency. It is particularly important for staff to understand why aseptic techniques are needed and for the hospital director to ensure that adequate equipment and supplies are available. Supervision and monitoring of infection control activities is a critical element of infection control.

Methods to achieve Asepsis

1. Hand antisepsis and the appropriate use of gloves.
2. Skin antisepsis of the site of insertion of invasive devices, e.g., IVs. Using and maintaining sterile patient care equipment, e.g., multidose medication vials, IV fluids and devices, by minimizing contact with nonsterile surfaces or reuse of equipment and devices intended for single patient use.
3. The introduction of a sterile item into a patient should always be performed with a no-touch-technique. This means that the skin in the area of insertion should not be touched after skin antisepsis. Similarly, IV administration tubing should be kept sterile and tops of vials of medication should be disinfected prior to entry.

3.8 Urine Examination

Urine tests are very useful for providing information to assist in the diagnosis, monitoring and treatment of a wide range of diseases.

In addition, a urine test can determine whether or not a woman is ovulating or pregnant.

Urine can also be tested for a variety of substances relating to drug abuse, both as part of rehabilitation programmes and in the world of professional sport.

The urine can be tested very quickly using a strip of special paper, which is dipped in the urine just after urination. This will show if there are any abnormal products in the urine such as sugar, protein, or blood.

If more tests are needed to get more details, the urine will be analysed at a laboratory.

Urine test reveals

It is possible to discover diseases of many different organs of the body with a urine test. It may represent the only necessary investigation if, for instance, the purpose is to find out if you suffer from cystitis. In other cases it will be taken along with other tests (such as stool or blood tests) as part of the investigation process. A urine test is a cheap, simple test that can provide a lot of important information, for example:

- Blood in the urine may be a sign of different diseases in the kidneys, the urinary system or the bladder.
- Sugar in the urine may be a sign of diabetes.
- Protein in the urine may be a sign of a kidney disease and can be used to detect the early signs of kidney damage from long-standing diabetes.
- Biochemical analysis of the urine can assist in the diagnosis of kidney stones, and myeloma.
- Analysis under a microscope of cells (cytology) shed from the lining of the bladder that are present in the urine, can assist in the diagnosis and treatment of bladder cancer.

Methods of urine analysis

1. **Naked eye testing and smell**: Colour and cloudiness of the urine is noted through naked eye. Yellow, amber, pale or red are the few colour types which can be noted and Clear or cloudy consistency and also the smell of urine is sensed which is of useful importance
2. **Protein testing**: Take around 1 ml of urine sample in 2 separate test tubes. Put one tube into the hot water bath, and leave the other at room temperature. After a few minutes, take the test tube out of the water bath, and compare the heated and unheated urine. If the heated sample is cloudier, it contains protein.
3. **pH testing**: Dip a piece of universal indicator paper into the urine. Quickly take it out, and leave it for 30 seconds. Compare the new colour with the pH colour chart, and note the pH

4. **Testing for glucose**: This test is used to know whether there is any presence of glucose in the urine, if yes then it can indicate disease conditions like Diabetes.

5. **Urine dipstick Test**: It is a long strip which has several squares of different colors on it. Each square is used to interpret urinalysis. The strip is dipped completely in the urine sample and color changes are noted after 5 minutes. The squares on the dipstick represent the following components in the urine-

6.Specific gravity, pH, protein in the urine, glucose, ketone bodies, blood, leukocyte, nitrite, bilirubin andurobilinogen

Microscopic evaluation: Cells, Cellular debris, Casts, Bacteria and crystals or small structures

7. **Culture and sensitivity**: This is used for culture of certain specific bacteria where the medicines are not effective in the treatment and the drug sensitivity.

Uses

- It is used more commonly to diagnose urine tract infections like cystitis, Prostatitis, Urethral infections etc
- To diagnose kidney infections like pyelonephritis, Glomerulonephritis
- To diagnose various other diseases like pyuria, Rhabdomyosis, Metabolic disorders, bleeding disorders, inherited disorders etc
- To screen chronic diseases like Diabetes mellitus and Hypertension
- In combination with other tests for evaluation of kidney stones, muscle protein breakdown and inflammation of kidney structures
- In medico legal cases where drugs have been taken and misused
- For interpretation of medicines and its efficacy.

Summary

Drug delivery to the posterior segment is limited by the epithelial barriers of cornea and conjunctiva following topical administration and by the blood-aqueous and blood-retinal barriers following systemic administration. Little or no drug reaches posterior segment following topical administration, necessitating the administration some drugs, such as anti-glaucoma drugs, corticosteroids, and certain antibiotics by the systemic route. However, a very small fraction of

the dose reaches the ocular tissues following systemic administration. Also, systemic route requires high doses, often leading to systemic side affects with ophthalmic drugs. Thus, drug delivery to the posterior segment of the eye is a major challenge. Due to the limitations of systemic and topical routes, drugs intended for the posterior segment are often administered as intravitreal injections. This mode of administration invades the sensitive retina and can cause endophthalmitis, cataracts, and retinal detachment. To overcome these limitations, The sclera has a large accessible surface area, a high degree of hydration, and paucity of enzymes and protein-binding sites. Even larger molecules like peptides and polymers can cross the sclera. Posterior segment, especially the retina, is afflicted by various chronic disorders, including age-related macular degeneration, diabetic retinopathy, and retinitis pigmentosa, disorders that will likely benefit from chronic drug therapy. If polymeric particulate systems remain in the subconjunctival space with minimal absorption into either the systemic circulation or any of the ocular tissues, then these could serve as depot devices for slowly releasing the drug in the subconjunctival space and providing a sustained effect for prolonged periods.

Selection of a topical, ophthalmic antibiotic for the preferred drug list should be based on the spectrum of activity, efficacy, and safety. Many of these agents are generically available. A fluoroquinolone agent should be utilized if there is a need to increase the spectrum of coverage for resistant organisms. Two newer fluoroquinolones (gatifloxacin and moxifloxacin) have been added to the arsenal of potent treatment agents for ophthalmic bacterial infections. However, current data does not suggest that the newer agents have any clinical advantage over previously available agents. Selection of an agent for the preferred drug list should be based on spectrum of coverage, safety and cost.

This chapter briefly discloses anti inflammatory drugs to the eye, their classification, mode of action, administration along with that ocular and systemic side effects in the line of treatment to the eye.

Symptoms of eye allergies, or allergic conjunctivitis, include watery, itchy, red, sore, swollen and stinging of the eyes. Itching of the eyes is the most important symptom of allergic conjunctivitis. Without itching, it is much less likely that a person is suffering from allergies of the eyes. Both eyes are usually affected, although one eye may be more symptomatic than the other.This chapter briefly describes anti-allergic precautions, indications and treatment to the eyes.

Pupil dilatation or mydriasis is of great significance in screening of various ophthalmological conditions. The factors that contribute to this phenomenon are disease,drugs etc. The ability of the agent that is used for producing dilatation has variable impact on each individual. Moreover the physiology of the eye is

another factor that gains prime attention in subjects with eye disorders. Innervations by parasympatholytic system can contract the radial muscles. Sympathomimetics and parasympatholytics are the common and main categories of mydriatic agents that have been used so far routinely. In contrast pupil constriction is called miosis of the pupil which is explained in this chapter briefly.

Antiseptics are antimicrobial substances that are applied to living tissue/ skin to reduce the possibility of infection, sepsis, or putrefaction. Antiseptics are generally distinguished from antibiotics by the latter's ability to be transported through the lymphatic system to destroy bacteria within the body, and from disinfectants, which destroy microorganisms found on non-living objects.

Some antiseptics are true germicides, capable of destroying microbes (bacteriocidal), while others are bacteriostatic and only prevent or inhibit their growth.

Aseptic technique refers to a procedure that is performed under sterile conditions. This includes medical and laboratory techniques, such as with cultures. It includes techniques like flame sterilization. The largest example of aseptic techniques is in hospital operating theatres. It is a method used to prevent contamination of wounds and other susceptible sites by organisms that could cause infection. This can be achieved by ensuring that only sterile equipment and fluids are used during invasive medical and nursing procedures. Medical or clean asepsis reduces the number of organisms and prevents their spread; surgical or sterile asepsis includes procedures to eliminate micro-organisms from an area and is practised by surgical technologists and nurses in operating theaters and treatment areas. In an operating room, while all members of the surgical team should demonstrate good aseptic technique, it is the role of the scrub nurse or surgical technologist to set up and maintain the sterile field.

To summarise the chapter urine examination we have tried to explain in simple terms about, Urine analysis is a simple procedure in which a small amount of urine is collected in a clean bottle of 5 to 10 ml and its quality and quantity is assessed for various health care problems usually done in clinics, laboratories, hospitals and other health care setups; it is very useful in diagnosing,screening, and treating of diseased conditions

Short Answer Type Questions

1. What do you understand by ocular pharmacology?
2. How are the drugs delivered to anterior segment of the eye.
3. What is the problem in delivering drugs to posterior segmnt of the eye?

4. What do you mean by Intravitreal administration?
5. What do you mean by antibiotics?
6. Name some commonly used antibiotics in eyes.
7. Antibiotics are used to treat.
8. Name the pathogens effecting eye, treated by antibiotics.
9. What do you understand by anti inflammatory?
10. What are the broad categories of ophthalmic anti-inflammatory preparations?
11. What are the Common conditions warranting anti-inflammatory treatment?
12. What do you mean by mast cell stabilisers?
13. What are the symptoms of eye allergies?
14. What do you mean by SAC and PAC allergic infections in eyes?
15. What are anti-histamine drops for eyes?
16. Give full form of NSAID.
17. What do you mean by mydriasis and miosis of pupil?
18. Name the muscles which aid in constriction and dilatation of pupil.
19. Which drugs are used for mydriasis and miosis.
20. Why do we dilate pupil.
21. What is the relation of iris with mydriasis and miosis?
22. Why does pupil dilate or constrict, explain briefly.
23. What is meant by blown pupil, Explain briefly?
24. What are the diseases which causes myosis or mydriasis of pupil?
25. What do you mean by antiseptics?
26. How is asepsis achieved.
27. What is the role of antiseptics?
28. What are the ideal conditions for growth of bacteria?
29. What are anti bacterials?

30. Why are aseptic techniques done.
31. What do you mean by urine examination?
32. Interpretations of eye effected diseases with urine examination.
33. What do you mean by urine dip stick?
34. Importance of checking specific gravity in urine analysis.

Long Answer Type Questions

1. Explain methods of drug delivery system in eye.
2. Explain topical, systemic, intraocular, and periocular drug delivary system to eye.
3. What are the complications in drug delivary to posterior segment of eye?
4. Explain briefly all about antibiotics for eyes.
5. Write classification of antibiotics.
6. On usage of anti inflammatory drugs, what are the ocular and systemic side effects.
7. What are the categories of anti inflammatory drugs, Explain briefly?
8. Explain briefly ocular anti allergic treatment.
9. How many types of prescription eye drops available for anti allergy.
10. Define briefly antiseptics.
11. Define briefly Aseptic technique and how is it achieved.
12. What is the role of nurses in achieving asepsis?
13. Importance of urine examination related to eye.
14. What are the different interpretations of urine analysis?
15. Methods of examinations of urine analysis.

IVC : Course Code 605

Ophthalmic Technician

Paper - II

Physical & Physiological aspects of Spectacles

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UNIT 1

Elementary basics of light and vision

Structure

1.0 Introduction

Light is a form of energy. It has dual nature Particle and wave. Light can pass through media as well as vacuum. It behaves like a corpuscle (photon) and can, therefore pass through vacuum and behaves like a wave when it passes through media.

The media through which light passes totally and almost undisturbed are termed transparent. Those which cause difficulty in its passage are called translucent and those which do not allow light to pass are called opaque.

It behaves like a particle (photon) as an individual characteristic when it is created or destroyed and like an electromagnetic wave when as a group it propagates through a space. A series of waves makes up the energy spectrum consisting of cosmic rays, electronic rays, gamma rays, x-rays, ultraviolet rays, the visible rays (consisting of violet, indigo, blue, green, yellow, orange, and red) in short we call them as "VIBGYOR", the infrared rays, the wireless rays (short and long), and the slow electromagnetic oscillations (Fig 1.1).

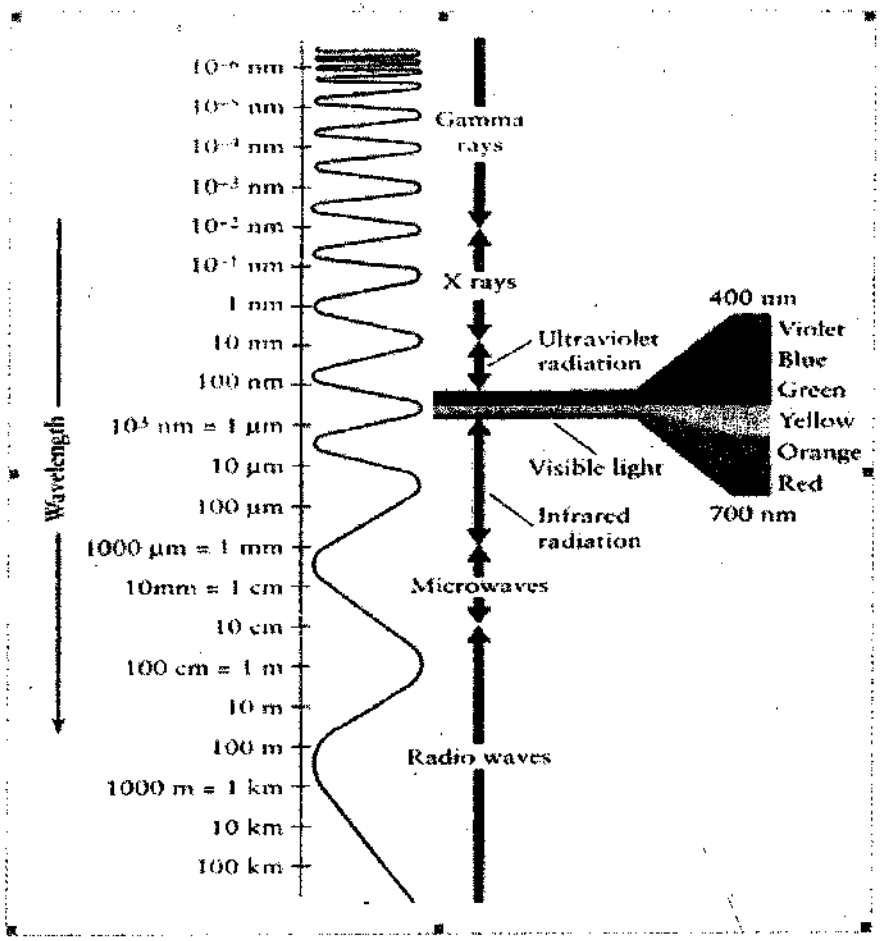


Fig 1.1 Electromagnetic Spectrum

The electromagnetic spectrum of visible light has wavelengths varying roughly between 400 and 800 nanometers (a nanometer is a billionth, i.e., 1/ 1,000,000,000 of a meter). Light is a very special form of electromagnetic energy. When it falls on retina it causes reactions included under the term of photobiology.

Photo biological process occurs when light is absorbed by certain chemicals in the retina. It produces mechanical, chemical and electrical changes. These changes stimulate certain highly specialized cells which produce nerve impulses. These produce perception of light, colour, from, size and motion.

Visible light is an agent which by its action on the retina excites a sensation of vision. When some objects are visible in the absence of all sources of light, they are called self-luminous, e.g., glowworm, a lighted match stick, a lighted candle, the sun, etc. There are other objects which are nonluminous and can only become visible by the light received from luminous objects and returned to the eyes.

Propagation of light

There are several theories to explain the propagation of light amongst which the wave theory is the most satisfactory. It says that from the propagating source they are set in motion waves of light which pass in various directions. Thus the light emitted from the luminous body is supposed to travel in a homogeneous medium in all directions and in straight lines.

Photon

Light may, therefore, be considered to be a stream of particles when it interacts with matter. An example is the liberation of photons from a metal surface by light, called the photoelectric effect.

For a complete explanation it should be assumed that light consists of small bundles of energy called photons, They can be explained by assuming that light consists of waves. The term ray is applied to the path along which light travels from each point of luminous object and can be represented by a line in a plane. A small bundle of rays is termed a pencil, which is usually in the form of a cone.

The rays may be convergent (+ vergence) they proceed towards a point or they may be divergent (- vergence) i.e. they proceed from a point or they may be parallel to each other i.e. zero vergence

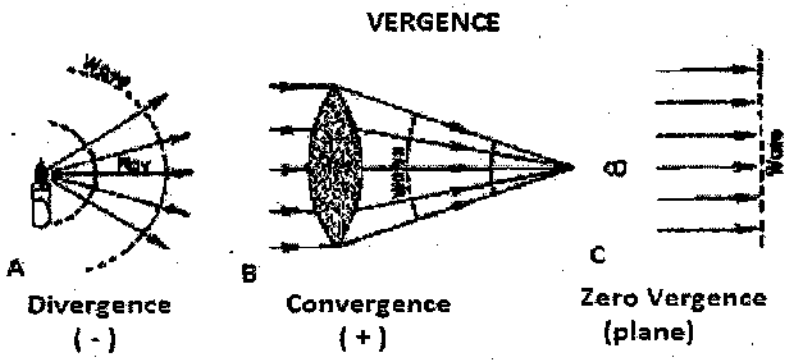


Fig 1.2 Vergence of rays

1.1 Laser

Laser is a device which converts electrical energy to light energy emerging as a monochromatic coherent light that can be directed to a desired target. The emitted light is a radiational energy in the nature of monochromatic light, the colour and wavelength of which depends upon the substance in which the electrical energy is passed.

The basic principle of Laser is that molecules of any substance oscillate and emit light at a certain frequency. A highly concentrated form of light. Can be coaxed out if the substance is stimulated with energy. The coaxed light is laser.

LASER by name itself, full form say's that Light Amplification by Stimulated Emission of Radiation, tells us the unique property of transferring electrons from one orbital of lower energy to a second metastable orbit of higher energy level. Thus this higher energy level causes the emission of a new light energy (photon) of a particular wavelength. It is coherent because all electrons jump at the same time and is, therefore at the same place. The light then oscillates back and forth within the laser cavity [tube with a mirror at either end; one mirror is highly reflective and the other mirror is highly reflective and the other mirror allows source laser light to pass through for use (in the eye).

The need in laser therapy is to further concentrate the laser light into a small time interval such as by quality switching(Q-switching) which may be active (Q-switching) of passive(Mode-locking). The active Q switching is performed by an acoustic-optical crystal.

The commonly used lasers are classified in Table 1.1

Table 1.2 commonly used ophthalmic lasers

Type	Material	Wavelength (nm)
Thermal	Argon	488-514
Photocoagulative	Argon/Krypton	488-514
	Krypton	647
	Dye lasers	575
Photodisruptive	Nd-YAG	1064
	Erbium-YAG	2940
Photoablators	Excimer	193

Note: Do not confuse between LASER and LASIK as already explained laser is a device, and LASIK is a procedure.

Lasik means Light Assisted In-situ Keratomileusis. Keratomileusis is the operation of corneal reshaping.

Sign Convention

1. Incident light is considered as travelling from left to right. An arrow head on a ray indicates the direction in which the light is travelling.
2. All distances (object distances, image distances, focal lengths, etc.) are measured from the optical system.

   a. If measured in the direction of which light is travelling (from left to right), distances are considered positive.

   b.If measured in the direction opposite to that in which light is travelling (from right to left), distances are considered negative.
3. Vertical distances measured from the optic axis to a point above the optic axis are positive, whereas vertical distances measured to a point below the optic axis are negative.

The angle between a ray and the optic axis is measured from the ray to the optic axis. Angles of incidence, refraction and reflection are measured from the normal to the ray.

Angles measured in anti-clockwise direction are considered as positive; angles measured in a clockwise direction are considered as negative.

An arrowhead on a line or a curve indicates the direction in which the distance or the angle is measured.

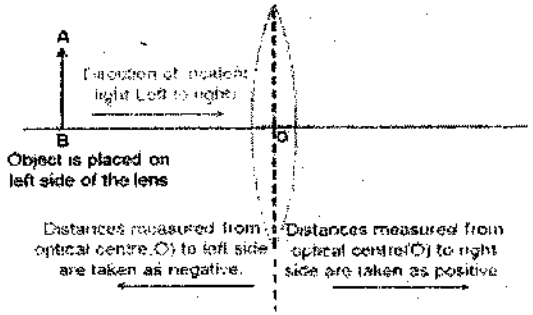


Fig 1.3 Direction of light

Vergence is defined as the curvature of a wave front at a specific distance from the origin, or focus. If a wave front is moving towards its focus (converging rays), the vergence is positive; if a wave front is emanating from its origin (diverging rays), the vergence is negative. The unit for specification of vergence is Dioptre. For a given wave front, the vergence in dioptres is given by the reciprocal of the distance (expressed in meters) from the wave front to its center of curvature.

1.2 Nomenclature

A ray represents the direction of propagation of the wavefront. Rays are considered to emanate from the point source or from any of the infinite number of points. A pencil is a bundle of rays and a beam of light is a collection of pencils arising from an extended source.

Objects may be either real or virtual. Real objects are those from which light actually radiates or from which is reflected. The object presented to the first source of an optical system is always real. Virtual objects are those toward which light is converging before interrupting a subsequent surface of the optical system. An image, produced by an optical system is the optical counter part of an object. It is formed by the light traveling from the object, after the optical system has acted on it. Just like real and virtual objects, Images can also be either real or virtual.

Real and virtual Images

A real image is one that is actually reached (and formed) by converging light rays. A real image will be formed on the screen if the screen is placed in the image plane.

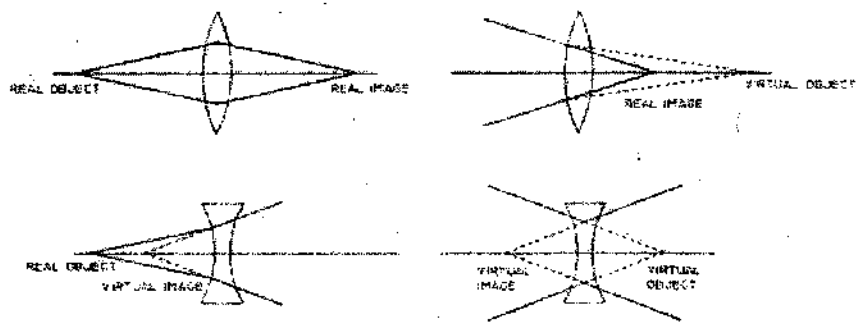


Fig 1.4 Diagram representing real and virtual images

A virtual image is formed by light that appears to be diverging from points in an optical system after treatment by the system. Such an image will not be found on a screen placed in the image plane, but may be found by placing a convex lens in the optical system with the result that the real image will be formed. The human eye is a converging optical system. Object space is the space in which light travels before encountering an optical system. Image space is the space in which light travels after being acted on by the optical system.

Properties of Real Images

- It usually appears INVERTED (depends on the type of mirror e.g. convex, concave).
- It can be OBTAINED ON A SCREEN
- In case of mirror, the image lies in front of the reflecting surface.
- In case of lens, the image lies on the other side of the object.
- The light rays meet at a focal point in front of the mirror.

Properties of virtual images

- It usually appears ERECT
- It CANNOT be obtained on a screen
- In case of a mirror, the image lies behind the mirror
- In case of lens, the image lies on the same side of the object
- The light rays meet at a focal point behind the mirror

Basically,

REAL- Images that are real, and can be captured on the screen. Light rays meet after refraction.

VIRTUAL-Images that aren't real, and can't be captured on screen. Light rays do not meet after refraction.

Short Answer Type Questions

1. Define light?
2. Draw neat labeled diagram of electromagnetic spectrum?
3. Define ray and what is vergence?
4. Define LASER and LASIK?

5. What are sign conventions?

6. Commonly used Ophthalmic LASERS?

Long Answer Type Questions

1. Explain briefly the properties of light?

2. What is the difference between real and virtual images?

3. What is LASER, and how helpful is it in ophthalmology?

4. Explain briefly sign conventions with diagram?

UNIT 2

Optics

Structure

2.0 Introduction

Everything we see is seen because light is reflected from it. The object itself does not produce light (unless it is a light source!). This explains why we cannot see in the dark - there is no light to reflect from objects.

A BEAM of light consists of light RAYS, which are shown as straight lines in optical diagrams. A beam of light can be PARALLEL, DIVERGENT or CONVERGENT. The rays from a spot or point source of light are divergent, but if looked at from a distance may be considered to be parallel.

Lights can be Reflected or Refracted

REFLECTION of light occurs from surfaces, most notably mirrors. The Law of Reflection states that - 'the angle of reflection is equal to the angle of incidence'. This means that, if a ray of light hits a mirror at a certain angle, it will bounce away at an equal angle.

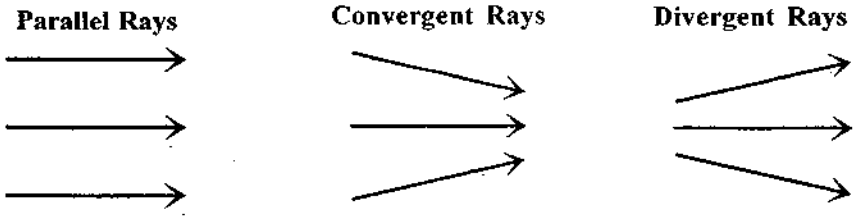


Fig 2.1

REFRACTION of light is the change of direction a ray takes when the ray passes from one medium (e.g. air) to another medium with a different refractive index (e.g. glass). The refractive index is a measure of how well the medium is able to bend light.

Light can be refracted by **lenses** or **prisms** which are made from transparent materials such as glass and optical plastic.

2.1 Principles of Reflection and Refraction of light

When a ray of light strikes any surface, a part of the incident light is absorbed, a part is refracted and a part is reflected back. If the surface is smooth and polished most of the incident light is reflected back. The reflection of light obeys certain laws.

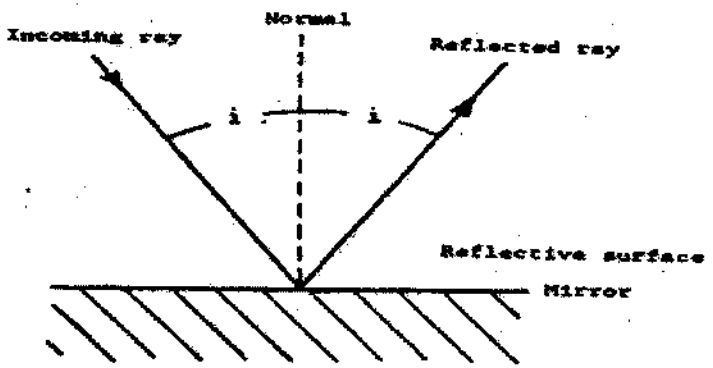


Fig. 2.2 Flat Horizontal Mirror

Laws of reflection

1. The incident ray, the normal to the surface at the point of incidence and the reflected ray lie in one plane.
2. The incident ray and the reflected ray are equally inclined to and lie on the opposite sides of the normal. This implies that the angle which the incident ray makes with the normal is equal to the angle which the reflected ray makes at the same point with the normal. i.e.. Angle of incidence=angle of reflection.

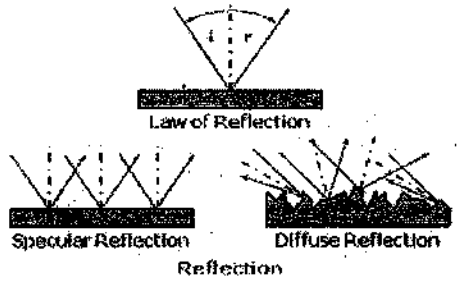


Fig 2.3

Principles of refraction of light

The phenomenon of the bending of light as it passes from one transparent medium to another of different density is known as refraction. The amount by which the beam of light is bent depends on the retardation of light, the more resistance the body offers, the more slowly will the light be made to travel and consequently the rays of light be bent. This property of offering resistance to light is known as optical density, and it varies in wide limits in different substances. The universal medium is the air, and so the optical densities of different substances are usually compared with that of air taken as standard. The refractive power of a substance in comparison with that of air is spoken of as its refractive index: thus the refractive index of the air is 1, that of water 1.33, that of crown glass is 1.56, and so on.

Laws of refraction

1. The incident ray, the normal to the surface on the point of incidence and the refracted ray lie in one plane.
2. Sine angle of refraction at an optical surface is proportional to the sine angle of incidence and to the ratio of the incidences of refraction on either side of the surface.

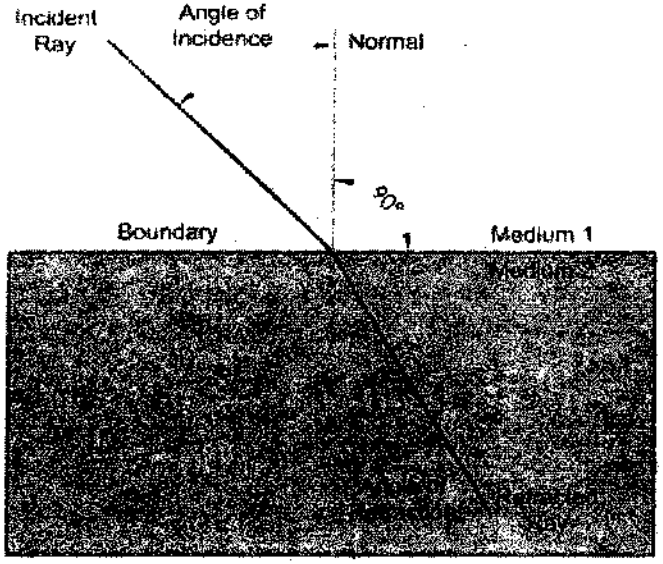


Fig 2.4

This can be mathematically represented as:

$$\frac{\text{Sine angle of incidence}}{\text{Sine angle of refraction}} = \text{a constant } (\mu).$$

The constant is termed as the refractive index (R.I)

2.2 Prisms

A prism is a wedge shaped piece of glass with 3 flat surfaces at angles to each other. One surface forms the base and the other 2 surfaces meet at the apex. The angle at the apex is called the apical angle, and the bigger this angle is, the greater the refracting power of the prism. Prism power is measured in Prism Dioptres.

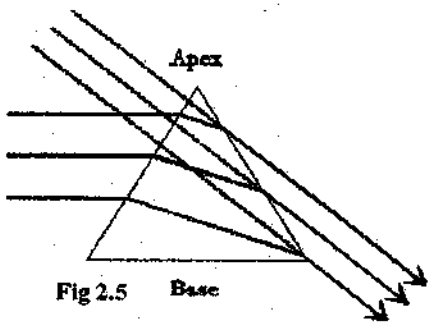


Fig 2.5

Definition

A one Prism Dioptre lens will refract light by 1 cm over a distance of 1 metre (100 cm).

A prism will deviate light passing through it towards the base of the prism, and an object viewed through the lens will appear to be displaced towards the apex of the prism.

Types of prisms And Their Uses

Dispersive prisms

Dispersive prisms are used to break up light into its constituent spectral colors because the refractive index depends on frequency; the white light entering the prism is a mixture of different frequencies, each of which gets bent slightly differently. Blue light is slowed down more than red light and will therefore be bent more than red light.

1. Triangular prism
2. Abbe prism

Grating and prism mountings

Diffraction gratings may be replicated onto prisms to form grating prisms, called "grisms". A transmission prism is a useful component in an astronomical telescope, allowing observation of stellar spectra. A reflection grating replicated onto a prism allows light to diffract inside the prism medium, which increases the dispersion by the ratio of refractive index of that medium to that of air.

Reflective prisms

Reflective prisms are used to reflect light, for instance in binoculars and prismatic sighting compasses.

1. Pentaprism
2. Porro prism(Is used in slit-lamp)
3. Porro–Abbe prism

Polarizing prisms

There are also *polarizing prisms* which can split a beam of light into components of varying polarization. These are typically made of abirefringent crystalline material.

1. Nicol prism
2. Wollaston prism
3. Nomarski prism – a variant of the Wollaston prism with advantages in microscopy

Deflecting prisms

Wedge prisms are used to deflect a beam of light by a fixed angle. A pair of such prisms can be used for beam steering; by rotating the prisms the beam can be deflected into any desired angle within a conical "field of regard". The most commonly found implementation is a Risley prism pair

Deck prisms were used as sources of light below deck on sailing ships, since candles and kerosine lamps were fire hazards.

In optometry

By shifting corrective lenses off axis, images seen through them can be displaced in the same way that a prism displaces images. Eye care professionals use prisms, as well as lenses off axis, to treat various orthoptics problems:

- Diplopia
- Positive and negative fusion problems
- Positive relative accommodation and negative relative accommodation problem.

Rotating Prims

If two prisms of equal strength are placed base to base they act as a thick plate of glass. If they are rotated in opposite directions they produce the effect of a single prism of gradually increasing strength which reaches its maximum when they lie apex to apex and the deviation is equal to the sum of the deviating power of the two prisms separately. Such combination of prisms is used to test the power of the eyes to overcome diplopia in different directions. The two prisms need not be placed before the same eye but one may be placed before the other of the same individual thus distributing the deviation equally in the two eyes and reducing the chromatic dispersion.

Prisms are used in a wide variety of optical instruments. In these total internal reflection is utilized. They permit the designer to bend light rays; since the reflection is total, there is very little loss. The light rays can be made to deviate 180degrees or 90 degrees.

Optical Lenses

A corrective lens is a lens worn in front of the eye, mainly used to treat myopia, hyperopia,astigmatism, and presbyopia. Glasses or "spectacles" are worn on the face a short distance in front of the eye. Contact lenses are worn directly on the surface of the eye. Lenses are surgically implanted most

commonly after cataract removal, but recently for purely refractive purposes. Myopia (near-sightedness) requires a divergent lens, whereas hyperopia (far-sightedness) requires convergent lens.

A lens has at least one curved surface. Optical lenses normally have both surfaces curved. Whilst a prism deviates light, a lens will focus light. Light will be refracted at BOTH surfaces of a lens, and the amount of refraction will be related to the refractive index and curvature of the surfaces. A higher refractive index produces more refraction, as does steeper curvature. The power of a lens is measured in Dioptres.

Definition: A one dioptre lens will focus light at one metre (100 cm). This is written as 1.00 DS.

The **FORMULA** relating **POWER** and **FOCAL LENGTH** is

$$P = 1 / f$$

where P is the power and f is the focal length of the lens in metres. It can also be written

$$f = 1 / P$$

Thus a 1.00 DS lens has a focal length of 1 metre (100 cm) and a 10.00 DS lens has a focal length of 0.1 metre (10 cm).

As far as we are concerned it is easier and better for us to think in centimetres rather than metres. This makes the formula

$$P = 100 / f$$

Or $$f = 100 / P$$

Where f is now measured in centimetres.

This formula is vital for much of the work we do. You must be able to use it freely, being able to convert focal length to dioptric power, and from dioptric power to focal length.

Plano Lenses

These lenses have no refractive power (i.e. 0.00 DS).

Light entering the lens at right angles are not bent, but pass straight through the lens.

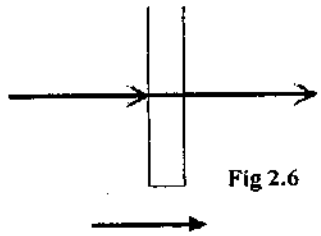


Fig 2.6

Oblique light rays will be (refracted) at both surfaces and end up leaving the lens at the same angle.

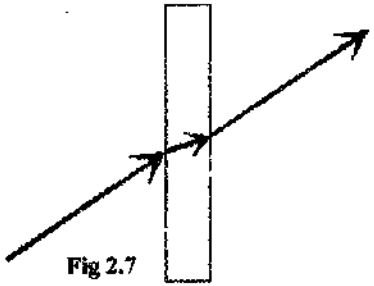


Fig 2.7

Plano lenses can be flat or curved. Plano spectacle lenses are always curved, and both surfaces have the same curvature. They are not normally used, but sunglasses are generally plano. Also, safety glasses may be plano.

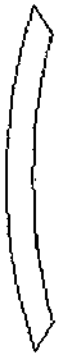


Fig 2.8

Positive/Plus/Convex Lenses (Abbreviation DS or Sph)

These **CONVERGE** light. They are used in hypermetropia, presbyopia and aphakia. Low vision devices also use this type of lens.

A convex lens can be thought of as two prisms with their **bases together (or apices apart)**. Light is refracted towards the base. This helps us when we consider some of the effects of lenses.

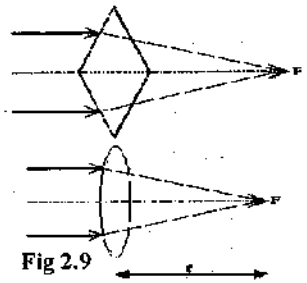


Fig 2.9

A convex lens will converge light towards a point which is called the focal point (focus) of the lens. The stronger the lens, the shorter is the focal length. (F = focal point of the lens).

Negative/Minus/Concave Lenses

(Abbreviation DS or Sph) These will **DIVERGE** light. They are used in myopia. A concave lens can be thought of as two prisms with their **bases apart** or **apices together**. Light is refracted towards the base of the prism. A concave lens diverges light as if the rays are coming from the focal point, which lies between the object and the lens.

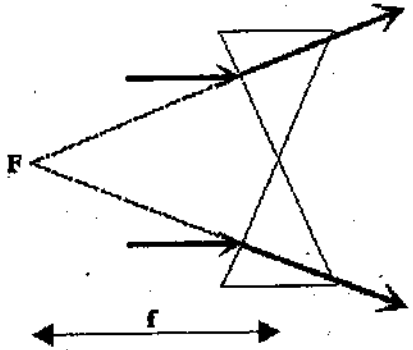
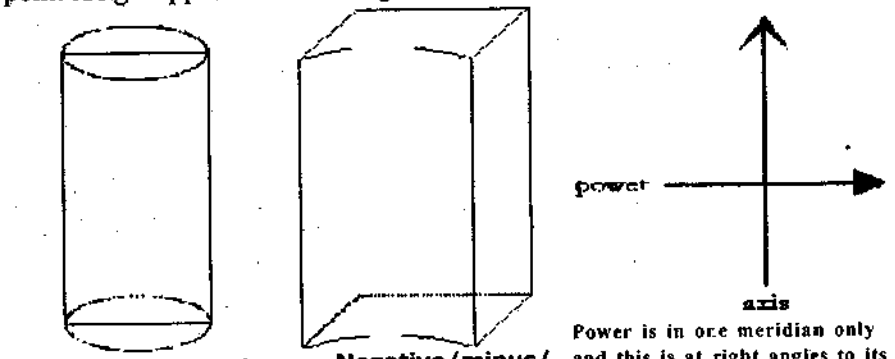


Fig 2.10

Cylinders(Abbreviation DC or Cyl)

Cylinders may be concave or convex, and both will be found in normal trial sets. However, we will only consider minus (concave) cylinders.

Spherical lenses have the same power all over the lens surface, and bring light to a point focus. Cylinder lenses have power in one meridian only. There are two principal meridians on a cylinder lens, the power meridian, and the axis meridian at right angles (90°) to the power meridian. These lenses will make a point of light appear as a line of light at the focal point of each meridian.



Positive/plus/convex cyl.

Negative/minus/ concave cyl.

Power is in one meridian only and this is at right angles to its axis

Fig 2.11

An object viewed through a cyl will appear to be elongated or distorted. Cyls are used to correct astigmatism. The axis of the cyl must be aligned with the axis of the astigmatism in the eye if the correction is to be effective.

The correction of refractive error normally uses a combination of spherical and cylindrical powers. This is covered in more detail later.

Optical Diagrams

For convenience, rather than drawing an eye each time we draw a ray diagram, which is quite difficult, we use the following form of diagram -

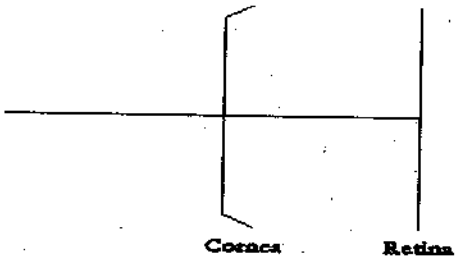
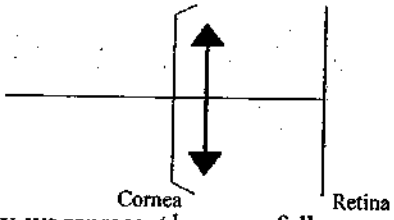


Fig 2.12

You will note that the natural lens is not drawn. This is because we normally consider the eye to be relaxed, or unaccommodated. However, if we consider the effect of accommodation, the diagram would be -



Diagrammatically, we represent lenses as follows -

Lens optical profile

Fig 2.14

Although corrective lenses can be produced in many different profiles, the most common is ophthalmic or convex-concave. In an ophthalmic lens, both the front and back surface have a positive radius, resulting in a positive / convergent front surface and a negative / divergent back surface.

A convex lens is usually considered as collection of prisms placed base to base. The line passing through this junction is called the principal axis. A concave lens may be considered as a collection of prisms placed apex to apex. The line passing through this junction is called the principal axis.

Principal axis or the optical axis

The principal axis or the optical axis of the lens may be defined as the common axis of the two surfaces of revolution and on it must be the two centers of curvature of the two surfaces.

Focal length

The focal length is the distance between the optical center of the lens and the image of an object or point at infinity. Rays that are running parallel to this principal axis are brought to a focus on a point or seem to diverge from the focal point on the principal axis.

Dioptre

It is the unit of measurement of the power of the lenses. It is denoted by the abbreviation D. One dioptre corresponds to a lens of the focal length of 1 meter. The dioptric value of the lens is inversely proportional to the focal length of the lens in meters. Thus 1 D means a lens of 1 meter focal length, 2 D means a lens of 1 meter focal length, 2 D means a lens of 1\2 meter focal length and 1\2 D means a lens of 2 meter focal length. Any ray that passes through the optical center of the lens passes undeviated.

2.3 Identification And Marking of Surfaces

Surfaces can either be convex, concave and plane surface. Determination of surface power generally requires the use of a lens measure. This instrument is placed on a lens surface and the power read off from the instrument dial. In the absence of lens measure, the form of the surfaces that is whether convex or concave, can be determined by the "straight edge" test. Here edge of the ruler is placed on the lens surface.

Convex surface

Convex surface is one that bulges; a straight edge ruler placed across it will touch at only one point.

Concave Surface

Concave surface is hollow; a straight edge ruler placed across it will touch at each extremity. (two point touch).

Base Curve

The lens blanks from which spectacle lenses are ground have an optimal *base curve* (lens shape) for every given lens power. Actually, each base curve in a series of "corrected curve" lens blanks encompasses a small range of lens powers. Thus, if the powers of two lenses are more than minimally different, their shapes are likely to be different also.

The definition of base curve varies with the type of lens. In a spectacle lens, it is the manufacturer's standard or reference surface:

1. For a single vision spherical lens, it is the lesser curvature, whether that is on the convex or concave side.
2. For a single vision cylindrical lens, it is the meridian of least curvature on the toric surface, whether it is ground in plus cylinder or minus cylinder form.
3. For a multifocal lens, it is the curve on the segment side (even if the multifocal has a cylindrical correction, the base curve is not on the toric side but on the segment side).
4. In a contact lens, it is the curve of the posterior surface in the optical zone.

Importance of base curve is determined, ideally in manufacturing of ophthalmic lens, Keeping the base curves of the lenses as flat as possible will not only reduce the lens induced magnification, it will also effectively shorten the vertex distance, which further decreases the magnification of the retinal image size, focused by the corrective lens on the retina.

Refractive Index

In the UK and the US, the refractive index is generally specified with respect to the yellow He-d Fraunhofer line, commonly abbreviated as nd. Lens materials are classified by their refractive index, as follows:

- Normal index - 1.48 d" nd < 1.54
- Mid-index - 1.54 d" nd < 1.60
- High-index - 1.60 d" nd < 1.74

- Very high index - 1.76 d" nd

This is a general classification. Indexes of nd values that are e" 1.60 can be, often for marketing purposes, referred to as high-index. Likewise, Trivex and other borderline normal/mid-index materials, may be referred to as mid-index.

Advantages of higher indices

- Thinner, sometimes lighter lenses
- Improved UV protection over CR-39 and glass lenses.

Disadvantages of increased indices

- Lower Abbe number meaning, amongst other things, increased chromatic aberration.
- Poorer light transmission and increased backside and inner-surface reflections (see Fresnel reflection equation) increasing importance of anti-reflective coating.
- Manufacturing defects have more impact on optical quality
- Theoretically, off-axis optical quality degrades (oblique astigmatic error). In practice this degradation should not be perceptible - current frame styles are much smaller than they would have to be for these aberrations to be noticeable to the patient, the aberration occurring some distance away from the optical centre of the lens (off-axis).

Optical quality

Abbe number

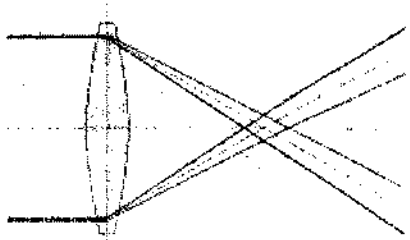


Fig 2.14 Chromatic aberration caused by a convex lens

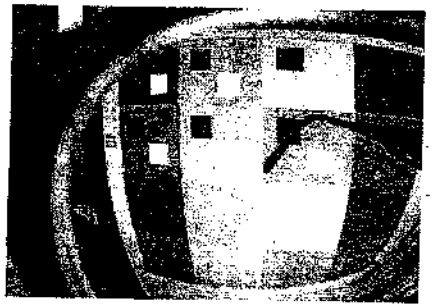


Fig 2.15 Prismatic color distortion shown with a camera set for nearsighted focus, and using -9.5 diopter eyeglasses to correct the camera's myopia.Close-up of color shifting through corner of eyeglasses. The light and dark borders visible between color swatches do not exist.

Of all of the properties of a particular lens material, the one that most closely relates to its optical performance is its dispersion, which is specified by the Abbe number. Lower Abbe numbers result in the presence of chromatic aberration (i.e., color fringes above/below or to the left/right of a high contrast object), especially in larger lens sizes and stronger prescriptions (±4D or greater). Generally, lower Abbe numbers are a property of mid and higher index lenses that cannot be avoided, regardless of the material used. The Abbe number for a material at a particular refractive index formulation is usually specified as its Abbe value.

In practice, a change from 30 to 32 Abbe will not have a practically noticeable benefit, but a change from 30 to 47 could be beneficial for users with strong prescriptions that move their eyes and look 'off-axis' of optical center of the lens. Note that some users do not sense color fringing directly but will just describe 'off-axis blurriness'. Abbe values even as high as that of (V_d"45) produce chromatic aberrations which can be perceptible to a user in lenses larger than 40 mm in diameter and especially in strengths that are in excess of ±4D. At ±8D even glass (V_d"58) produces chromatic aberration that can be noticed by a user. Chromatic aberration is independent of the lens being of spherical, aspheric, or atoric design.

The eye's Abbe number is independent of the importance of the corrective lens's Abbe,

To minimize chromatic aberration:

- Try to use the smallest vertical lens size that is comfortable. Generally, chromatic aberrations are more noticeable as the pupil moves vertically below the optical center of the lens (e.g., reading or looking at the ground

while standing or walking). Keep in mind that a smaller vertical lens size will result in a greater amount of vertical head movement, especially while performing activities that involve short and intermediate distance viewing, which could lead to an increase in neck strain, especially in occupations involving a large vertical field of view.

- Restrict the choice of lens material to the highest Abbe value at acceptable thickness. Lenses sold in the USA must pass the Food and Drug Administration ball-drop impact test, and depending on needed index these seem to currently have 'best in class' Abbe vs Index (N_d):. For impact resistance safety glass is offered at a variety of indexes at high Abbe number, but is still 2x the weight of plastics. Polycarbonate (V_d=30-32) is very dispersive, but has excellent shatter resistance. Trivex (V_d=43 @ 1.53), is also heavily marketed as an impact resistant alternative to Polycarbonate, for individuals who don't need polycarbonate's index. Trivex is also one of the lightest materials available.

- Use contact lenses in place of eyeglasses. A contact lens rests directly on the surface of the cornea and moves in sync with all eye movements. Consequently the contact lens is always directly aligned on center with the pupil and there is never any off-axis misalignment between the pupil and the optical center of the lens.

Lenses are available in glass and plastic. Plastic lenses scratch too easily and should be avoided. Glass lenses are heavier and more fragile, but will last much longer than plastic. In time the situation may change, as optical plastic is now much more resistant to scratching and can be coated to improve this further, but this is expensive. Photochromic lenses are always made in glass and are more expensive than ordinary, 'white' glass. This is the best way of tinting lenses as the tint is in, rather than coated onto, the lens. In other words, you cannot tint a white glass lens.

2.4 Lens Types

Single vision

Single Vision Lens

Fig 2.16

Single vision has the same optical focal point or correction over the entire area of the lens.

Single lenses in CR-39 plastic come finished and unfinished. An unfinished lens is ground at the time your prescription is filled and the base curve is called a compensated base curve due to the fact that the lab tech can use a wide range of base curves to make the lens. A finished lens on the other hand, has been made using the exact base curve to match the prescription and the natural curve of the eyeball and is therefore called a correct base curve.

Bifocal

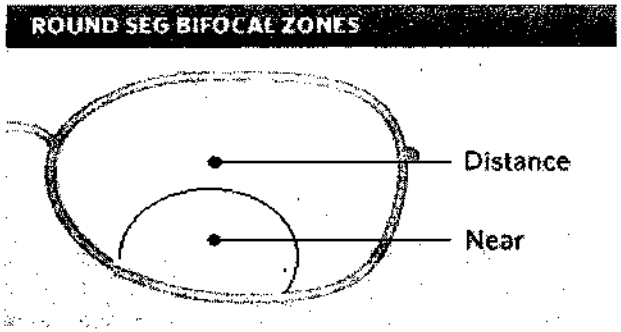


Fig 2.17

With a bifocal, the upper part of the lens is generally used for distance vision, while the lower part is used for near vision. Usually, a segment line separates the two. Typically a person with myopia would have one section of a prescription lens that has a certain diverging power while another section of the lens would have a lower diverging power for close-up work. Similarly a person with hyperopia would have one section of the lens with a certain converging power and another section with a greater power for close-up work.

Trifocal

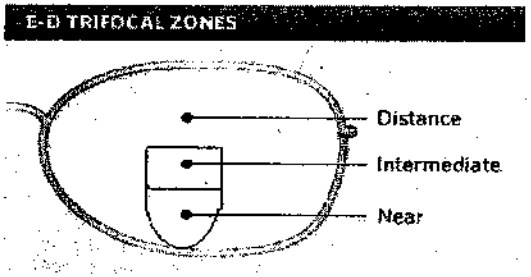


Fig 2.18

Trifocal lenses are similar to bifocals, except that the two focal areas are separated by a third middle area with intermediate focus correction, used for intermediate vision, roughly at arms' length, *e.g.* computer distance. This lens type has two segment lines, dividing the three different correcting segments.

Progressive

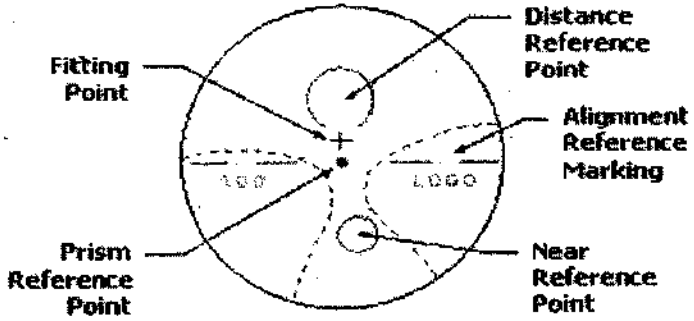


Fig 2.19

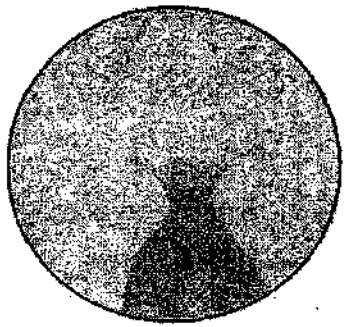


Diagram showing the visual zones of a multipurpose PAL

distance zone
progressive zone
near zone
peripheral zones

Fig 2.20

Progressive or varifocal lenses provide a smooth transition from distance correction to near correction, eliminating segment lines and allowing clear vision at all distances, including intermediate (roughly arms' length) These lenses have many advantages over bifocals and trifocals because they allow the wearer to focus at many different distances, not just two or three. Because they have no lines, Progressive lenses allow a smooth, comfortable transition from one distance to another. They are a much better for active, multitasking people.

Plastic (CR-39)

- Refractive index (n_d): 1.498 (standard)
- Abbe value (V_d): 59.3
- Density: 1.31 g/cm³
- UV cutoff: 355 nm

Plastic lenses are currently the most commonly prescribed lens, due to their relative safety, low cost, ease of production, and outstanding optical quality. The main drawbacks of many types of plastic lenses are the ease by which a lens can be scratched, and the limitations and costs of producing higher index lenses. CR-39 lenses are the exception to the plastics in that they have inherent scratch resistance

Lens coatings

Anti-reflective

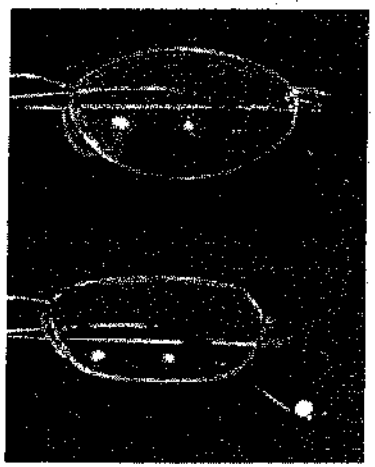


Fig 2.21 The effects of an anti-reflective coating applied (as seen on the bottom picture) as compared to regular eyeglass lens (notice how the reflection of the photographer in the top lens is clearly visible)

Anti-reflective coating

Anti-reflective coatings help to make the eye behind the lens more visible. They also help lessen back reflections of the white of the eye as well as bright objects behind the eyeglasses wearer (e.g., windows, lamps). Such reduction of back reflections increases the apparent contrast of surroundings. At night, anti-reflective coatings help to reduce headlight glare from oncoming cars, street lamps and heavily lit or neon signs.

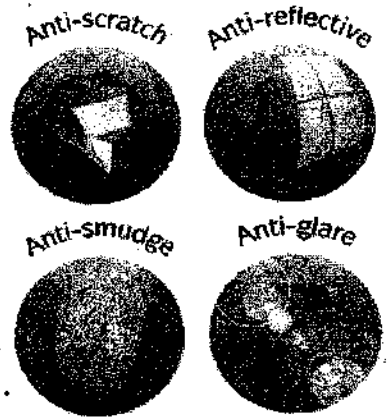


Fig 2.22

One problem with anti-reflective coatings is that historically they have been very easy to scratch. Newer coatings, such as Crizal Alizé with its 5.0 rating and Hoya's Super HiVision with its 10.9 rating on the COLTS Bayer Abrasion Test (glass averages 12–14), try to address this problem by combining scratch resistance with the anti-reflective coating. They also offer a measure of dirt and smudge resistance, due to their hydrophobic properties.

Ultraviolet Protection

A UV coating is used to reduce the transmission of light in the ultraviolet spectrum. UV-Bradiation increases the likelihood of cataracts, while long term exposure to UV-A radiation can damage the retina. DNA damage from UV light is cumulative and irreversible.

Some materials, such as Trivex and Polycarbonate naturally block most UV light and do not benefit from the application of a UV coating.

Scratch resistance

Resists damage to lens surfaces from minor scratches.

Short Answer Type Questions

1. Define refraction,reflection and absorbtion.
2. Define Prism.
3. Different shapes of optical lenses.
4. What is base curve?
5. What is the relation between refractive index and abbe value?
6. What is the difference between A.R.C and S.R.C?

Long Answer Type Questions

1. What are the principles of reflection and refraction?
2. Types of prisms and their uses.
3. What are different types of lenses?
4. Different types of lens coatings done.

UNIT 3

Vision and Visual Acuity

Structure

3.0 Introduction

We need to show the difference between visual acuity obtained with and without glasses. The measurement of how well the eye can see detail without glasses is called **Vision** (V) whilst with correction is called **Visual Acuity** (VA).

There are several ways that vision and visual acuity can be recorded. The system that seems to be most commonly used is the Snellen Fraction notation. This shows two numbers, the first (numerator) tells us the distance at which the test is done and the second (denominator) is a measure of the eye's standard of vision. This number represents the distance at which a 'normal' eye would be able to see the letter.

Examples

- **6/6** - the test is done at 6 metres, and the patient can see the letter that you would expect the eye to be able to see at 6 metres. Therefore, this eye is 'normal'.
- **6/60** - the test is again at 6 metres, but this time the patient only sees the largest letter at 6 metres, which a 'normal' patient could see at 60 metres.

You should decide on which notation to use, based on that used by your colleagues, and use this one exclusively. In this manual we will use Snellen measure in metres and not in feet.

Table of different systems of visual acuity notation

Snellen Letters 6m	Snellen Letters 20ft	Decimal Notation	Percentage Notation
6/6	20/20	1.0	100
6/9	20/30	0.67	67
6/12	20/40	0.5	50
6/18	20/60	0.33	33
6/24	20/80	0.25	25
6/36	20/120	0.17	17
6/60	20/200	0.1	10

3.1 Snellen Charts

This is the normal letter chart used for vision testing. They can have normal lettering, reverse lettering (for use with a mirror), 'illiterate E' or numbers. Some charts have pictures, but these are not so successful. The chart is normally designed for use at 6 metres, either directly or in a mirror.

Each eye is tested separately, with the other eye occluded. The patient reads the letters (or indicates which way the 'E' is pointing) until he can read no further. Do not assume that this is his visual acuity, however, and you must encourage him to try to read further! Guessing must be encouraged, as you will often find that the patient can read further. Note that you need to watch the patient to make sure they do not look around the occluder.

Near Vision Testing

There are several charts available for near vision assessment. They are mainly 'Times Roman' styles, with the letter sizes marked in N point size (e.g. N5). The Jaegar scale may also be found in use. We normally use the 'N' scale.

To test near vision the patient needs to hold the book at their normal reading distance. Do not tell the patient where this is, let them decide! This will frequently explain their visual problems as they read too close. The normal reading distance is between 33 and 40 cm. This will be covered in more detail later.

We always attempt to obtain N5 vision with each patient. However, N8 is the equivalent of normal newsprint, so we are trying to obtain better vision than necessary. If this is possible, then the normal near vision tasks are made easy and comfortable.

Asking patients, who need to sew, to thread a needle is also a near vision test!

3.2 Other Vision Tests

With children, it is often difficult to determine vision with our normal tests. There is a test called the **Sheridan-Gardiner** test which may overcome these problems. It requires the patient to be able to match letters, without them actually having to know what the letters are.

Problems

In all tests, vision will be affected if:

- The chart is dirty (which reduces the contrast available)
- There is poor lighting for the test
- There is a refractive error present
- If there are corneal or lenticular opacities, or retinal pathology is present

The Pinhole Disc

If poor vision is found, then use of the pinhole will show us whether the vision may be improved with glasses. This works by reducing the blur circle caused by refractive errors.

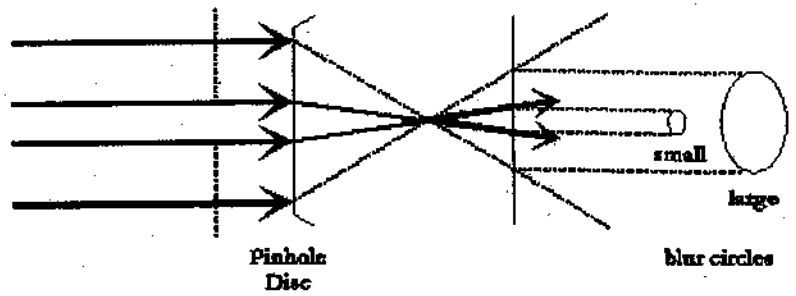


Fig 3.1

It is important, when checking vision with a pinhole, that the patient is able to see through the pinhole to the chart!

There are a few occasions when you will find improved vision with a pinhole that will not improve with glasses. They are all medical conditions:

- Lenticular opacities
- Corneal opacities or scarring
- Keratoconus
- Marfan's Syndrome

It is possible to make a pinhole from stiff card or thin plywood. E.g.

Short Answer Type Questions

1. Define vision.
2. What is visual acuity?
3. How do you explain 6/6 and 6/60.
4. What do you mean by occluder?
5. How do you use pin hole in refraction.
6. Which visual acuity chart generally we use.

Long Answer Type Questions

1. Explain briefly Snellens charts.
2. What is the principle of pinhole?
3. While refraction, vision improves with pinhole but not with glasses, reasons.
4. How is refraction done in childern.

UNIT 4

Refractive Errors

Structure

4.1 Types of Refractive Errors

Emmetropia

This is the normal eye, having no refractive error. It is an unaccommodated eye in which the rays of light from a distant object are focused onto the retina.

The **CORNEA**: T[illegible] is an unchanging refractive surface with a power of about 42.00 DS.

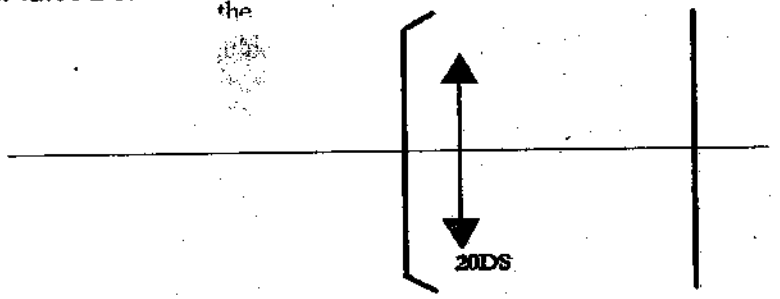


Fig 4.1

The **NATURAL CRYSTALLINE LENS:** This is a variable, refractive body which can **ACCOMMODATE** (focus) to increase its power. In its unaccommodated condition it has a power of around 20.00 DS and this power increases with accommodation.

Ametropia

This is the general term applied to an eye with any refractive error, with the eye unaccommodated. In an ametropic eye, light rays do not focus onto the retina, but focus in front of, or behind the retina.

There are three main classes of ametropia

- Hypermetropia
- Myopia
- Astigmatism

Hypermetropia

(Hyperopia, long sight)

Rays of light are focused behind the eye, when the eye is unaccommodated. This can be due to the eye being too short or the refractive components of the eye too weak.

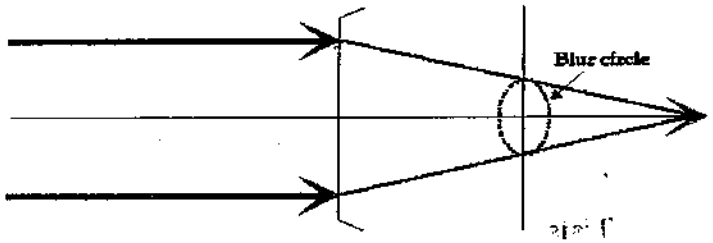


Fig 4.2

By accommodation (focusing), objects can be brought into focus and seen clearly.

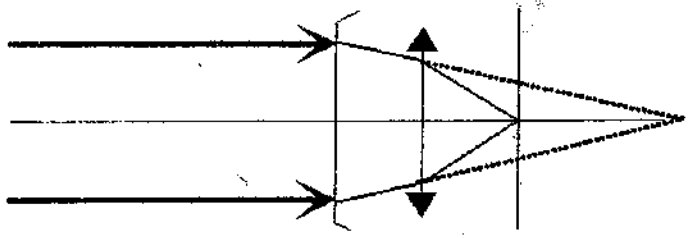


Fig 4.3

The constant effort required to maintain accommodation in hypermetropia can result in **aesthenopia** (eyestrain), giving symptoms of headache, tired and aching eyes, and even watering eyes (lacrimation).

4.2 Hypermetropia

Hypermetropia is divided into several parts, based on the ability of the eye to cope with the refractive error.

- **Total Hypermetropia** is the full amount of hypermetropia
- **Latent Hypermetropia** is the portion of the total error which is easily overcome by accommodation, and any attempt to correct this will result in blurring the vision
- **Facultative Hypermetropia** is the portion that can be corrected by lenses, or by accommodation
- **Absolute Hypermetropia** is the portion that cannot be corrected by accommodation.

Example

Let us assume that a patient has vision of 6/24. If we add positive lenses we will reduce the remaining refractive error and improve vision.

We add + 3.00 DS and find that the vision has now improved to 6/6. We then add more positive power to make + 5.00 DS, and the visual acuity remains at 6/6. Adding any more positive power blurs the vision. We then do refraction under cycloplegia (see later) and find that the patient accepts +6.50. Cycloplegia gives us the **total** hypermetropia which is therefore + 6.50 DS

The initial + 3.00 DS which improved the visual acuity corrected the **absolute** hypermetropia. The addition of power up to + 5.00 DS reveals more about the hypermetropia. This amount is the sum of the absolute and facultative hypermetropia. Thus the facultative hypermetropia is + 2.00 DS. Addition of further positive power blurs the patient. The **latent** hypermetropia is + 1.50 DS. We calculate this by deducting the absolute and facultative from the total hypermetropia.

Therefore, **Total = Latent + Facultative + Absolute**

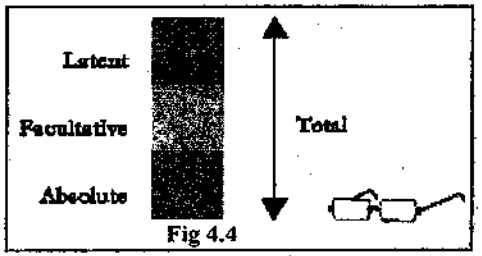


Fig 4.4

Myopia

(Short sight)

This time rays of light are focused in front of the retina, whether or not the eye is accommodating. In fact, accommodation will result in even more blurring. Myopia is due to either the eye being too long or the refractive components too strong.

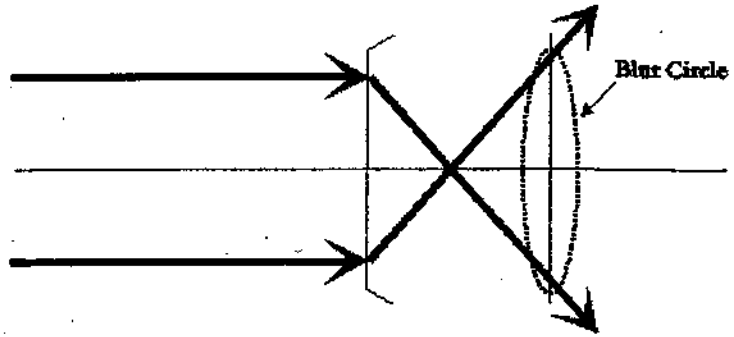


Fig 4.5

4.3 Astigmatism

Astigmatism - Regular

Here, the eye has a different refractive power in different meridians of the eye - this means that the eye is not spherical. For example, vertical rays entering the eye may be focused behind the retina while horizontal rays focus in front of the retina. The two meridians are always at right angles (90°) to each other in regular astigmatism. This type of astigmatism is correctable with cylinders.

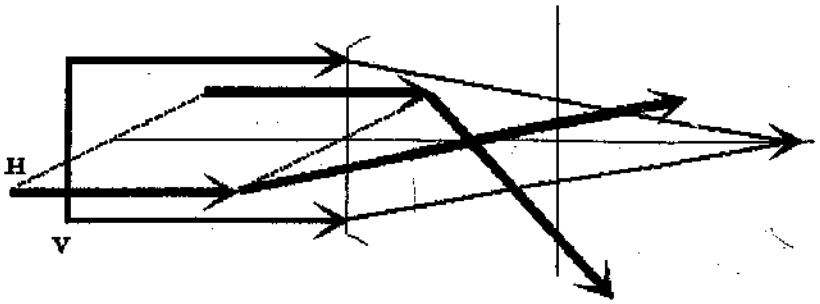


Fig 4.5

Between the two focal points there is the **circle of least confusion** or **blur circle**. This is the position that gives the least blurring of vision for the eye.

There are several categories of astigmatism:

- **'With the rule'** where the stronger refracting meridian is vertical and the weaker horizontal. The minus cyl axis is at about 180°
- **'Against the rule'** where the stronger meridian is in the horizontal. The minus cyl axis is at about 90°
- **Oblique astigmatism**, where the axes are around 45° and 135°.

Oblique astigmatism has a greater effect on vision than with or against the rule. It is also necessary to prescribe for oblique astigmatism carefully as the distortion caused can be more difficult to adapt to.

Each of these, when combined with a spherical element, can also be sub-divided into 5 groups:

- Compound myopic - both meridians are myopic
- Simple myopic - one meridian is plano, the other myopic
- Mixed - one meridian is hypermetropic, the other is myopic
- Simple hypermetropic - one meridian is plano, the other hypermetropic
- Compound hypermetropic - both meridians are hypermetropic

Astigmatism may be due to

- Corneal - the corneal surface, which has a refractive power of about 42.00 D, may not be spherical and has radius of curvature which is greater in one meridian than the other.
- Lenticular - due to the lens tilting within the eye. This is normally a maximum of 0.50 DC and is against the rule

Frequency of astigmatic corrections

- With the rule 80%
- Against the rule 10%
- Oblique Astigmatism 10%

Astigmatism - Irregular

This is normally due to a medical condition such as keratoconus, pterygium, intra-orbital space occupying lesion, etc. These conditions should be referred.

Ray Diagrams for Astigmatism

Simple Myopic Astigmatism - One meridian is focused in front of the retina, the other on the retina.

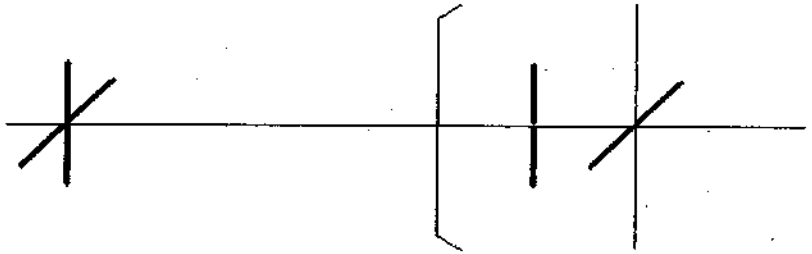


Fig 4.6

Simple Hypermetropic Astigmatism - One meridian is focused behind the retina, the other on the retina.

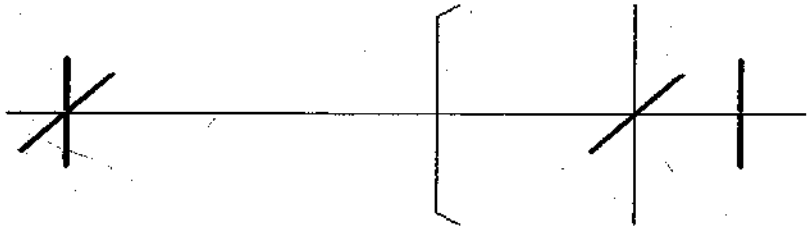


Fig 4.7

Compound Myopic Astigmatism - Both meridians are focused in front of the retina.

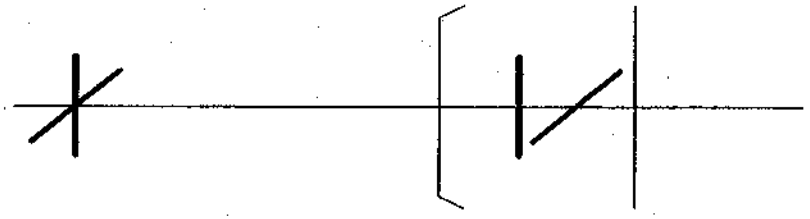


Fig 4.8

Compound Hypermetropic Astigmatism - Both meridians are focused behind the retina

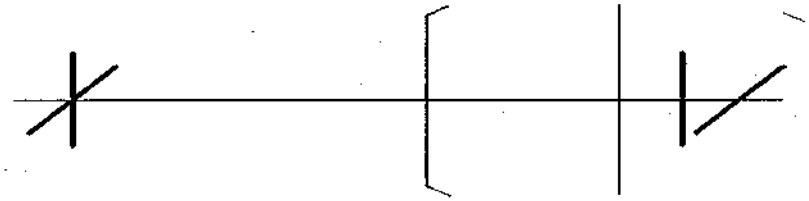


Fig 4.9

Mixed Astigmatism - One meridian is focused in front of the retina, the other behind.

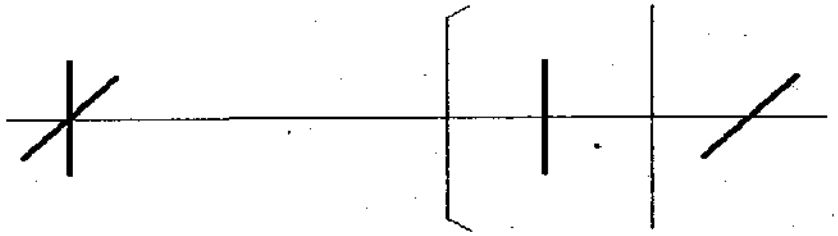


Fig 4.10

Short Answer Type Questions

1. What is the difference between Emmetropia and Ammetropia?
2. What is Myopia?
3. What is hypermetropia?
4. What is astigmatism?
5. What is the role of cornea in refraction?
6. What do you mean by with the rule and against the rule astigmatism?

Long Answer Type Questions

1. What are the various types of refractive errors?
2. What do you mean by regular and irregular astigmatism?
3. Give examples of kinds of astigmatism with ray diagram.
4. Explain briefly hyperopia.

UNIT 5

Refractive Errors &Correction

Structure

5.1 Myopia and correction

5.2 Hypermetropia and correction

5.3 Astigmatism and correction

5.1 Myopia and correction

- Light from infinity is focused in *front of* the retina.
- Light from the far point is naturally focused *onto* the retina.

Therefore, we want to provide a spectacle lens that will make light from infinity *appear* to come from the far point. By doing this we correct the refractive error. In myopia we need to use negative lenses.

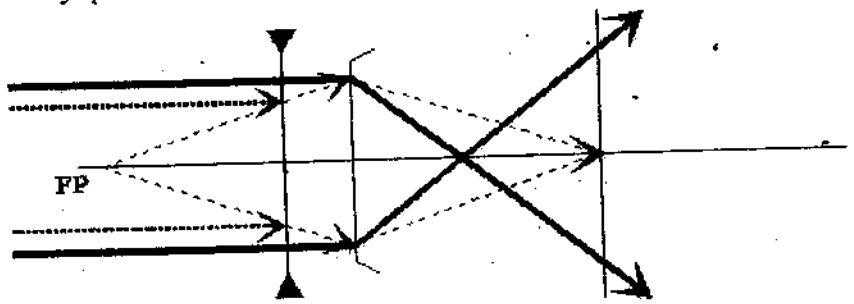


Fig 5.1

5.2 Hypermetropia and correction

- Light from infinity is focused *behind* the retina.
- Light from the far point is naturally focused *onto* the retina.
- Therefore, we, again, want to provide a spectacle lens that will make light from infinity *appear* to come from the far point. In hypermetropia we need to use positive lenses.

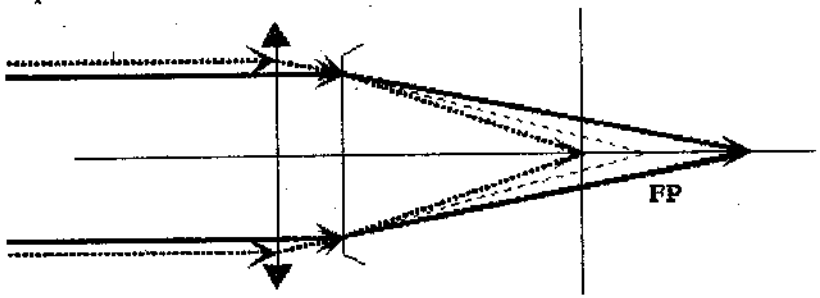


Fig 5.2

5.3 Astigmatism and correction

Here we need to use a sphere and cyl combination to correct both principal meridians to make light from infinity appear to come from the respective far points.

Short Answer Type Questions

1. How do you correct myopia.
2. Methods of correction of hypermetropia.
3. Astigmatism and spectacle correction.

Long Answer Type Questions

1. Refractive errors and types of correction.
2. What type of lens are used for correction of various refractive errors?

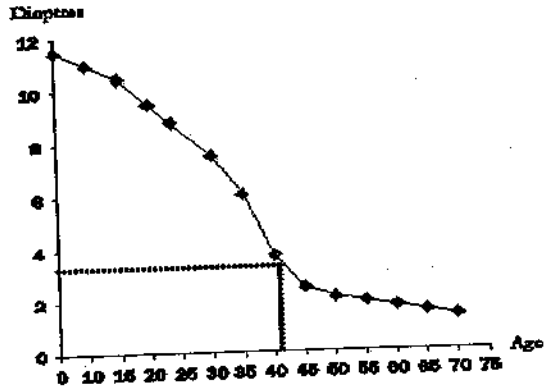
UNIT 6

Accommodation

Accommodation is the process in which the eye focuses onto an object. When we want to look at a close object we must accommodate or change the focus of the eyes in order to see clearly.

What happens in the eye when we accommodate is, the ciliary muscle contracts which allows the zonules attached to the lens to **relax** and the elastic lens capsule can then increase its curvature. This makes the lens more powerful and shortens its focal length. The ability to accommodate, therefore, depends largely upon the elasticity of the lens capsule and the lens itself. As we get older, this elasticity decreases and thus our accommodative ability reduces. This follows a normal pattern which is shown in the graph.

Graph showing minimum amplitude of accommodation vs. age



The line drawn at 3.50 DS indicates the average age at which reading problems should be evident. It has been found that African races in hot climates have lower amplitudes of accommodation than Caucasians in temperate climates.

In the graph we compare **amplitude of accommodation** to age. The amplitude of accommodation is the maximum amount of accommodation that can be exerted, and is measured in dioptres. This is normally done when the eye is fully corrected for distance, and we then measure the nearest point that the patient can accommodate to.

As you can see from the graph, children and young adults have high amplitudes of accommodation and can focus easily on objects at any distance. However, as we get older, that ability reduces, and we find it more difficult to focus on near objects. When this affects our near vision this is known as **presbyopia** ('old sight').

When we are refracting children we need to be careful to make sure the patient is not accommodating as this will affect our results. It may be necessary to use a cycloplegic drug to paralyse accommodation before an accurate result can be obtained. This is covered later in the manual.

Also, it is only possible to sustain the use of half to two thirds of the accommodative ability available. This means that, even if a patient has the ability to accommodate on close work, if he is using more than the comfortable amount, he will have symptoms of eye strain.

Short Answer Type Questions

1. Define accommodation in eye.
2. What is amplitude of accommodation?
3. What is the relation of ciliary muscle with accommodation?

Long Answer Type Questions

1. Explain the mechanism of accommodation.
2. Does amplitude of accommodation change with age, If so why.

UNIT 7

Presbyopia

Structure

7.1 Introduction

7.2 Spectacle corrections in Presbyopia

7.1 Introduction

This is the reduction in amplitude of accommodation with advancing age, and is caused by hardening of the crystalline lens. The patient will complain of close work difficulties, particularly with seeing small detail and in poor lighting. This will affect reading, sewing, knitting, etc.

In myopes, this problem is delayed if the patient removes their glasses as he is naturally focused up close.

In temperate climates, presbyopia is expected in the early to mid 40's. However, in India the problem occurs earlier, normally around the age of 40. Some people believe that presbyopia starts earlier than this, but the reading problems that occur before the age of 40 are more likely to be due to photophobia than by genuine presbyopia, and sunglasses should be advised as the first choice treatment.

Presbyopia is corrected by use of simple positive spherical lenses *on top of* the distance prescription. This is known as the **reading addition** or **add**. In doing this we effectively make the eye myopic, so we will prevent the patient seeing in the distance when wearing the reading glasses. Remember, although

the patient may not read, they may still need glasses for close work such as sewing or knitting.

When prescribing for presbyopia, we want to allow the patient to use their remaining accommodation. Thus, we only give them the *minimum* amount of reading add in order for the patient to be able to perform their near tasks.

As a rough guide, the following applies:

Age	Near Addition
40 to 45	+1.00 to + 1.50
45 to 50	+1.50 to + 2.00
50 to 55	+2.00 to + 2.50
55 upwards	+2.50 to + 2.75
Aphakes	+2.75 to + 3.00

However, the most important consideration in determining the reading addition is the requirements of the patient - how near do they have to work and what close work tasks do they have to perform.

Remember that the reading addition is added to the power required for distance. Thus a + 2.00 DS hypermetrope aged 50 will probably need + 4.00 DS in his reading glasses. Also, a 50 year old - 3.00 DS myope will need - 1.00 DS glasses for reading, but could read at 33 cm without glasses!

Consider what a 40 year old - 1.00 DS myope will need for reading. The reading add will be + 1.00 DS. This means that the reading power would be Plano and the patient will be able to read without any glasses.

A presbyope should only need a change in reading addition every 4 to 5 years and then it will be a change of +0.50 DS only.

7.2 Spectacle Corrections for Presbyopia

A correction for reading can be made up in two distinct ways - **single vision reading spectacles** or **bifocals**. There are several considerations that need to be made before prescribing either of these.

1. Amount of distance and reading corrections - are they worth giving?
2. Improvement in visual acuity - is it enough to be worth giving glasses?
3. What does the patient need to do - are bifocals more suitable or single vision?

4. What does the patient want?
5. What can the patient afford?
6. What is practically available (maybe certain lens types are not available locally)

Bifocals should be avoided when distance prescription is large. If there is a large difference between the refractive error of the 2 eyes bifocals may not be successful unless there is a big difference in visual acuity between the two eyes.

Short Answer Type Questions

1. What do you mean by presbyopia?
2. How does presbyopia occur?
3. Presbyopia starts at what age and why?
4. In presbyopia, what is the advantage for refractive error myopia?
5. What care should be taken taken while giving presbyopic correction?

Long Answer Type Questions

1. Presbyopia occurs at what age and why?
2. What type history taken from the patient while giving presbyopic correction?
3. How much amount of correction to be given in presbyopia, according to age?

UNIT 8

The Written Prescription

Structure

8.1 Introduction

8.2 Abbreviations and Terms

8.3 The Spoken prescriptions

8.1 Introduction

An eyeglass prescription is an order written by an eyewear prescriber, such as an optometrist or ophthalmologist, that specifies the value of all parameters the prescriber has deemed necessary to construct and/or dispense corrective lenses appropriate for a patient.

There is a standard way of writing a prescription in order to prevent confusion. The prescription for the right eye is always written first.

DV	Sph	Cyl	Axis	Prism	Base	NV add
R)	+2.00 /	-1.00 ×	90	1.0	OUT	+2.50
L)	+2.50 /	-2.00 ×	110	1.0	OUT	+2.50

The readings add can be written underneath the distance prescription. The add is normally the same for each eye. The main exception to this is in monocular aphakia when the aphakic eye will normally have a larger add than the phakic eye. Prisms are prescribed according to their power and the direction of the base (IN, OUT, UP, DOWN).

8.2 Abbreviations and Terms

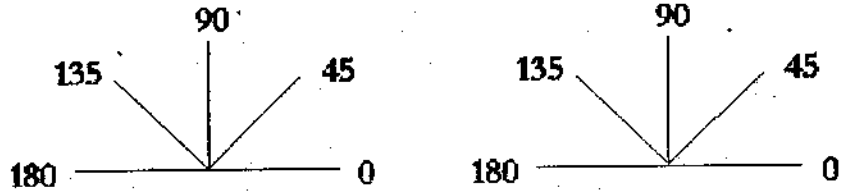
Similar to medical prescriptions, eyeglass prescriptions are written on paper pads that frequently contain a number of different abbreviations and terms:

- DV is an abbreviation for distance vision. This specifies the part of the prescription designed primarily to improve far vision. In a bifocal lens, this generally indicates what is to be placed in the top segment.
- NV is an abbreviation for near vision. This may represent a single-vision lens prescription to improve near work, or the reading portion of a bifocal lens. Some prescription forms useADD in place of NV with a single box to indicate the additional refractive power to be added to the spherical of each eye.
- OD is an abbreviation for oculus dexter, Latin for right eye.Oculus means eye. In some countries, such as the United Kingdom and India, RE (right eye), LE (left eye), and BE (both eyes) are used. Sometimes, just right and left are used.
- OS is an abbreviation for oculus sinister, Latin for left eye.
- OU is an abbreviation for oculi uterque, Latin for both eyes.
- A spherical correction corrects refractive error of the eye with a single convergent or divergent refractive power in all meridians.
- A cylindrical correction corrects astigmatic refractive error of the eye by adding or subtracting power cylindrically in a meridian specified by the prescribed axis.
- The axis indicates the angle in degrees of one of two major meridians the prescribed cylindrical power is in. Which major meridian is referenced is indicated by the cylindrical correction being in plus or minus notation. The axis is measured on an imaginary semicircle with a horizontal baseline that starts with zero degrees in the 3 o'clock (or east) direction, and increases to 180 degrees in a counter-clockwise direction.
- Prism and Base are usually left empty, as they are not seen in most prescriptions. Prism refers to a displacement of the image through the lens, and is used to treat eye muscle imbalances or other conditions that cause errors in eye orientation or fixation. Prism correction is measured in "prism diopters", and Base refers to the direction of displacement.
- Pupillary Distance (PD) is the distance between pupils, usually given in millimeters, it is sometimes known as the interpupillary Distance (IPD).

It is written as two values if the prescription is for bifocals or progressive lenses - these are the pupillary distances for the distance and near fixation (essentially, the upper and lower part of the lenses). They differ due to pupillary convergence when looking at near objects. Additionally, an eyeglasses prescription may include a monocular pupillary distance ("monocular PD"). These measurements indicate, in millimeters, the distances from each pupil to the center of the nose where the center of the frame bridge rests. PD measurements are essential for all spectacle dispensings, monocular PDs being essential in progressive lenses and for those with high prescription. PDs can be measured using a pupilometer or by using a ruler.

- Back vertex distance (BVD) is the distance between the back of the spectacle lens and the front of the cornea (the front surface of the eye). This is essential in higher prescriptions (usually above ±4.00D) as slight changes in the distance between the spectacles and the eyes above this level can cause the patient to perceive a different power, leading to blur and/or other symptoms.

The cylinder axis is placed at a specific angle. This is measured in degrees, but the degree sign is not written as it can be mistaken for a zero (0). The trial frame has a protractor scale from which we can determine the axis.



Trial frame right eye Trial frame left eye

8.3 The Spoken Prescription

There is a system for speaking the prescription too! Get used to it as; again, it will avoid confusion.

Examples : + 0.25: plus owe (0) two five - 1.50: minus one fifty

+ 0.50: plus owe fifty - 2.25: minus two two five

+ 0.75: plus owe seven five + 10.00: plus ten

+ 1.00: plus one - 10.50: minus ten fifty

The decimal point is *never* mentioned.

Short Answer Type Questions

1. What do you mean by ophthalmic prescription.
2. What is the importance of prescription writing.
3. What do you mean by NV.Add, in prescription.
4. What does OD represent in prescription.
5. What does OS represent in prescription.
6. What does OU represent in prescription.

Long Answer Type Questions

1. What are all the points to be noted while writing prescription?
2. What are all the specifications written in prescription, describe briefly?
3. Importance of cylindrical lens angle in prescription writing
4. Explain complete ophthalmic prescription with representation

UNIT 9

Neutralisation and Focimetry

Structure

9.1 Introduction

There are several ways available to determine the power of a lens. A **focimeter** (or lensmeter) may not always be available, but you should have your trial lenses available. It is possible to get a good idea of the power by using these.

9.2 Hand Neutralisation

If you look at an object through a lens and move the lens, the object will appear to move. If the lens is convex (positive) the object will appear to move in the **opposite** direction to the movement of the lens. This is called an **against** movement. If you look at an object through a concave (negative) lens the movement appears to move in the **same** direction, and this is known as a **with** movement. This will allow us to tell, by a quick check on the glasses, if the patient is hypermetropic or myopic.

If you place a pair of lenses together of equal, but opposite, powers there will be no movement of the object viewed as the net power is plano. These lenses have **neutralised** each other.

Therefore using a combination of lenses to neutralise the movement of the object, it is possible to determine what the unknown lens power is.

Technique

To find the power (or prescription) of a lens we use trial lenses and an object to view. The best object is a cross as this allows us to assess astigmatic corrections.

1. Hold the lens so that the crossed lines can be seen, and move the lens, noting the direction of movement.

   WITH = MINUS LENS

   AGAINST = PLUS LENS

2. Rotate the lens. If the lines appear to twist, or 'scissor', then there is an astigmatic element to the lens power.
3. If there is a with movement, then this is a minus lens and needs to be neutralised with a plus lens; if against then a minus lens is needed to neutralise.
4. Select a trial lens and hold it against the lens and assess the movement. If there is no movement then the lens is neutralised, and the power is equal to, but of the opposite sign to the trial lens.
5. If, when neutralising, there is a remaining movement, then another trial lens is needed. Consider the remaining movement and select an appropriate trial lens to proceed with.
6. If there is astigmatism, then rotate the lens until the cross lines run through the lens continuously, vertically and horizontally. Keep the lens at this angle and move the lens along each line in turn. The movement will be different in each direction.
7. Neutralise **all** with movement first (or, if both are against, the smaller with movement). This will leave an against movement in the other meridian, and this meridian is the **axis** of the cylinder.
8. Neutralise the remaining meridian (against movement) with a minus sphere. This second lens will be equal but opposite in power to the cylinder power in the lens

Always remember that the lens that is used to neutralise is opposite in power to the one you are measuring, but of the same size.

9.3 Geneva Lens Measure

The lens measure, lens clock, or lens gauge has two fixed pins on the outside and in the center, a spring-loaded, movable pin. This device physically measures the sagital depth of a refracting surface and calculates the refracting power of the surface. A pointer that is activated by a system of gears indicates the position of the movable pin in relation to the fixed pins. If the instrument is placed on a flat surface, the protrusion of the central pin is equal to that of the fixed pins, with the result that the scale reading is zero.

If placed on a convex surface, the protrusion of the central pin is less than that of the fixed pins, but if placed on a concave surface, the protrusion of the central pin is greater. Because the chord length (the distance between the two outer pins) has a constant value for the instrument, the position of the central pin, indicates the sagitta of the surface, which provides a direct reading of diopters of refracting power of a surface of the lens.

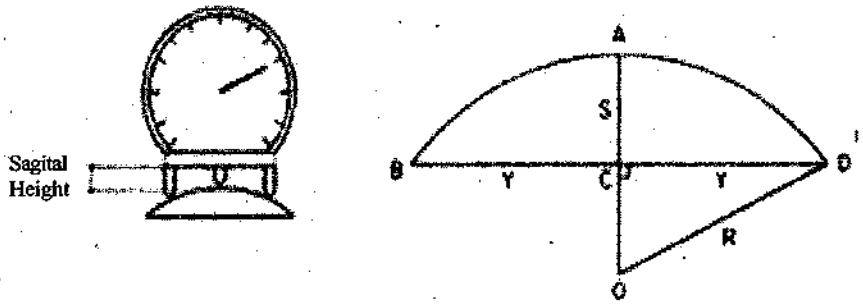


Fig 9.1

1. The lens clock physically measures the sagital height/depth.
2. The reading is in power (diopters)
3. The lens clock assumes that n is in air and n' = 1.53 (crown glass)

To calculate for the lens radius (assumes that s is very small) $r = y^2/2s$ (see diagram)

To calculate true power of a single refracting surface (SRS)

F true = F lens clock (n' true – n)/(n' lens clock – n)

9.4 Focimetry

A focimeter or lensmeter is an instrument which is used to measure the power of a lens. It is much more accurate than neutralisation, but not always available to use. The sphere and cyl powers can be measured, the axis determined, and the optical centre of the lens found. It is also possible to measure the bifocal addition on most lenses. There are 2 types of target in focimeters, but both use the same principles.

Note: Before trying to measure any lenses with a focimeter, the eye piece MUST be focused for you to see clearly. This is done by setting the machine to read plano, and then adjusting the eyepiece so that the target and graticule markings in the focimeter are in focus.

European Dot Target

A spherical lens will simply blur the dots, and adjusting the power dial will bring them into sharp focus. The power can now be read and noted.

If there is cylinder power, the dots are blurred into lines which can be brought into 2 foci. The **most positive** (or least negative) is the spherical power, and the **difference between the 2 powers** is the cyl power. The axis is the axis for the **more negative** power reading. We will normally record lens powers in **MINUS CYL FORM.**

American crossed line target

This has two, crossed lines, instead of the circle of dots, which can be rotated through 180° so that we can determine cylinder axis. Again, a spherical lens will simply blur the target and can be corrected easily.

The technique is the same for both machines.

1. Place the lens in the lensmeter, and adjust the dioptre scale until it shows a well focused target (spherical lens) or until one meridian is clearly in focus (astigmatic lens) and note the power and axis. On the American system, the cylinder wheel needs to be adjusted so that the astigmatic lines are aligned.
2. Refocus to obtain the second set of lines (at 90 to the first axis) and note the power and axis again.
3. To calculate the sphero-cyl power in negative cyl form, select the more positive/less negative power as your sphere.

4. Calculate the difference between the main powers (take the sphere power from the other) remembering the power signs - this is the cylinder power. Be very careful with the maths doing this.
5. The axis is the one found with the second power (*not* the one selected as the sphere).

Example

+ 1.00 × 90 and + 3.00 × 180

The second power is the more positive and is therefore chosen as the sphere power.

The difference between the powers is + 1.00 - (+ 3.00) = - 2.00.

The axis is taken from the second, less positive power. In this case it is 90. Therefore the sphero-cyl power is + 3.00 / - 2.00 x 9

Example

+ 1.50 × 60 and - 2.50 × 150

The first power is the more positive and is therefore chosen as the sphere power.

The difference between the powers is - 2.50 - (+ 1.50) = - 4.00. The axis is taken from the second, less positive power. In this case it is 150. Therefore the sphero-cyl power is + 1.50 / - 4.00 x 15

Questions

1. + 2.50 × 65 and + 1.00 × 155 =
2. + 1.50 × 85 and - 1.00 × 175 =
3. - 3.75 × 45 and - 1.00 × 135 =
4. Plano × 90 and + 1.75 × 180 =
5. - 0.25 × 10 and + 1.50 × 100 =
6. + 6.00 × 90 and - 1.00 × 180 =
7. + 10.00 × 80 and + 12.00 × 170 =
8. - 1.75 × 180 and Plano × 90 =
9. + 3.00 × 125 and -3.00 × 35 =
10. - 4.75 × 25 and Plano × 115 =

Note! The power of a lens can be written in three different ways

+ 1.00 × 90 / + 2.00 × 180 - Crossed cylinder form

+ 1.00 DS / + 1.00 × 180 - Plus cylinder form

+ 2.00 DS / - 1.00 × 90 - Minus cylinder form

These are all the same power! The focimeter works with crossed cylinder form, and we should work with minus cylinder form.

Short Answer Type Questions

1. What do you mean by neutralization in optometry?
2. What are the different methods of neutralization?
3. In hand neutralization, with movement of the object determines.
4. What is the use of lensometer?
5. How do you recdord readings in a lensometer.

Long Answer Type Questions

1. Write step by step procedure of hand neutralization.
2. Write procedure of lensometry and final power of spectacle lens with examples.
3. What are the basic procedure to be done before doing lensometry?
4. What is geneva lens measure? How do you use it?

UNIT 10

Transposition

Structure

10.1 Introduction

The prescription for a lens can be written in several different forms. We will consider the two most commonly used forms: the **PLUS CYLINDER** form and the **MINUS CYLINDER** form.

For both forms the lens is effectively the same, but the written form looks very different. To transpose from one form to the other -

1. The cylinder **POWER** stays the same.
2. The cylinder **SIGN** always changes.
3. The cylinder axis always changes by 90 (if less than 90 add 90, or more than 90 subtract 90 to give an axis between 1 and 180 inclusive).
4. **ADD** the old sphere power and the old cyl power (always remembering the signs) to obtain the new sphere power.

Examples

+ 1.00 / + 3.00 × 90 = + 4.00 / - 3.00 × 180

+ 5.00 / - 1.00 × 75	=	+ 4.00 / + 1.00 × 165
- 6.00 / + 2.50 × 125	=	- 3.50 / - 2.50 × 35
- 3.00 / - 1.25 × 20	=	- 4.25 / + 1.25 × 110
+ 2.00 / - 4.00 × 180	=	- 2.00 / + 4.00 × 90
- 1.50 / + 3.50 × 45	=	+ 2.00 / - 3.50

Questions

1. + 2.50 / - 1.50 × 40 =
2. + 6.00 / + 2.50 × 130 =
3. - 1.00 / + 2.00 × 55 =
4. - 3.00 / - 2.25 × 175 =
5. + 5.00 / - 4.25 × 95 =
6. + 2.25 / - 2.25 × 160 =

10.2 Spherical Equivalent

1. There are several reasons why we will not prescribe toric lenses.
2. This manual is not designed to teach you to refract for astigmatism very accurately. All we require from you is recognition of the presence of astigmatism. If the spherical equivalent gives good enough vision, you should prescribe this.
3. Many patients cannot tolerate cylindrical prescriptions, and experience is needed to be able to prescribe it successfully.
4. The costs involved for the patient in having toric lenses is high, and the lenses are not always readily available, so we should avoid prescribing them unless they are of sufficient benefit to the patient.

Spherical equivalent power is calculated from the sphere and cylinder powers. The resulting sphere should be tried subjectively to make sure that the patient is getting the best possible spherical correction.

A spherical equivalent must, obviously, obtain an improvement in vision over the unaided acuity! It may well produce worse acuity than the full prescription including the cyl.

RULE: Add half the cylinder power to the sphere power.

If we use the examples from above -

Sphero-cyl	Spherical equivalent
+ 1.00 / + 3.00 × 90	+ 2.50
+ 1.00 + half (+ 3.00) = + 1.00 + 1.50 = + 2.50	
+ 5.00 / -1.00 × 75	+ 4.50
- 6.00 / + 2.50 × 125	- 4.75
- 3.00 / -1.25 × 20	- 3.50 or -3.75
+ 2.00 / -4.00 × 180	plano
- 1.50 / + 3.50 × 45	+ 0.25

Short Answer Type Questions

1. Why do we transpose ophthalmic lenses.
2. What do you mean by transposition?
3. Transpose them;

   +1.00 / -1.00 x 90

   Plano/+2.25 x 110
4. What do you mean by plus cylinder form?
5. Advantages of transposing lenses.

Long Answer Type Questions

1. Explain briefly step by step procedure of transposing lenses
2. Importance of transposing one form of cylindrical lenses into other forms.
3. What do you mean by spherical equivalent?

UNIT 11

Best Sphere

Structure

11.1 Introduction

11.2 Blur Test

11.1 Introduction

This is a subjective technique which is used to improve the prescription after retinoscopy and also can be used when the retinoscope is not available or when the retinoscope reflex is so poor that retinoscopy is impossible.

The best sphere lens is the spherical lens that focuses light onto the retina. In astigmatism, it is the *circle of least confusion* that is on the retina. (It is also the spherical equivalent of the prescription).

The best sphere is the maximum plus (or minimum minus) power lens which gives the best possible visual acuity. It is found by increasing the plus power until vision **becomes worse**, or adding minus power until the vision **does not get better**.

It is important to ask questions which offer a simple choice of answers. For example:

- Are the letters better with or without this lens?
- Are the letters clearer with or without the lens?

- Is this lens the same or less clear / worse? (plus lens)
- Is this lens the same or more clear / better? (minus lens)

Remember, we want to prevent the patient having to accommodate. We therefore give the **maximum plus** or **minimum minus**.

To find the best sphere, firstly consider the vision. If this is good, start by using a + 0.50 DS lens. If this is the same, leave this in place and keep adding more + 0.50 DS until the patient reports that the lens makes vision worse. If the vision is poor, then a power larger than + 0.50 DS should be used.

If positive lenses make the vision worse immediately, then the patient may be myopic and minus lenses should be used to improve vision in a similar way to that described above for plus lenses.

When you think you have found the best sphere you need to check that you have not over-corrected the patient. **If hypermetropic, addition of - 0.50 DS should not make vision better (the patient should report that this is the same). If myopic, then addition of + 0.50 should make vision worse.**

If the patient is uncertain of an answer it often means that there is little difference (answer = same)!

11.2 Blur Test

The + 1.00 blur test is a simple and quick screening test for low hyperopia, and also a check to ensure that you have given the correct prescription.

By placing a + 1.00 DS lens in front of the patient, their visual acuity should reduce by at least 2 or 3 lines on the chart. If there is less reduction in acuity, you must re-check the prescription.

Short Answer Type Questions

1. Best sphere means.
2. What do you mean by blurr test?
3. How do you prevent over correction in best sphere method.

Long Answer Type Questions

1. How do you give correction with the help of best sphere technique.
2. What is the technique followed while best sphere method correction?
3. In what conditions of the eye we follow best sphere method.

UNIT 12

Retinoscopy

Structure

12.1 About Retinoscopy

Retinoscopy is an objective method which is done to find out the refractive status of the eye. It is a optometric/ophthalmological refractive procedure of examination ideally done. And is very useful in uncooperative, children and mentally retard patients in whom subjective examinations are difficult to perform.

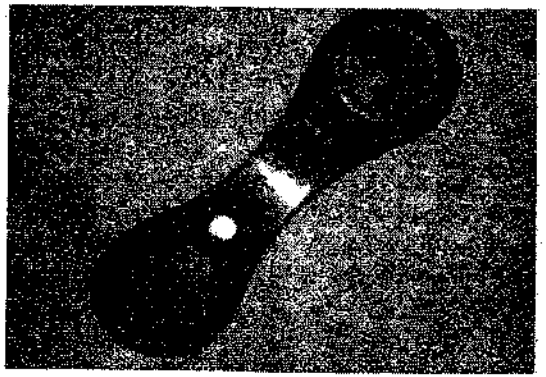


Fig 12.1 Plane and concave mirror retinoscope

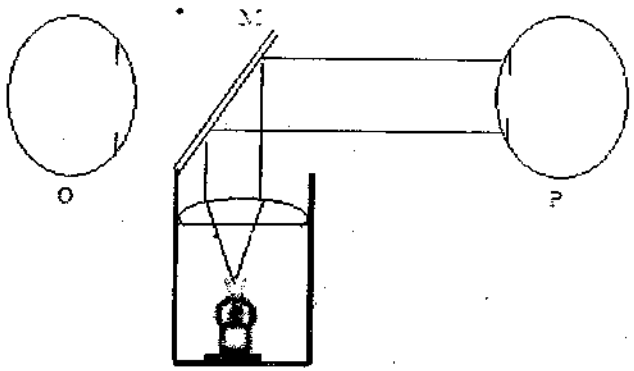


Fig 12.2 Observation and illumination system in self illuminated retinoscope. 'O' stands for observer. 'P' stands for Patient. 'M' stands for Mirror

The principle of retinoscopy is to convert the observed eye into a degree of myopia that the image formed by the fundus in front of the observed eye coincides with the pupillary plane of the observer. Principally a spot of the fundus of the patient's eye is illuminated by reflecting light into the patient's eye, when the light is reflected back, is observed. In use of the plane mirror to obtain results the opening in the mirror should be 4 mm in size. The advantage is however, counterbalanced by the appearance of a circular dark patch. To get over this difficulty a concave mirror of about 150 cm focal length should be employed. It acts as a plane mirror for all practical purposes and gives a bright light to play with.

Now a day's self-illuminating retinoscopes are being used based on the above principles. They are alternative more easily manipulated systems with the advantage that the intensity and size of the beam can be readily controlled. Both types of mirror effects can be provided by moving a strong converging lens to and from the bulb to vary the angularity of the light leaving the mirror, so that at one extreme the rays converge at a point close to the instrument (concave type mirror) and the other rays are parallel (plane type mirror). As long as this image is not coinciding with the pupillary plane of the observer there remains some parallax and by placing suitable lenses in front of the observed eye this parallax is eliminated. Retinoscopy is carried out preferably from a distance of one meter purely as a matter of convenience both for the manipulations required during the procedures and subsequent mathematical calculations. The choice of distance should be left to the observer as long as it is understood that the mathematical

correction is to be accurately applied according to the formula 100/D, where D is the distance in centimeters at which retinoscopy is done.

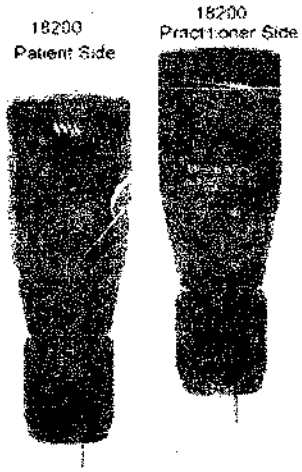


Fig 12.3 Streak Retinoscope

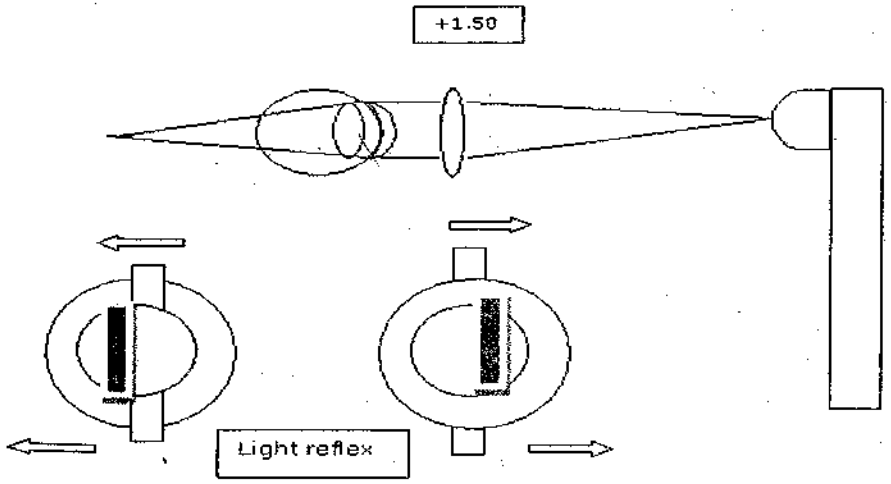


Fig 12.4 Nature of light reflex in Streak retinoscope Arrow denotes movement of retinoscope. First arrow mark denotes against movement.Second arrow mark denotes with movement.

The movement of the image (or shadow) is estimated in relation to the movement of the mirror performed by the observer. If a distance of 1 meter is

used with the plane mirror and if the image moves in the same direction as the movement of the mirror the refractive state of the eye is

1. Emmetropia
2. Hypermetropia, or
3. Myopia of less than one dioptre.

And if the Image moves in the direction opposite to the movement of the mirror the refractive state of the eye is myopia of more than one dioptre. With a concave mirror the findings opposite to these obtained with the plane mirror are recorded. With either mirror if there is no parallax in the movement of the image the refractive state of the eye is myopia of one dioptre.

The rays that enter the patient's eye are reflected from the mirror and should be regarded as emanating from the image of the source of light. This image of the source of light should be considered as immediate source of light. The shape of the illuminated area depends upon the shape of the original source of light. The light is usually kept at about 25 cm behind the patient and is small, i.e., about 25 mm in diameter. The observer sits at about 1 meter distance. The distance of the mirror from the source of light is, therefore, 1.25 meters. In a plane mirror the image will form as far behind as the object is in front and will be equal in size. The eye of the patient will therefore, be 2.25 metres from the immediate source of light. The diameter of the retinal image I is:

I=dv /u

But v=N

And u=D

Hence I=dN/D

Where d is the diameter of the source of light, N is the distance of the nodal point from the retina, and D is the distance of the nodal point from the immediate source of light.

Or **25 X 15/2250 = 0.16mm**

This is rather very small. In streak retinoscopy we use a linear source of light and a linear image upon the fundus is formed. The intensity of illumination of the fundus will depend upon

1. Clarity of the media.
2. Refraction of the patient's eye.

3. Type of mirror plane or concave.
4. Distance of original source of light from the mirror, and
5. The intensity of the original source of light.

The portion of the illuminated fundus that can be seen at one time depends upon the size of the pupil and the distance at which the observer sits i.e.,

4 X 25/1000 = 0.06mm

We know that the illuminated area of the fundus is 0.16 mm, i.e., only a small area of the illuminated fundus is seen at one time and the surrounding fundus is invisible. If the immediate source of light be moved, i.e., the movement of the mirror, the illuminated area of the fundus will be succeeded by a dark area, usually termed as a shadow. It is on the junction of the illuminated area that one's attention is concentrated while doing retinoscopy. When a plane mirror is moved upwards the immediate source of light moves downwards while the opposite is true in the case of a concave mirror.

The retinoscope is the most important tool in refraction. It is invaluable in allowing us to assess the refractive state of the eye with little, or no, co-operation from the patient. We call this an objective method (as opposed to a subjective method where we depend on the patient to give accurate answers to our questions!).

The retinoscope is relatively inexpensive and portable, and it can be used on all types of patients. In the hands of an experienced user it may be the only way of getting a result, particularly with young children.

There are essentially two types of retinoscope - the spot and the streak. The spot, as the name suggests, projects a spot of light which can normally be focused to produce a smaller, but brighter beam. The streak projects a rectangular patch of light onto the patient's retina and this can be focused to a thin line of light. The patch can also be rotated through 360°.

Of course, the retinoscope only works if there are batteries in it and the bulb is working. Get used to the retinoscope, know how to change the batteries and, most importantly, the bulb!

When the light is shone into the patient's eye some of the light is reflected out of the eye and this you will see. This is called the retinoscopic reflex (or ret reflex). When the light is passed over the eye, the reflex will be seen to move. This movement helps us to assess the patients refractive error. The movement can be with (hypermetropia), against (myopia) or 'scissor' (astigmatism), or no

movement (emmetropia) will be seen. This direction of movement is a guide to refractive error. Also, if there are different movements in different meridians this is astigmatism.

The relative speed of movement of the reflex is also useful in determining refraction - the slower the movement, the higher the refractive error. The speed of movement does not depend on the speed of movement of the retinoscope, but *is* related to that movement. The brightness of the reflex gives some information too. If the reflex is dull, then a high refractive error is present.

Thus we need to consider, when examining a ret reflex, the following four characteristics.

- **Direction** - is it with or against?
- **Brightness** - is it bright or dull?
- **Speed** - is it fast or slow?
- Is the movement the same in all meridians?

A **with** movement is corrected with a **positive** lens.

An **against** movement is corrected with a **negative** lens.

Scissors movement is corrected with a combination of spherical and cylindrical lenses, with the cyl axis aligned correctly.

Basic Principles

Retinoscopy is done at arms length from the patient, around 50 to 66 cm. This is known as the **working distance** and is used for convenience and accuracy.

The aim of retinoscopy is to find the lens that will stop the ret reflex moving. This is done by adding lenses to make the reflex brighter, move faster, and, ultimately, stop (or neutralise) the movement. This point is known as the **end point** or **point of reversal**. *To do this the patient must look at distant object (to prevent accommodation) and retinoscopy must be performed as close as possible to the patient's visual axis.* At the end point, the patient's eye is focused on the retinoscope - in other words the patient is now myopic.

The working distance is now of importance as we can calculate how myopic the patient is. Using the formula P = 100 / f we know that, if the working distance is 66 cm, we need a 1.50 DS lens. Likewise, if the working distance is 50 cm, the working distance lens will be 2.00 DS. This is the working distance lens, and we need to subtract this from our result.

12.2 Clinical Retinoscopy

1. Place your working distance lens ('retinoscopy lens') in the trial frame.
2. Before testing an eye, the other eye **MUST** be blurred to prevent accommodation. This only takes a few seconds as the movement in all meridians must be **against** in this eye - add positive sphere until this is the case.
3. In a darkened room, assess the ret reflex horizontally, vertically and then each diagonal.
4. If 'with' movement is seen, add plus sphere until all with movement is removed. If 'against' movement is seen, add minus sphere until you just see a 'with' movement in one meridian.
5. In clinical practice, a 'with' movement is seen more easily than an 'against'. The end point is almost impossible to recognise. Thus, the end point is found when adding + 0.25 produces an 'against' movement and addition of - 0.25 produces a 'with' movement. Alternatively, moving slightly closer to the patient (shortening your working distance) should produce a 'with' movement, and moving away should produce an 'against' movement. **You should always obtain this reversal as proof that you have reached and passed the end point/point of reversal.**
6. If the reflex is the same in all meridians we have reached the end of the retinoscopy routine for this eye when the point of reversal is found. If there is astigmatism, however, we need to correct the more positive/ least negative meridian with a sphere, leaving the other meridian with an 'against' movement (i.e. simple myopic astigmatism). Note the *axis* of the against movement as this is the *axis* of the astigmatism.
7. With astigmatism, we now need to correct the cylinder element of the prescription. This 'against' movement should now be neutralised using a minus cylinder lens, **leaving the sphere in place**.
8. You should now have in the trial frame the working distance lens, a sphere and a cycle. Check the reflex in all meridians to ensure that all astigmatism has been corrected and that there are no remaining movements. The cyl axis may need to be modified.
9. Repeat the procedure for the other eye.
10. Remove the working distance lenses from the trial frame and proceed to subjective refinement of the prescription.

Think

Is the movement with or against?

- If the movement is **WITH**, add a **POSITIVE** lens
- If the movement is **AGAINST**, add a **NEGATIVE** lens

Is the reflex bright or dull?

- If the reflex is dull, then start with a relatively large power
- If bright a smaller power can be used

Is the movement fast or slow?

- If the movement is fast, then a smaller lens power should be used
- If slower, a larger power should be used

Is the movement the same in all meridians?

- Astigmatism!

Note: The decision of which power to use is a matter of experience and guess-work!

Short Answer Type Questions

1. Define retinoscopy.
2. Types of retinoscopes.
3. Basic principles, while doing retinoscopy.
4. What do you mean by with and against movement in retinoscopy?
5. What does working distance signify in retinoscopy?
6. What is the relation between working distance with retinoscopy?

Long Answer Type Questions

1. Method of doing retinoscopy.
2. Explain briefly the types of retinoscopy.
3. What do you mean by reflex in performing retinoscopy?
4. What are the basic principles in doing retinoscopy?

UNIT 13

The Crossed Cylinder Lens

Structure

13.1 Introduction

13.2 Crossed cylinder techniques

13.1 Introduction

A **crossed cylinder (cross-cyl, x-cyl or Jack sons cross cylinder)** lens is used to find, subjectively, the astigmatic component of a patient's prescription. This will be after retinoscopy is done or best sphere is determined.

The cross-cyl lens is mounted in a rim with a handle. The lens is formed from a plus cyl at right angles to a minus cyl of equal power. The axis of a cross cyl is at 45° to the axes of the cyls, and this is in line with the handle. The axes of the cyls are marked, and normally engraved with their powers.

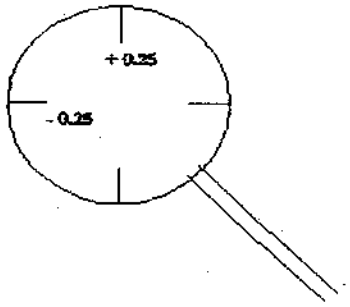


Fig 13.1 The Jackson Crossed Cylinder.

The markings refer to the axes of the cylinders. This is a +/- 0.25 x-cyl.

Cross cyls are available in powers of +/- 0.25, +/- 0.50 and +/-1.00.

A +/- 0.50 cross cyl has the following power

- + 0.50 DC / - 0.50 DC
- + 0.50 DS / -1.00 DC
- - 0.50 DS / + 1.00 DC

These are all the same power!

What is the spherical equivalent of a +/- 0.50 cross-cyl?

13.2 Crossed Cylinder Technique

The technique is very simple and quick, but very hard to describe so the following text will make it look far worse than it actually is! We are mainly concerned with the minus axis in refraction.

Technique for axis

After retinoscopy we need to check the power and axis of the astigmatism found. This is done in a systematic way, as follows:

1. The patient should have one eye occluded (or blurred), and asked to look at a suitable target letter - rounded letters (O, U, C) are better than ones with horizontal and vertical lines (H, T, E). The 6/12 or 6/18 letter should be used, if the patient is able to see these letters clearly.
2. The sphere should be reduced by 0.50 DS (add - 0.50 DS) to allow some accommodation for this test.
3. Place the cross cyl with the **handle in line** with the axis line of the cylinder lens and rotate the x-cyl about its axis, asking the patient whether he sees the target more clearly with the first position or the second. **(Question: Is the letter more clear with lens 1 or lens 2)**
4. Move the axis of the trial lens towards the better position of the minus axis on the x-cyl. This should be about 20° movement first time, and reduced as the axis is refined.
5. Repeat the process, always making sure that the handle is lined up with the axis line of the cylinder lens.

6. When the patient reports that there is no difference between the two positions (or you are back where you started!) you have now found the axis. NOTE IT DOWN!

Technique for power

1. This time you need to line up the power markings on the x-cyl lens with the axis line of the cylinder lens. Twirl the lens as before and note if the plus or minus axis is the clearer position.
   - If PLUS is better, **reduce** the cylinder power
   - If MINUS is better, **increase** the cylinder power
2. As the cyl power is altered, so too must the sphere power in order to maintain the same spherical equivalent, e.g. if the cylinder power is increased by - 1.00 DC, you need to add + 0.50 to maintain the spherical equivalent
3. Check the VA. How does it compare to the retinoscopy VA?
4. Repeat for the other eye.

If retinoscopy has not been possible, the x-cyl can still be used after best sphere has been found.

1. Find best sphere. Add - 0.50 to allow some accommodation.
2. Twirl the x-cyl about 90°/180°. If neither position is better, try at 45°/ 135°. If none of these are better then there is no astigmatism.
3. If one position is better then place a - 1.00 DC at that axis. Then check the axis and power as before.
4. Repeat for the other eye.

Remember

To use the x-cyl successfully, you need to hold the x-cyl firmly, supporting your hand or arm to keep the lens steady.

Question the patient clearly - **Which is more clear - number 1 or number 2?** (or any suitable question). It is often useful to alter the number as the patient will often keep replying with the same number each time!

- Select a suitable fixation target for the patient
- To check the cylinder axis, you must place the x-cyl handle in line with the axis line of the trial lens

- To check the power, the power markings on the x-cyl must be lined up with the axis line of the cylinder lens

Depending on what you are checking, you must always orientate the crossed-cylinder lens so that it is in line with the axis of the trial lens

Short Answer Type Questions

1. What is the use of jackson's cross cylinder?
2. Draw a neat diagram of jacksons cross cylinder?
3. What is the relation of J.C.C with retinoscopy?

Long Answer Type Questions

1. Explain briefly how to use jackson's cross cylinder?
2. For best sphere correction, what instrument is used and how?
3. How do you refine cylindrical power with the help of Jackson's cross cylinder?

UNIT 14

Refraction Routine

In order to assess a patient quickly and efficiently you will need to follow a systematic approach to refraction, so that you cover all the necessary tests in a logical order, and not repeat tests unnecessarily. We will, obviously, only be concentrating on the refraction aspects of your work, and you will need to sort out how this is added to your system for the general eye work.

Firstly, write everything down on the patient's record card for future reference as well as to prevent the need to repeat tests unnecessarily. By keeping a thorough record of your findings you are able to tell whether or not the patient is improving with the treatment you are giving.

1. Record vision and visual acuity with current distance spectacles, monocularly.
2. Symptoms - question the patient and record the symptoms. Assess the symptoms - are glasses likely to help?
3. Measure and record the patient's pupillary distance (PD). Adjust the trial frame to fit the patient properly.
4. Retinoscopy - use clean trial lenses!
5. Record your result and check the visual acuity monocularly.
6. Adjust the spherical power subjectively to obtain best possible visual acuity, using maximum plus (or minimum minus).
7. Use x-cyl to refine the cylindrical power and axis.

8. Record subjective refraction result and VA.
9. Check spherical equivalent subjectively and record VA with this lens.
10. Repeat for the other eye.
11. Uncover both eyes and check binocular VA - this is often a line better than monocularly.
12. Assess near vision ability. Is there presbyopia? If so, prescribe an appropriate reading addition.
13. Write out final prescription, and explain your findings and recommendations.

UNIT 15

Cycloplegia

Strucutre

15.1 Introduction

There are many drugs used in eye work. In refraction we are only concerned with cycloplegics.

Our main aim of using a cycloplegic is to prevent accommodation. There are several choices - atropine, homatropine, cyclopentolate, hyoscine and tropicamide - so which is most suitable for our needs in refraction?

We need a drug which will:

- Have rapid onset (act quickly)
- Be short acting
- Achieve maximum cycloplegia
- Be non-toxic
- Be readily available and cheap

Cyclopentolate is, actually, the most suitable of all the choices. Cycloplegia is sufficient after 20 minutes, the effects last 5 to 6 hours, and there is sufficient

amount of action. It is relatively non-toxic, although there can be some adverse reactions to it.

Atropine is still used, but the effects last too long and it is far too toxic to be of safe use.

Cyclopentolate

To obtain good cycloplegia for refraction, we will normally use a 1% solution and instil one drop in each eye, repeated five minutes later. At least 20 minutes should be allowed before carrying out the refraction

There are a few side effects of cyclopentolate which are unhelpful. The main problem is the mydriasis which reveals peripheral distortions in the reflex. The central portion of the reflex is what we need to consider. Also, the cycloplegia will wear off within about 6 hours, but the mydriasis lasts for around 24 hours, which makes the patient light sensitive. The patient needs to be advised about this.

15.2 Uses of Cycloplegia

The patient will, generally, not thank you for giving them a cycloplegic! So, why is it important to use it?

The main patients who need cyclopentolate are the young, uncooperative ones. Remember that the patient needs to look in the distance whilst you do retinoscopy. Children are not going to co-operate so well! I suggest that, if the patient is not cooperating, use cyclopentolate.

There is some discussion as to how much of the cycloplegic correction should be given, as the muscle tonus around the lens may be affected. I consider that it is unnecessary to modify the result for young children as their world is close to them and not far away. However, some people will reduce the prescription by 0.50 DS or even 1.00 DS. For atropine refractions, allowance does need to be made. Again, opinion varies. I suggest allowing 1.00 DS, or better still, don't use atropine for refractions!

If there is a convergent squint then cyclopentolate MUST be used to find the full refractive error as the squint may be due to high hypermetropia. The full correction should be given in these cases.

As the patient gets older there is much less need to use cyclopentolate, and there are, indeed, good reasons NOT to. As cyclopentolate dilates the pupil, it is possible that the drainage route for aqueous can be blocked causing an increase in the intraocular pressure - i.e. you could give them an attack of acute glaucoma.

NoteIt is often necessary to maintain your own supply of cyclopentolate. It should be available locally, or you may need to order it. Some pharmacies will sell it under a 'trade name', but the ingredients will always include cyclopentolate.

Short Answer Type Questions

1. Cyclopegia means.
2. How do you do cycloplegic refraction.
3. Uses of cycloplegia.

Long Answer Type Questions

1. How do you do cycloplegic refraction.
2. What are the indications for cycloplegic refraction?
3. Which drug we use in cycloplegic refraction and it's importance.

UNIT 16

When to Prescribe

- We have touched on this subject already. Glasses are not necessarily the best treatment for a patient. Always bear in mind that the glasses must be of sufficient benefit to the patient to be worth the money spent on them. Do not give glasses to satisfy a patient's demands unless they will help anyway.
- Low hyperopes, especially the young, can cope without glasses as they can easily accommodate to overcome the error. Certainly + 0.25 and + 0.50 (and perhaps even + 0.75) should not be prescribed.
- Remember that low myopes will survive without reading glasses, and - 0.25 (and even - 0.50) should not be prescribed.
- Remember that a person who does not read does not need reading glasses, but may need glasses for sewing, knitting, sorting rice, etc.
- Do not encourage people to have bifocals if their distance prescription is small.
- If the astigmatic element is high, and spherical equivalent is not satisfactory, then refer. Warn the patient first that these glasses will be more expensive, otherwise the referral may be a waste of time.
- If you obtain less than one line improvement in vision there is no real benefit in prescribing new glasses.
- Aim for 6/9 or better.

UNIT 17

Contact Lenses

Structure

17.1 Introduction

A contact lens can be defined as an optical aid which is placed on the cornea to correct refractive errors. Contact lenses are considered medical devices and can be worn to correct vision, for cosmetic or therapeutic reasons., the average age of contact lens wearers globally was 31 years old and two thirds of wearers were female.

People choose to wear contact lenses for many reasons. Aesthetics and cosmetics are often motivating factors for people who would like to avoid wearing glasses or would like to change the appearance of their eyes.

Other people wear contacts for more visual reasons. When compared with spectacles, contact lenses typically provide better peripheral vision, and do not collect moisture such as rain, snow, condensation, or sweat. This makes them ideal for sports and other outdoor activities. Additionally, there are conditions such as keratoconus and aniseikonia that are typically corrected better by contacts than by glasses.

History

Fig 17.1

In 1888, Adolf Fick was the first to successfully fit contact lenses, which were made from blown glass

Leonardo Da Vinci is frequently credited with introducing the idea of contact lenses in his 1508 *Codex of the eye, Manual D*, where he described a method of directly altering corneal power by submerging the eye in a bowl of water. Leonardo, however, did not suggest his idea be used for correcting vision—he was more interested in learning about the mechanisms of accommodation of the eye.

Also in 1887, Louis J. Girard invented a similar scleral form of contact lens. Glass-blown scleral lenses remained the only form of contact lens until the 1930s when polymethyl methacrylate (PMMA or Perspex/Plexiglas) was developed, allowing plastic scleral lenses to be manufactured for the first time. In 1936, optometrist William Feinbloom introduced plastic lenses, making them lighter and more convenient. These lenses were a combination of glass and plastic.

In 1949, the first "corneal" lenses were developed. These were much smaller than the original scleral lenses, as they sat only on the cornea rather than across the entire visible ocular surface, and could be worn up to sixteen hours per day. PMMA corneal lenses became the first contact lenses to have mass appeal through the 1960s, as lens designs became more sophisticated with improving manufacturing (lathe) technology.

One important disadvantage of PMMA lenses is that no oxygen is transmitted through the lens to the conjunctiva and cornea, which can cause a number of adverse clinical effects. By the end of the 1970s, and through the 1980s and

1990s, a range of oxygen-permeable but rigid materials were developed to overcome this problem. Chemist Norman Gaylord played a prominent role in the development of these newer, permeable contact lenses. Collectively, these polymers are referred to as "rigid gas permeable" or "RGP" materials or lenses. Although all the above lens types — sclerals, PMMA lenses and RGPs — could be correctly referred to as being "hard" or "rigid", the term hard is now used to refer to the original PMMA lenses, which are still occasionally fitted and worn, whereas rigid is a generic term that can be used for all these lens types: hard lenses (PMMA lenses) are a sub-set of rigid lenses. Occasionally, the term "gas permeable" is used to describe RGP lenses, but this is potentially misleading, as soft lenses are also gas permeable in that they allow oxygen to move through the lens to the ocular surface.

The principal breakthrough in soft lenses was made by the Czech chemists Otto Wichterle and Drahoslav Lim who published their work "Hydrophilic gels for biological use" in the journal *Nature* in 1959. This led to the launch of the first soft (hydrogel) lenses in some countries in the 1960s and the first approval of the Soflens material by the United States

Food and Drug Administration (FDA) in 1971. These lenses were soon prescribed more often than rigid lenses, mainly due to the immediate comfort of soft lenses; by comparison, rigid lenses require a period of adaptation before full comfort is achieved. The polymers from which soft lenses are manufactured improved over the next 25 years, primarily in terms of increasing the oxygen permeability by varying the ingredients. In 1972, British optometrist Rishi Agarwal was the first to suggest disposable soft contact lenses.

In 1998, an important development was the launch of the first silicone hydrogels onto the market by CIBA VISION in Mexico. These new materials encapsulated the benefits of silicone — which has extremely high oxygen permeability — with the comfort and clinical performance of the conventional hydrogels which had been used for the previous 30 years. These lenses were initially advocated primarily for extended (overnight) wear although more recently, daily (no overnight) wear silicone hydrogels have been launched.

17.2 Types of Contact Lenses

Contact lenses can be classified in many different manners.

Contact lenses can be separated by;

1. Their primary function,
2. Material,

3. Wear schedule (how long a lens can be worn before removing it), and
4. Replacement schedule (how long before a lens needs to be discarded).

Functions

Corrective contact lenses

Spherical Contact Lenses

Corrective contact lenses are designed to improve vision, most commonly by correcting refractive error. This is done by directly focusing the light so that it enters the eye with the proper power for clear vision. Recently, there has been renewed interest in orthokeratology, the correction of myopia by deliberate overnight flattening of the corneal epithelium, leaving the eye without a refractive error during the day.

A spherical contact lens bends light evenly in every direction (horizontally, vertically, etc.). They are typically used to correct myopia and hyperopia.

Toric Contact Lenses

A toric contact lens has a different focusing power horizontally than it does vertically, and as a result can correct for astigmatism. Some spherical rigid lenses can also correct for astigmatism. Because a toric lens must have the proper orientation to correct for a person's astigmatism, a toric contact lens must have additional design characteristics to prevent the lens from rotating out of the ideal alignment. This can be done by weighting the bottom of the lens or by using other physical characteristics to rotate the lens back into position. Some toric contact lenses have marks or etchings that can assist the eye doctor in fitting the lens. The first disposable toric lenses were introduced in 2000 by Vistakon.

Multifocal(Bi-focal) Contact Lenses

The correction of presbyopia (a need for a reading prescription that is different from the prescription needed for distance) presents an additional challenge in the fitting of contact lenses. Two main strategies exist: multifocal contact lenses and monovision. Multifocal contact lenses are comparable to bifocals or progressive lenses because they have multiple focal points. Multifocal contact lenses are typically designed for constant viewing through the center of the lens, but some designs do incorporate a shift in lens position to view through the reading power (similar to bifocal glasses). Monovision is the use single vision lenses (one focal point per lens) to focus one eye for distance vision (typically the person's dominant eye) and the other eye for near work. The brain then learns to use this setup to see clearly at all distances. A technique

called modified monovision uses multifocal lenses and also specializes one eye for distance and one eye for near. Alternatively, a person may simply wear reading glasses over their distance contact lenses.

Other types of vision correction

For those with certain color deficiencies, a red-tinted "X-Chrom" contact lens may be used. Although the lens does not restore normal color, it allows some colorblind individuals to distinguish colors better.

ChromaGen lenses have been used and these have been shown to have some limitations with vision at night although otherwise producing significant improvements in color vision. An earlier study showed very significant improvements in color vision and patient satisfaction.

Cosmetic contact lenses

Fig 17.2 A woman wearing a cosmetic type of contact lenses; the enlarged section of the image shows the grain produced during the manufacturing process. Curving of the lines of printed dots suggests these lenses were manufactured by printing onto a flat sheet then shaping it.

A cosmetic contact lens is designed to change the appearance of the eye. These lenses may also correct refractive error. Although many brands of contact lenses are lightly tinted to make them easier to handle, cosmetic lenses worn to change the color of the eye are far less common, accounting for only 3% of contact lens fits in 2004.

Cosmetic lenses can be used to drastically alter the appearance of the eye, as seen in the entertainment industry. Scleral lenses that cover the white part of the eye (i.e., sclera) are used in many theatrical applications. These lenses are typically custom made for a specific production and as a result have very limited

availability to the general public. As with any cosmetic lens, if the design changes the clarity of the center of the lens, the lens may interfere with vision.

Cosmetic lenses can have more direct medical applications. For example, some lenses can restore the appearance and, to some extent the function, of a damaged or missing iris.

Therapeutic contact lenses

Soft lenses are often used in the treatment and management of non-refractive disorders of the eye. A bandage contact lens protects an injured or diseased cornea from the constant rubbing of blinking eyelids thereby allowing it to heal. They are used in the treatment of conditions including bullous keratopathy, dry eyes, corneal abrasions and erosion, keratitis, corneal edema, descemetocele, corneal ectasis, Mooren's ulcer, anterior corneal dystrophy, and neurotrophic keratoconjunctivitis. Contact lenses that deliver drugs to the eye have also been developed.

Materials

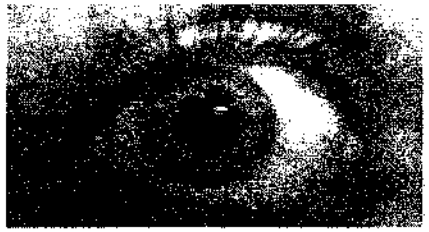


Fig 17.3

Contact lenses, other than the cosmetic variety, become almost invisible once inserted in the eye. Most corrective contact lenses come with a light "handling tint" that may render the lens slightly more visible on the eye. Soft contact lenses extend beyond the cornea, and the border is sometimes visible against the sclera.

Rigid Lenses

Glass lenses were never comfortable enough to gain widespread popularity. The first lenses to do so were lenses made from polymethyl methacrylate (PMMA or Perspex/Plexiglas). PMMA lenses are commonly referred to as "hard" lenses. A disadvantage of these lenses is that they do not allow oxygen to pass through to the cornea, which can cause a number of adverse clinical events. Starting in the late 1970s, improved rigid materials which were oxygen-permeable were developed. Lenses made from these materials are called rigid gas permeable or 'RGP' lenses.

A rigid lens is able to replace the natural shape of the cornea with a new refracting surface. This means that a spherical rigid contact lens can correct for astigmatism. Rigid lenses can also be made as a front-toric, back-toric, or bitoric.

This is different from a spherical lens in that one or both surfaces of the lens deliver a toric correction. Rigid lenses can also correct for corneal irregularities, such as keratoconus. In most cases, patients with keratoconus see better through rigid contact lenses than through glasses. Rigid lenses are more chemically inert, allowing them to be worn in more challenging environments than soft lenses.

Soft Lenses

While rigid lenses have been around for about 120 years, soft lenses are a much more recent development. Soft lenses are immediately comfortable, while rigid lenses require a period of adaptation before full comfort is achieved. The biggest improvements to soft lens polymers have been increasing oxygen permeability, lens wetability, and overall comfort.

In 1998, silicone hydrogels became available. Silicone hydrogels have both the extremely high oxygen permeability of silicone and the comfort and clinical performance of the conventional hydrogels. Because silicone allows more oxygen permeability than water, the oxygen permeability of silicone hydrogels is not tied to the water content of the lens. Lenses have now been developed with so much oxygen permeability that they are approved for overnight wear (extended wear). Lenses approved for daily wear are also available in silicone hydrogel materials.

Disadvantages of silicone hydrogels are that they are slightly stiffer and the lens surface can be hydrophobic and less "wettable." These factors can influence the comfort of the lens. New manufacturing techniques and changes to multipurpose solutions have minimized these effects.

A surface modification processes called plasma coating alters the hydrophobic nature of the lens surface. Another technique incorporates internal rewetting agents to make the lens surface hydrophilic. A third process uses longer backbone polymer chains that results in less cross linking and increased wetting without surface alterations or additive agents.

Hybrid

A small number of hybrid lenses exist. Typically these lenses consist of a rigid center and a soft "skirt". A similar technique is "piggybacking" of a smaller, rigid lens on the surface of a larger, soft lens. These techniques give the vision corrections benefits of a rigid lens and the comfort benefits of a soft lens.

Wear Schedule

A "daily wear" (DW) contact lens is designed to be worn for one day and removed prior to sleeping. An "extended wear" (EW) contact lens is designed for continuous overnight wear, typically for up to 6 consecutive nights. Newer materials, such as silicone hydrogels, allow for even longer wear periods of up to 30 consecutive nights; these longer-wear lenses are often referred to as "continuous wear" (CW). Extended and continuous wear contact lenses can be worn overnight because of their high oxygen permeability. While awake, the eyes are typically open, allowing oxygen from the air to dissolve into the tears and pass through the lens to the cornea. While asleep, oxygen is supplied from the blood vessels in the back of the eyelid. A lens that interferes with the passage of oxygen to the cornea can cause corneal hypoxia which can result in many complications, including a corneal ulcer, which has the potential to permanently decrease vision. Extended and continuous wear contact lenses typically transfer 5–6 times more oxygen than conventional soft lenses, allowing the eye to remain healthy, even when the eyelid is closed.

Wearing lenses designed for daily wear overnight has an increased risk for corneal infections, corneal ulcers, and corneal neovascularization. The most common complication of extended wear lenses is giant papillary conjunctivitis (GPC), sometimes associated with a poorly fitting contact lens.

Replacement Schedule

The various soft contact lenses available are often categorized by their replacement schedule. The shortest replacement schedule is single use (1-day or daily disposable) lenses which are disposed of each night. Shorter replacement cycle lenses are commonly thinner and lighter, due to lower requirements for durability against wear and tear, and may be the most comfortable in their respective class and generation. These may be best for patients with ocular allergies or other conditions because it limits deposits of antigens and protein, and is considered the healthiest wear schedule due to the most frequent replacement. Single use lenses are also useful for people who use contacts infrequently, or for purposes (e.g., swimming or other sporting activities) where losing a lens is likely.

More commonly, contact lenses are prescribed to be disposed of on a two-week or 4-week basis. Quarterly or annual lenses, which used to be very common, have lost favor because a more frequent replacement allows for increased comfort and fewer on-lens deposits. Rigid gas permeable lenses are very durable and may last for several years without the need for replacement. PMMA hard lenses were very durable, and were commonly worn for 5 to 10

years. Interestingly, a careful analysis of the materials used to manufacture many "daily" disposable lenses show that they are often manufactured from the same material as the longer life disposables (4-week replacement for example), from the same company. Although the materials are the same, the manufacturing processes by which the respective contact lenses are made is what differentiates a "daily disposable" lens from a lens recommended for two-week or 4-week replacement.

Contrary to popular belief, replacement schedule is not determined by the Food & Drug Administration (FDA). Replacement schedule is recommended only by the manufacturer of that contact lens. The only FDA-approved measure of contact lens wear is the "wear indication" or "wear schedule" (extended wear or daily wear) as was discussed in the previous section.

Implantation

Some intraocular lenses are known as *implantable contact lenses*. While these implants are used to correct refractive error, because of their surgical implantation in the eye, they are not true contact lenses.

17.3 Manufacturing of Contact Lenses

Typically, soft contact lenses are mass produced while rigid lenses are made-to-order. This is because the size and shape of a rigid lens is made to exact specifications for each and every patient.

- **Spin-cast lenses** – A spin-cast lens is a soft contact lens manufactured by whirling liquid silicone in a revolving mold at high speed.
- **Diamond turning** – A diamond-turned contact lens is cut and polished on a CNC lathe. The lens starts out as a cylindrical disk held in the jaws of the lathe. The lathe is equipped with an industrial-grade diamond as the cutting tool. The CNC lathe may turn at nearly 6000 RPM as the cutter removes the desired amount of material from the inside of the lens. The concave (inner) surface of the lens is then polished with some fine abrasive paste, oil, and a small polyester cotton ball turned at high speeds. In order to hold the delicate lens in reverse manner, wax is used as an adhesive. The convex (outer) surface of the lens is thus cut and polished by the same process. This process can be used to shape rigid lenses, but can also be used to make soft lenses. In the case of soft lenses, the lens is cut from a dehydrated polymer that is rigid until water is reintroduced.

- **Molded** – Molding is used to manufacture some brands of soft contact lenses. Rotating molds are used and the molten material is added and shaped by centrifugal forces. Injection molding and computer control are also used to create nearly perfect lenses. The contact lens is kept moist throughout the entire molding process and is never dried then rehydrated.

Although many companies make contact lenses, in the US there are four major manufacturers

- **Bausch & Lomb**: Makers of Boston rigid lens materials and care system as well as various soft lens brands and the ReNu line of multipurpose solutions.
- **Ciba Vision**: Owned by Novartis; when Novartis purchased Alcon in August 2010, Ciba Vision was absorbed by Alcon, though products continue to carry the Ciba name.
- **CooperVision**: Makers of Biofinity and Proclear brand lenses.
- **Vistakon**: Makers of Acuvue brand lenses, and a subsidiary of Johnson & Johnson

Contact lens prescriptions

The parameters specified in a contact lenses prescription may include:

- Material / Brand name
- Base curve radius (BC, BCR)
- Diameter (D, OAD)
- Power in diopters
- Center thickness (CT)

Prescriptions for contact lenses and glasses may be similar, but are not interchangeable. While every country is different, the prescribing of contact lenses is usually restricted to various combinations of ophthalmologists optometrists and opticians. An eye examination is needed to determine an individual's suitability for contact lenses. This typically includes a refraction to determine the proper power of the lens and an assessment of the health of the anterior segment of the eye. Many eye diseases prohibit contact lens wear, such as active infections, allergies, and dry eye. Keratometry is especially important in the fitting of rigid lenses.

Contact lenses are prescribed by ophthalmologists, optometrists, or specially licensed opticians under the supervision of an eye doctor. Contact lenses can typically be ordered at the office that conducts the eye exam and contact lens fitting.

Complications

List of contact lens complications

Complications due to contact lens wear affect roughly 5% of contact lens wearers each year. Most complications arise when lenses are worn differently than prescribed (improper wear schedule or lens replacement) Sleeping in lenses not designed or approved for extended wear is a common cause of complications. Many people go too long before replacing their lenses, wearing lenses designed for 1, 14, or 30 days of wear for multiple months or years. While this does save on the cost of lenses, it risks permanent damage to the eye and loss of sight. Prolonged use of contact lens (more than 8 hour of use) may cause feeling of pain or redness in the eyes. Due to extra weight of lenses on the cornea a feeling of sleepiness or tiredness in the eyes are observed by contact lens wearers. Sudden blurring of vision is other drawback of contact lenses, blurring lasts for only 1-2 seconds; generally vision is normalized after adjustment of lenses with blinking.

Improper use of contact lenses may affect the eyelid, the conjunctiva, and the various layers of the cornea. Poor lens care can lead to infections by various microorganisms including bacteria, fungi, and *Acanthamoeba*. Long-term (over 5 years) use of contact lenses may "decrease the entire corneal thickness and increase the corneal curvature and surface irregularity." Long-term wear of rigid contact lens is associated with decreased corneal keratocyte density and increased number of epithelial Langerhans cells.[

Usage

Before touching the contact lens or the eye, it is important to thoroughly wash and rinse hands with soap. Soaps that contain moisturizers or potential allergens should be avoided as these can cause irritation of the eye. Next the lens should be cleaned, rinsed, and inspected for defects.

Care should be taken to ensure that soft lenses are not inside-out. The edge of a lens that is inside out will have a different appearance, especially when the lens is slightly folded. Insertion of an inside-out lens for a brief time (less than one minute) should not cause any damage to the eye, but the discomfort will help identify that the lens is not in the proper orientation. Some brands of lenses have markings that make it easier to tell the front of the lens from the back.

The technique for removing or inserting a contact lens varies depending upon whether the lens is soft or rigid. There are many subtle variations to insertion and removal techniques. Because of differences in anatomy, manual dexterity, and visual limitations, every person must find the technique that works best for them. In all cases, the insertion and removal of lenses requires some training and practice on the part of the user.

Insertion

Fig 17.4 Inserting a contact lens

Contact lenses are typically inserted into the eye by placing them on the index finger with the concave side upward and then using the index finger to place the lens on the eye. Rigid lenses should be placed directly on the cornea. Soft lenses may be placed on the conjunctiva (the white part of the eye) and slid into place. The other hand may be used to keep the eye open. Problems may arise if the lens folds, turns inside-out, slides off the finger prematurely, or adheres more tightly to the finger than the surface of the eye. A drop of solution may help the lens adhere to the eye.

When the lens first contacts the eye, it should be comfortable. A brief period of irritation may be caused by a difference in pH and/or salinity between the lens solution and the tears. This discomfort fades quickly as the solution drains away and is replaced by the natural tears. If the irritation persists, the cause could be a dirty, damaged, or inside-out lens.

Removing the lens, cleaning it, and inspecting it again for damage and proper orientation should correct the problem. If discomfort continues, the contact lens should not be worn. In some cases, taking a break from lens wear for a day may correct the problem. If the discomfort is severe, or does not resolve the next day, the person should be seen by an eye doctor to rule out potentially serious complications.

Removal

Rigid contact lenses may be removed by pulling the eyelid tight and then blinking. With one finger on the outer corner of the eyelids, or lateral canthus, the person stretches the eyelids towards the ear. The increased tension of the eyelid margins against the edge of the lens allows the blink to break the capillary action that adheres the lens to the eye. The other hand is typically cupped underneath the eye to catch the lens. This technique can also be used for soft lenses.

A soft lens may be removed by pinching the edge between the thumb and index finger. Moving the lens off the cornea first can improve comfort during removal and reduce the risk of scratching the cornea with a fingernail. It is also possible to push a soft lens far enough to the side or bottom of the eye to get it to fold out of the eye without pinching it. Using these techniques on a rigid lens will likely scratch the cornea.

There are also small tools specifically for removing lenses. Usually made of flexible plastic, these tools can resemble small tweezers, or plungers that suction onto the front of the lens. Typically these tools are only used with rigid lenses.

Care

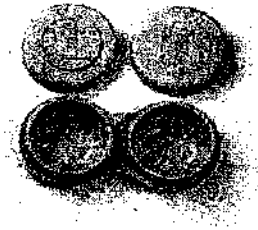


Fig 17.5 Lens case to store contact lens

Lens care varies depending on material and wear schedule. Daily disposable lenses are discarded after a single use and thus require no cleaning. Other lenses require regular cleaning and disinfecting to prevent surface coating and infections.

There many ways to clean and care for contact lenses, typically called care systems or lens solutions:

Multipurpose solutions

Multipurpose solutions are the most common method for rinsing, disinfecting, cleaning, and storing soft lenses. In 2002, concerns were raised that some multipurpose solutions are not effective at disinfecting *Acanthamoeba* from the lens. In May 2007, one brand of

multipurpose solution was recalled due to a cluster of *Acanthamoeba* infections. Newer generations of multipurpose solutions are effective against bacteria, fungi, and acanthamoeba. The latest multipurpose solutions also contain ingredients that improve the surface wetability and comfort of silicone hydrogel lenses.

Saline solution

Sterile saline is used for rinsing the lens after cleaning and preparing it for insertion. Saline solutions do not disinfect, so it must be used in conjunction with some type of disinfection system. One advantage to saline is that it can not cause an allergic response, so it is well suited for individuals with sensitive eyes and/or strong allergies.

Daily cleaner

Used to clean lenses on a daily basis. A few drops of cleaner are applied to the lens while it rests in the palm of the hand, and the lens is rubbed for about 20 seconds with a fingertip (depending on the product) on each side. The lens must then be rinsed. This system is commonly used to care for rigid lenses.

Hydrogen peroxide systems

Hydrogen peroxide can be used to disinfect contact lenses. Care should be taken not to get hydrogen peroxide in the eye because it is very painful and irritating. With "two-step" products, the hydrogen peroxide must be rinsed away with saline before the lenses may be worn. "One-step" systems allow the hydrogen peroxide to react completely, becoming pure water. Thus "one-step" hydogen peroxide systems do not require the lenses to be rinsed prior to insertion, provided the solution has been given enough time to react.

- Enzymatic cleaner – Used for cleaning protein deposits off lenses, usually weekly, if the daily cleaner is not sufficient. Typically, this cleaner is in tablet form.
- Ultraviolet, vibration, or ultrasonic devices – Used to both disinfect and clean contact lenses. The lenses are inserted inside the portable device (running on batteries and/or plug-in) for 2 to 6 minutes during which both the microorganisms and protein build-up are thoroughly cleaned. These devices are not usually available in optic retailers but are in some electro-domestic stores.

Some products must only be used with certain types of contact lenses. Water alone will not adequately disinfect the lens, and can lead to lens contamination and has been known in some cases to cause irreparable harm to the eye.

Contact lens solutions often contain preservatives such as thiomersal, benzalkonium chloride, and benzyl alcohol. In 1989, thiomersal was responsible for about 10% of problems related to contact lenses. As a result, many products no longer contain thiomersal. Preservative-free products usually have shorter shelf lives, but are better suited for individuals with an allergy or sensitivity to one or more preservatives.

Current Research

A large segment of current contact lens research is directed towards the treatment and prevention of conditions resulting from contact lens contamination and colonization by foreign organisms. It is generally accepted by clinicians that the most significant complication of contact lens wear is microbial keratitis and that the most predominant microbial pathogen is *Pseudomonas aeruginosa*. Other organisms are also major causative factors in bacterial keratitis associated with contact lens wear, although their prevalence varies across different locations. These include both the *Staphylococcus* species (*aureus* and *epidermidis*) and the *Streptococcus* species, among others. Microbial keratitis is a serious focal point of current research due to its potentially devastating effect on the eye, including severe vision loss.

One specific research topic of interest is how microbes such as *Pseudomonas aeruginosa* invade the eye and cause infection. Although the pathogenesis of microbial keratitis is not well understood, many different factors have been investigated. One group of researchers showed that corneal hypoxia exacerbated *Pseudomonas* binding to the corneal epithelium, internalization of the microbes, and induction of the inflammatory response. One way to alleviate hypoxia is to increase the amount of oxygen transmitted to the cornea.

Another important area of contact lens research deals with patient compliance. Compliance is a major issue surrounding the use of contact lenses because patient noncompliance often leads to contamination of the lens, storage case, or both. The introduction of multipurpose solutions and daily disposable lenses have helped to alleviate some of the problems observed from inadequate cleaning but new methods of combating microbial contamination are currently being developed.

Short Answer Type Questions

1. Define Contact lens
2. Write Classification of contact lens.
3. What are the materials used in contact lens?

4. Types of contact lens available.
5. Which kind of patients are suitable for contact lens wearing.
6. What is the difference between bandage and cosmetic contact lens?

Long Answer Type Questions

1. Write briefly advantages of contact lens over spectacles.
2. What is the wearing time of different types of contact lenses?
3. What is the difference between conventional, disposable and extended wear type of contact lens?
4. What are the precautions to be followed while wearing contact lens?

UNIT 18

Spectacle Dispensing

- It is very important to select a suitable size of frame for the patient.
- You must always state the patient's pupillary distance (PD) and near centration distance (CD, otherwise called the near PD) on the order. Although this is not normally a problem, in higher powers and bifocals it is essential. The IPD of the patient should match with frame PD otherwise, decentration will induce prismatic effect for the wearer.
- Choice of lens is fairly limited, but you need to know the advantages and disadvantages of bifocals, in order to offer the patient the best possible correction.
- The side length needs to be adjusted to make the glasses fit the patient on collection.
- Order writing MUST be clear. Remember the correct notation.
- Avoid large frames if the prescription is big as the glasses will be heavy and the lenses much thicker.
- If a patient has two pairs of glasses (distance and reading) it is useful to supply different colour frames to help identify what the glasses are for.
- In case of cylindrical correction try to avoid round or oval shaped frames, because lens may rotate internally due to age and become off axis. Idea of square shaped frames is lens get locked inside, impossible to rotate.

- In giving spectacle correction to children, use big diameter frame and tight locking at the ear-ends of the frames (with bands or twirl ends) so that they don't slip from nose and not allowing the child to see from non frame zone.
- In case of children with congenital cataract operated, we need to give bifocal correction. In such case of dispensing frame, give maximum height possible of bifocal segment drop and preferably D-bifocal type recommended.

Short Answer Type Questions

1. What do you mean by IPD?
2. How do you measure frame PD?
3. What is the importance of order writing?
4. In case of cylindrical correction, which frames are to be given?
5. For children, which type of frames will you recommend?

Long Answer Type Questions

1. Write complete step by step procedure of spectacle dispensing?
2. What is the importance of matching IPD of the patient with frame PD?
3. In children having spectacle correction which frames are to be given?

UNIT 19

Aphakia and Pseudophakia

Structure

19.1 Introduction to Aphakia

Definition

Aphakia can be dedfined as the absence of the human crystalline lens from its normal anatomical positon.

Surgical treatment of cataract by removal of the crystalline lens of the eye results in an aphakic eye which has very different optical properties from the normal or phakic eye.

Aphakic Refraction

In particular, after the removal of the crystalline lens which accounts for about two-thirds of the eye's optical power, the patient requires a spectacle lens about +10.00D stronger than has previous spectacle correction. Thus it is very important to establish the exact vertex distance at which an aphakic refraction is done. This can be done with a distometer, a mechanical device which measures the distance between the back surface of the phoroptor lens and the patient's closed eyelid, with the pupillometer, or simply with a PD rule.

If the patient already has a pair of glasses, the whole vertex distance problem can be avoided by doing an over-refraction. Eschewing the phoroptor, perform the refraction through lenses held before the patient's habitual prescription with a pair of trial clips. When the refraction is completed, read the resulting prescription by placing the habitual glasses with trial lenses in the lensometer.

If the patient has completely recovered, the actual refraction goes about like an ordinary refraction. One difference—since the main source of internal astigmatism is gone, the keratometric cylinder should be about the same as the refractive cylinder.

Aphakic Spectacles

Aphakic spectacle corrections require powers of +8.00 to +15.00diopters. Such high powered corrections produce a number of difficulties. Among them

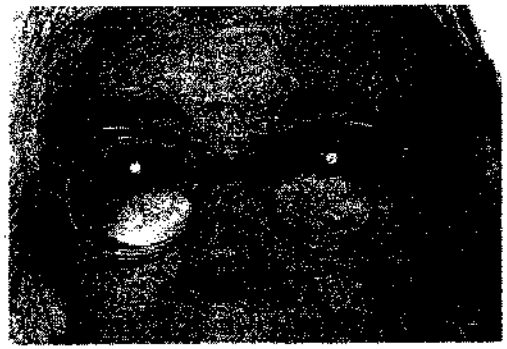


Fig 19.1 Spectacle Correction in Aphakia

- Spectacle magnification of about 35%
- Decreased field of view with ring scotoma
- Aberrations and swimming of objects in field of view
- "Popeye" appearance of patients
- Sensitivity to exact position of the lens
- Lens weight and thickness

The patient can't see objects within the scotoma add the edge of a high powered plus lens. Various design approaches have been taken to cataract lenses, some paralleling the philosophies used in developing corrected curve series, some not. There are two main approaches the "foveal philosopy" and the "peripheral philosophy". Both, as we'll see, make use of aspheric curves, but each with a different reason.

Scotoma

Foveal Philosophy

This philosophy parallels the standard lens design philosophy, namely trying to give the patient the largest possible dynamic field of view. As indicated by Tscherning ellipses, this cannot be done for high plus lenses with spherical curves. Instead aspheric curves are used. In order to cut down on weight, lenticular designs are often employed.

Peripheral Philosophy

This assumes aphakics are head—not eye—turners. It uses front surface curves of diminishing power away from center as in the Welsh Four Drop or Signet Hyperaspheric. These diminish the lens thickness and lower its weight. When these came out they were accompanied by much fitting information and, especially useful, nice looking frames.

Contact Lenses

Optically, contact lenses are the best correction for aphakia since they leave the retinal image almost the same size as before cataract surgery.Image sizes with spectacles and contact lenses turns out to be just the ratio of the powers of the two corrections once vertex effects have been taken into account

7.2 Pseudophakia

True aphakia is increasingly rare nowadays due to the advent of the ocular implant. These small plastic lenses are routinely inserted in the eye to replace the patient's own crystalline lens. A patient wearing an implant is termed a pseudophakic.

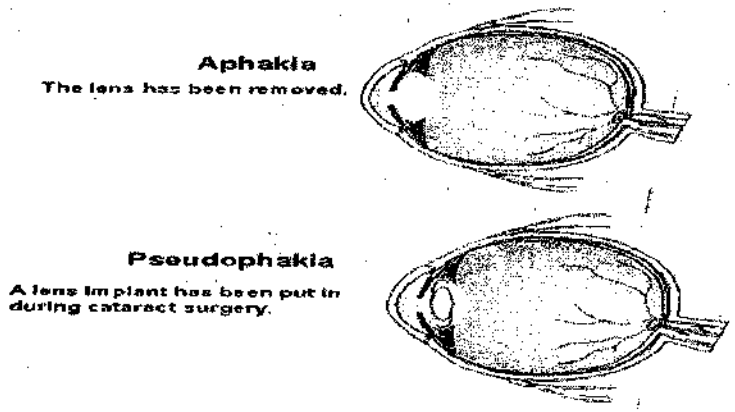


Fig 19.2

Ophthalmologists have experimented with intraocular lens implants (IOL's) for over thirty years, but they have become popular only in the last decade. Initial experiments used "iris clip" lenses which were mechanically attached to the iris and sat in the anterior chamber. Since those earliest efforts virtually every conceivable design has been tried. Now surgeons almost universally employ posterior chamber lenses inserted in the lens capsule after an extracapsular cataract extraction (an extraction which removes the cataractous material while leaving the capsule intact). The commonest lenses are made of polymethylmethacrylate (PMMA) fitted with a couple of "J" loops.

Since the crystalline lens is responsible for most of the UV light absorption in the eye, UV blocking filters are now incorporated in the PMMA prior to lens fabrication.

Typical Posterior chamber Implant

The choice of lens powers prior to surgery is based on keratometry and on the A-scan measurement of the axial length of the eye. These numbers are run through formulas based on schematic eye calculations modified with statistical fudge factors. The most popular of these equations is the 'SRK' formula used in dedicated calculator and computer programs. The latestversion is the SRK II formula which looks something like this: power of implant in eye

= 118.7-2.5[axial length(mm)]-0.9[average keratometer reading (D)].

Usually this formula is programmed into a calculator or microcomputer to prevent calculation errors.

There has been some experimentation with bifocal IOL's. These are based on one or another of the "simultaneous focus" systems used in bifocal soft contact lenses. They can be expected to be about as successful as those contacts.

Pseudophakic Refraction

Refraction of the pseudophakic patient procedes exactly as it does for any other absolute presbyope.

Summary

To summarize this book, which mainly deals with the topics of Elementary basics of light, like properties of light, definitions of terminology, about laser and vision, basic refractive principles, introduction to basic optics along with retinoscopy, practice and simple steps to proceed and to correct ammetropic conditions of the eye. This book also deals with the different ophthalmic optical procedures including correct procedure for making a complete eye wear

according to specifications, Checking of ophthalmic lenses after finishing i.e.. neutralization(all techniques), prescription writing without errors along with correct decimal notation and meanings of Latin terminology used in ophthalmic prescriptions.

To add up to summary analysis the author also introduced basics of contact lens, types, materials, and all ethics needed for contact lens practice not only contact lenses but along with contact lenses, different types of spectacle lenses including glass and resin materials(like CR39, polycarbonate) their refractive indices, abbe value and aberrations are also given in brief. Along with them, different refracting procedures like cycloplegia, refraction routine, Aphakia, psuedophakia its image formations and how to tackle such patients, when to prescribe(i.e.. glass or contact lens) and spectacle dispensing is written.

Short Answer Type Questions

1. Define Aphakia.
2. What is the difference between aphakia and psuedophakia?
3. What are the difficulties faced in aphakic correction?
4. Explain SRK formula in aphakia.
5. Which is the best correction for aphakia?
6. How much near vision correction we give fro aphakic patient and why?

Long Answer Type Questions

1. How do you differenciate aphakia and pauedophakia explain briefly.
2. What do you mean by foveal philosophy and peripheral philosophy?
3. By giving spectacle correction in aphakic patient, what problems will he face?
4. Contact lens or spectacle lens to correct aphakic patient. Explain why?

IVC : Course Code 605

Ophthalmic Technician

Paper - III

Community Ophthalmology and Health Education

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UNIT 1

Examination of the Eye

Parts and Function of Eye

The Eye Ball

The eye ball measuring approximately 2.5 cm in diameter and a normal adult eyeball is almost spherical and its volume is about 7m.

The eye ball is positioned in the bony orbit and is supported in its position by a connective tissue.

The Eye brow

The eye brow marks the upper extent of the upper eyelid and overlies the body orbital rim. The bony rim of the orbit provides protection for the eye from injury.

Eye Lids

The upper and lower eyelids also project and shield the eye.

Conjunctiva

Conjunctiva overlies the sclera and the inner surfaces of the eyelids. A healthy conjunctiva is transparent, but some times, small normal blood vessels may be seen in the conjunctiva.

The Cornea

The cornea is the clear and transparent window at the front of the eye through which iris and pupil are visible. The cornea is transparent tissue that joins the sclera at the limbus. The normal cornea is 10.5 mm to 12 mm in diameter and 1mm in thickness.

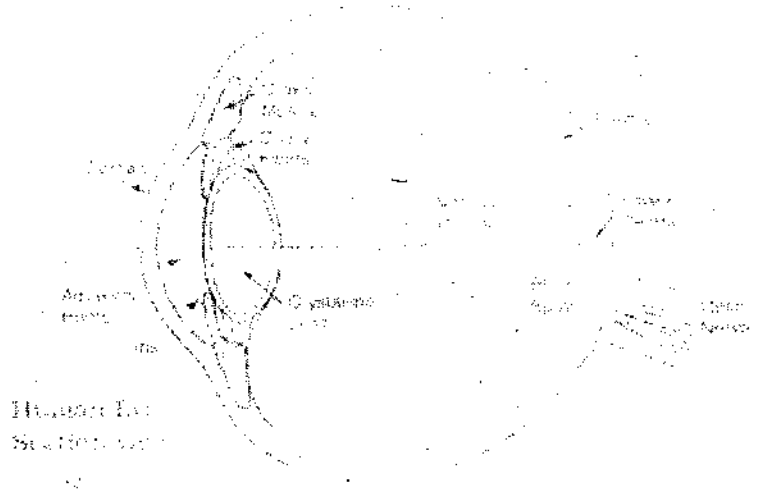

Fig. 1.1 Human Eye Section view

The sclera

The sclera, a tough and strong tissue, gives the white colour to a healthy eye which is also approximately 1mm in thickness. This is the firm white external supporting tissue of the eye ball.

Iris and Pupil

The coloured part of the eye is called the iris. The round opening in the center of the iris is called the pupil. It controls light entering the eye. The color, texture, and the patterns of each person's iris are as unique as a finger print.

Lens

The crystalline lens is located just behind the iris. Its purpose is to focus light onto the retina. The lens is suspended with the help of zonules.

In young people, the lens changes shape to adjust for near and distance vision. This is called accommodation. With age, the lens gradually hardens, diminishing the ability to accommodate.

Vitreous

The vitreous is a thick, transparent gel that fills the eye behind the lens. It is composed mainly of water and comprises about 2/3 of the eye's volume, giving it form and shape.

Retina

The retina is a multi-layered photosensitive layer. It contains millions of photoreceptors that capture light rays and convert them into electrical impulses. These impulses travel along the optic nerve to the brain where they are turned into images. There are two types of photoreceptors in the retina; rods and cones. The cones are concentrated in the macula, the portion of the retina responsible for central vision. They are most densely packed within the fovea, the central portion of the macula. Cones function best in bright light and allow us to appreciate color

Rods are spread throughout the peripheral retina and function best in dim lighting. The rods are responsible for peripheral and night vision.

Macula

The macula is located roughly in the center of the retina, temporal to the optic nerve. It is a small and highly sensitive part of the retina responsible for detailed central vision. The macula allows us to appreciate detail and perform tasks that require central vision such reading.

Optic Nerve

The optic nerve transmits electrical visual signals from the retina to the brain where vision is interpreted, attaches at the posterior sclera.

The optic nerve transmits electrical impulses from the retina to the brain. It connects to the back of the eye near the macula. When examining the back of the eye, a portion of the optic nerve called the optic disc can be seen.

Extra Ocular muscles

The six muscles that surround the eye and control its movement are known as the extra ocular muscles. All six muscles work in unison to move the eye. As one contracts, the opposing muscle relaxes, creating smooth movements.

How the Eye Sees

The eye is a complicated organ composed of many small parts, each is essential to normal vision. The ability to see clearly depends on how well these parts work together.

Light rays bounce back from all objects. If a person is looking at a particular object like a tree, light is reflected off the tree and enters the person's eye through the cornea. The light rays then pass through pupil. The iris controls the amount of light entering the eye by dilating or constricting the pupil. In bright light the pupils shrink to the size of a pin head to prevent too much light from entering. In dim light the pupil enlarges to allow more light to enter the eye.

Then the light reaches the crystalline lends that focuses light rays onto the retina by bending them. The cornea does most of the refraction and the crystalline lens fine-tunes the focus. In a healthy eye the lens can change its shape to provide clear vision at various distances.

Light rays pass through the vitreous before reaching the retina. The retina lines two thirds of the back portion of the eye and is responsible for the wide field of vision that most people have. For clear vision, light rays must focus directly on to the retina. When light focuses in front of, or behind, the retina the result is blurry vision.

The retina contains millions of specialized photoreceptor cells called rods and cones that convert light rays into electrical signals that are transmitted to the brain through the optic nerve. Rods and cones enable us to see in dim light and to see color, respectively. Most of the cone cells are located in the macula situated in the center of the retina. The fovea, a small depression in the center of the macula, has the highest concentration of cone cells. The macula is responsible for central vision, seeing color and distinguishing fine detail.

The optic nerve located behind the retina transmits signals from the photoreceptor cells to the brain. Each eye transmits signals of a slightly different image and the images are inverted. Once they reach the brain, they are corrected and combined into one image. This complex process of analyzing data transmitted through the optic nerve is called visual processing.

Eye Movement

Eye movement is stabilized by six extraocular muscles that are attached to each eye ball for performing horizontal, vertical and rotational movements. These muscles are controlled by impulses from the cranial nerves that tell the muscles to contract or relax. When certain muscles contract and others relax, the eye moves.

Practical demonstration of eye problems and their management

1. Refractive Errors

The most common eye disorders are refractive errors, which mean that the image of the object a person is looking at is not focused properly onto the retina. For perfectly clear vision, the image of a viewed object need to be focused onto the retina, just as a camera has to be focused properly in order to take a clear picture.

If the image is not focused exactly on the retina, then the image will be blurred, just like an out-of-focus photograph. In this case, the person is said to have a refractive error.

Refractive errors occur when there is a mismatch between the length of the eye, and its optical power. These mismatches usually originate during childhood, when the eyes are growing. The exact causes of refractive errors are still being studied, but it is known that both hereditary and enrivonmental influences can affect their development.

Refractive errors can usually be corrected using spectacles or contact lenses. There are also surgical techniques, which can be used to correct refractive erros.

There are three main types of refractive errors among children.

a. Myopia (short sightedness)

b. Hyperopia (Long sightedness)

c. Astigmatism

a. Myopia

Myopia is a very common condition. Usually myopia begins to develop in teenage years and it may get worse over the following few years.

Myopia is called as shortsightedness. Short sighted persons do not see distant objects clearly. The eye's lens and cornea normally focus light into an image on the retina. In a myopic eye the light is focused in front of the retina and so the image is blurred.

Signs and Symptoms of myopia

Shortsighted persons have difficulty in seeing distant objects clearly. They find it hard to read blackboard, road signs, and place and number details of a public bus and play games. Recognizing people in the distance may be a problem

for many shortsighted people. Often a person will not realize that they cannot see clearly.

Causes and conditions of myopia

No one knows for sure. People think that excessive amounts of reading, poor metabolism, poor diet, poor light, poor posture and genetic reasons are responsible.

- Screwing / squeezing up eyes to see distant objects.
- Difficulty reading the black board at school
- Poor posture while reading
- Lack of interest in playing out door games.

Diagnosis and correction of myopia

A complete eye test done by a qualified ophthalmic person is the only sure way of determining whether the child's vision is normal.

Properly prescribed spectacles or contact lenses will enable the child to see clearly. Laser surgery to reshape the front surface of the eye can also help some person with myopia. In some cases spectacles may stop or slow its progression.

b. Hyperopia

The eye's lens and cornea focus light into an image on the retina, just as a camera lens focuses light on to a film. In a hyperopic (longsighted) eye, the light is focused behind the retina and so the image is blurred.

Signs and Symptoms of Hyperopia

A significant amount of hyperopia, the effort of focusing can lead to symptoms. A hyperopic person finds harder to focus on near objects. Vision may become blurry, especially for close objects, because the closer the object the more focusing is required. Hyperopic persons may get tired eyes or headaches after a lot of visual work, even if their visions is clear. Reading is more difficult and work can be affected.

Causes and Conditions of hyperopia

- Vision is more likely to be blurred, especially for close objects.
- It is difficult for performing close work and reading.
- Often hyperopes will have eye problems because focusing requires much effort.

- Hyperopia is often through to be hereditary, but no one is certain.
- The eye ball may be a little smaller than average
- Hyperopia will not change with age.
- It tends to increase, but not always
- We all find it harder to focus on close objects as we get older.
- Hyperopes have trouble sooner and may need reading spectacles earlier because they have to focus more to start with.

Diagnosis and correction of hyperopia

Because a hyperopic person often can see well in the distance, a letter chart test alone may miss hyperopia. Special tests have to be done by an qualified ophthalmic person, including near vision visual acuity chart test, retinoscopy and refraction and provision of correct spectacles.

c. Astigmatism

Signs and symptoms of astigmatism

Astigmatisms may cause eyestrain and may be combined with near sightedness or farsightedness.

Cause and conditions of astigmatism

Astigmatism can start in child hood or in adulthood. Some symptoms include headache, eyestrain, and / or fatigue. Eye rubbing, lack of interest in school and difficulty in reading are often seen in children with astigmatism.

Diagnosis and correction of astigmatism

Astigmatism correction with help of spectacles or contact lenses makes all the rays of light focus at the same distance so that they all fall correctly on the retina. This diagnosis and spectacle prescription has to be done by a qualified ophthalmic person.

2. The Red Eye

A red eye is a common condition, which may be due to allergy, infection, and other internal eye conditions. The associated symptoms include pain, watering, itching, irritation and discharge. The symptoms may be bilateral or unilateral and visual acuity may or may not be affected.

Causes

Dust, exposure to flame or steam, chemical fumes, sweat entering eye, inflammation to eye, infection caused by bacteria or virus, exposure to sun light, pollution and etc.

Treatment

Do not allow children with red eyes to mingle and play with other children.

To wash eye frequently with clean cold water

Avoiding rubbing the eyes.

Refer to an eye doctor if there is discharge, watering and burning sensation persists and affects vision.

3. Foreign body

Causes

Burning particles flying from firewood or crackers, insect stings or bites, dust particles, and etc.

Signs and Symptoms

Foreign body visible on conjunctiva or on cornea, redness and watering

Treatment

Do not allow children to rub eyes

Tie the hands at the back if they do not obey

Remove the foreign object with a clean moist narrow swab or twisted corner of a handkerchief in bright light.

If the foreign body is not visible, take some clean water in the hand and blink briskly in it.

If still unsuccessful, pull the upper lid forward, push the lower lid upwards and let go of both the lids. The lashes of the lower lid can often dislodge the foreign body.

If the foreign body is embedded in the cornea, apply a soft pad, shild the eye and take the patient to a hospital immediately.

4. Trauma

Eye trauma is a major cause of blindness in the eye. In most trauma cases people go blind due to lack of sufficient medical facilities or trained personnel.

Eye injuries must be considered as emergencies and treated promptly. Immediate first aid and referral is essential for restoration of sight.

Causes

Household injuries, speck in the eye, burning particles flying form firewood or crackers, exposure to flame or steam, insect stings or bites, flame or steam, facial lacerations, chemical burns, accidents, broken glass from vehicles, injuries due to fall, penetration by sharp or blunt objects, harmful eye practices, self medication, traditional eye medication, extracts from leaves or herbs/human urine / animal products that cause permanent damage to the ocular surface and cause visual impairment and blindness.

Signs and Symptoms

Redness, watering, bleeding, visible particles on eye, blood clotting, wound on the eye and loss of vision may be the signs and symptoms.

Treatment

Immediate first aid is essential. For chemical injuries, thoroughly wash the face, eye lids and the eye for at least five minutes as soon as possible. Pour more water into the eye's inner corner. Make sure that the chemical does not run into the other eye. Cover the eye with a dry, clean protective dressing shield.

For bleeding conditions caution the patient against rubbing eye and get medical help immediately. Apply a soft pad, shield the eye and take the patient to a hospital immediately.

Prevention for other ocular injuries

Caution children about the dangers of self-medication and traditional practices discourage children from playing with sharp objects, bows and arrows and gilli-danda.

5. Squint

A squint is not a sign of good luck and must be treated as early as possible.

Causes and Conditions

Causes may be due to congenital and weakening of one or more eye muscles. Eyes will be focusing in different directions. Hence there will be a problem in perceiving binocular vision. Too many persons this condition would cause amblyopia.

Ambloypia is an eye problem that causes poor vision in children. It occurs when the pathways of vision in the brain does not grow strong enough.

Amblyopia is also known as a lazy eye. A person affected by amblyopia has reduced vision. Since the child has probably not used the amblyopic eye from early childhood, the condition cannot be treated with spectacles.

Signs and Symptoms

The symptoms include the eye turning in, out or up; the patient closing one eye particularly in bright sung light; squint; and headaches or eyestrain. The two eyes are pointed in different directions, one eye may point straight ahead while the other turns inward, outward, upward or downward.

Treatment

Treatment for a squint should be given as early as possible; the patient may required glasses or surgery. An eye doctor should be consulted as soon as squint is noticed. If treatment is delayed till after the age of eight, the child will see only with one eye even after the squint is corrected.

This is because the eyes develop and learn to work together till the child is eight. In the case of a squint only one eye works. After the age of eight the brain will not process the information from the poor eye and even if the squint is corrected only a cosmetic result can be achieved.

Prevention of Squint

Treat all eye defects in children as early as possible. Convergence exercises will help in coordinated eye movements.

Eye Ailments

Stye

Stye is a small abscess in the eyelid margin. A warm cmpress cures this .

Chalazion

Chalazion is a blocked eye lid tear or fat gland. It appears as pea-sized lump of the eye lid surface. It needs to be surgically removed.

Blepharitis

The eye lid margins are the area most often affected by blepharitis. Blepharitis is a chronic inflammation of the eye lids and eye lash hair follicles, affecting both children and adults. It causes swelling, itching, and irritation of the eye lids.

Symptoms and Blepharitis

- Blepharitis is characterized by redness of the eyelids; scaling and flacking around the eye lashes are also common.
- Hard crusts form around the eye lases, which makes it difficult to open the eyes in the morning. Removal of the crusts often leaves small ulcers that bleed or ooze.

Treatment

Treatment focuses on maintaining very clean eye lid margins – the eye lids must be kept immaculately clean. Careful hygiene of the eye lid can help control this disease.

6. Blindness due to Vitamin A deficiency

Vitamin A is essential for normal vision and variety of bodily functions. Considerable amounts of vitamin A can be stored in the liver and made available for use as the need arises.

For children, lack of vitamin A causes severe visual impairment and blindness and significantly increases the risk of severe illness and even death, from such common childhood infections as diarrhoeal disease and measles.

Deficiency of Vitamin A deficiency is one of the most serious nutritional deficiency diseases in the world today. It is one of the most prevalent deficiencies in India and is seen among children.

- Between 100 and 140 million children is vitamin A deficient.
- A estimated 2,50000 to 5,00,000 vitamin A deficient children become blind every year, half of them dying within 12 months of losing their sight.
- Nearly 6,00,000 women die from child birth-related causes each year, the vast majority of them from complications which could be reduced through better nutrition, including provision of vitamin A.

Causes of Deficiency

Inadequate intake of vitamin A, and protein energy malnutrition can cause vitamin A deficiency.

Signs and Symptoms

One of the earliest symptoms of vitamin A deficiency is night blindness and more severe deficiencies include ocular changes leading to blindness, particularly in young children.

Night blindness is the most recognizable manifestation of vitamin A deficiency. The first symptom of Xerophthalmia is a child cannot see to get around after dark or in a dark room.

Bitot's Spots

Bitot's spots are accumulation of foamy, cheesy material on the white part of the eye, often in association with night blindness. Bitot's spots differ in size, location and shape but they have a similar appearance.

Corneal Xerosis / Ulceration

The cornea becomes dry. If the disease is not treated, the xerosis can progress within hours to an ulcer of the cornea.

Keratomalacia

- The final stage is keratomalacia, which is softening of the cornea. Keratomalacia destroys the cornea, which results in permanent blindness which is incurable.
- The presence of keratomalacia indicates a poor prognosis of health and life.

Corneal Scar

- A dry corneal epithelium is sensitive to infection by bacteria. A corneal ulcer due to infection of bacteria / virus will likely result in scarring of the cornea.
- Visual acuity may be considerably affected.
- The eye can shrink and become atrophic (phthisis bulbi)
- Keratomalacia can lead to perforation of the cornea and corneal ulcer. If treated earlier the corneal scar will remain small and does not cause significant loss.

Measles

- Visual disability and blindness from measles occurs due to vitamin malnutrition.
- Children who suffer from diarrhea, acute respiratory infections and measles should be monitored carefully and given usual preventive dose of Vitamin A.

Prevention of blindness due to Vitamin A deficiency

- Early identification, accurate diagnosis, and proper management, along with comprehensive vaccination programs will reduce blindness due to vitamin A deficiency.
- Corneal scars and blindness can be prevented if identified and treated early.
- Vaccination programs would controlled measles.
- Pre school children are to be encouraged to include dairy products, curd, butter, liver, eggs, oil and fat in the daily diet who are liable to develop vitamin A deficiency.
- Promotion of dietary intake of vitamin A rich foods, which are cheap and locally available.
- Regular consumption of vitamin A rich foods such as dark green leafy vegetables, yellow vegetables and fruits must be added in the regular diet to prevent deficiency due to lack of vitamin A.
- Nutrition education, cultivating a home garden with crops which will ensure adequate availability of vitamin a rich vegetables and fruits.

Summary

This unit briefly describes the importance of eye and vision. Eye as a refractive element, which is safely protected in the cone shaped bony cavity and comprising of eye lids, which in turn moisture the outermost surface of eye ball by blinking mechanism. The uniform tear film maintains the corneal metabolism, which does not have blood supply, but rich unmyelinated nerve supply.

The tear film, cornea, aqueous humor, human crystalline lens, and vitreous humor not only maintains their transparency but acts as refracting elements and helps the images focus on the outer most retinal nerve fiber layer, which in turn by photoresponse functions which leads to photochemistry , converts images to electrical impulses and transmits to brain, by which we recognize and see.

Short Answer Type Questions

1. What is human eye?
2. Draw neat labeled diagram of human eye.
3. What are common eye problems?
4. Write about refractive errors.

5. What are the common causes for red eyes?

6. Define squint.

Long Answer Type Questions

1. Explain all parts of human eye.

2. How does the eye see and eye movements.

3. What are the common eye problems and their causes?

4. Blindness caused due to vitamin A deficiency.

UNIT 2

Community Ophthalmology

Introduction

Children are the most precious resources of families and they represent the families future and their hopes. A blind child is a tragedy for these families and their society. 75 to 89 percent of the children population is out of reach of an ophthalmologist and also accessibility to eye facility is difficult and most of the parents are ignorant of children's visual performance and many do not help children in studies.

Aim of School Screening

The aim of school screening is to detect ocular ailments including significant refractive errors for providing appropriate treatment in the form of spectacle correction, medical treatment, surgery and therapy.

Purpose of Screening at schools

Children are the needy and big target group requiring identification and treatment of refractive errors and other eye ailments.

Children are the 'Captive' group and can be reached through the organized educational system and reading and writing are their felt needs.

Children carry the message on the need for testing and retaining good eye sight back home to their parents, siblings, and friends, who do not attend the schools'.

Teachers see their eyes, daily – observe the behavior of their students – detect vision defects – facilitate appropriate services. School teachers can insist on the children who are provided with spectacles, to use them regularly while reading, writing or working.

Characteristics of Children with visual impairment

Children usually do not complain of defective vision because they may not even be aware of their visual problem.

They adjust to the poor eye sight by sitting nearer to the blackboard, holding the books closer to their eyes, squeezing the eyes and even avoiding work requiring visual concentration and many a times they try to copy from the child sitting beside.

Due to the poor visual condition a child may become a slow student and hesitate to participate / involve in the group circular and extra curricular activities.

Reading is affected the most by poor vision skills: Students often have no accurate left to right eye movement, a skill necessary for reading books.

Words and even lines are skipped, words are misread, and students do not understand what they read. Because all schools subjects depend heavily on reading, a student is in jeopardy even though he may be normal intelligence.

Social Problems

Behavior difficulties arise due to of reading and writing problems. Teachers and parents often look for a psychological reason for poor work production and poor behavior, while the cause may be near vision skills.

Typical behaviours of students with poor vision skills

Distractibility : Avoidance of reading or writing, indications of frustration, excessive blinking and eye strain when working at close range, or 'near point'.

Disruptive behavior in class, aggressive behavior in groups, good attention to auditory learning, distrust of adults who scold them to work harder for succeed and poor social skills.

A few children cannot learn to read quickly and easily due to their vision problems and they fail to remember letter forms. They have trouble with spatial concepts on paper due to poor visual attention.

Magnitude of childhood blindness and its causes.

Childhood blindness is the second largest cause of blind-person years. Approximately seven crores (70) million blind person years are caused by

childhood blindness globally. There are about fourteen lakhs blind children worldwide. Approximately 5,00000 children become blind every year – approximately one every minute and about half of them die within one or two years of becoming blind. Recent research on the economic cost of blindness indicates that blindness costs the community billions of dollars in lost productivity, caring for blind people rehabilitation and special education. Approximately one third of this cost is incurred by blindness in children. Children of school age children i.e. 6 to 14 are more than 25 percent of our India's population and there are about 4,50,00,000 children are school drop outs.

Prevalence and incidence of visual impairment in children

The prevalence of blindness ranges from 0.3/1000 to 1.5/1000.

The prevalence is approximately

- 0.4/1000 children in high –income regions.
- 0.7/1000 children in middle-income regions and
- 0.9/1000 children in low-income regions

Incidence of blindness

There are few data on the incidence of blindness in children. Register of the blind in Nordic countries suggest an incidence of 6-11-100 000 children / year.

The causes of childhood blindness and strategy for prevention

- Malnutrition – Vitamin A deficiency
- Illiteracy, superstitions, ignorance and lack of awareness regarding eye health and care among parents.
- Recklessness towards immunization
- Consanguinity
- Harmful traditional eye health and treatment practices
- Untreated ocular ailments of the children
- Injuries : eye / head
- Fear of punishments and more

Overall approximately 40% of blindness in children is avoidable. Thereupon, the 'Vision 2020 : The Right to Sight" Global program for the Elimination of Avoidable blindness suggests the main priorities for action by :

- Elimination of vitamin A deficiency
- Treatment of congenital cataract, glaucoma, retinopathy of prematurity
- Serious refractive errors

This will be achieved through

Promotion of : Primary health care (PHC)

Developing specialist children eye services, including surgery and low vision clinics

School screening

Definition

UNICEF defines a child as an individual aged less than 16 years.

In India, the broad definition of visual impairment as adopted in the Persons with Disabilities (Equal opportunities, Protection of Rights and Full participation) Act, 1995 as well as under the national programme for Control of Blindness (NPCB) is :

Blindness

Refers to a condition where a person suffers from any of the following conditions, namely,

1. Total absence of sight, or

2. Visual acuity not exceeding 6/60 or 2/200 (snellen) in the better eye even with correction lenses; or limitation of the field of vision subtending an angle of 20 degree or worse.

Low Vision

"Low vision are those who suffer visual acuity between 2-/200 to 70/200 (Snellen) or 6/18 to 6/60 in the better eye after the best possible correction or a field of vision between 20 to 30 degrees".

The WHO working definition of Low Vision (WHO, 1992) :

"A person with low vision is one who has impairment of visual functioning even after treatment, and / or standard refractive correction and has a visual acuity of less than 6/18 to light perception or a visual field of less than 10 degrees from the point of fixation, but who uses, or is potentially able to use, vision for the planning and / or execution of a task".

For a person with low vision, there is significantly reduced vision, visual performance is affected but that there still is vision that can be used. If there is usable vision, training to use that vision might be possible. In addition, this person is not labeled blind.

Role of School Teacher

- Teachers play a critical role in the detection of symptoms of vision problems among children.
- Teachers are in the unique position where you observe the close and distance work of your students regularly.
- Teachers are very perceptive in recognizing behavioural and physical changes in students and we understand that teachers are concerned for the overall welfare of the students in your care.

What the teachers have to do

Teachers have to identify children suffering with refractive errors and other easily identifiable eye ailments and refer them for appropriate treatment and also create awareness in the aspects of eye health and care.

For identifying children with poor vision teachers should conduct a Visual acuity

Vision Screening Method

Purpose : Vision screening helps to find out if the child has normal vision or needs further eye check up.

Place

Place for vision screening should have adequate space, proper light (preferably outdoor-natural sun light)

Steps :

- Measure 20 feet distance
- Mark standing points

Good Eye Health Practices and First Aid

- Discourage children from playing hide and seek to prevent transmission of diseases by touching one another's eyes.
- Discourage children from playing with sharp edged objects such as gulli-danda and rough games.

- Do not punish or threaten children those suffered eye injury while playing or accidentally.
- Advice children to burn crackers under elders supervision

Good Reading habits

- Hold the printed page about a foot and half away from the eyes and tilted at an angle of 45 to 70 degrees.
- Do not read in moving trains and buses, while lying down or in flickering / dim light.
- Do not read fine print under insufficient light.
- Rest your eyes frequently when reading or doing concentrated eye work by either closing the eyes or looking at a distant object for a minute.

Basic First Aid

- Eye emergencies include cuts, scratches, objects in the eye, burns, chemical exposure, and injuries with blunt objects. Since the eye is easily damaged any of these conditions can lead to vision loss if left untreated.

- In case of corneal trauma due to injury with sharp objects – such as blade of grass, the corner or edge of a paper, a pencil, a knife or other injuries due to burns, hot water, oil, vapour, hot ashes, firecrackers, caustic soda, lime, acid or any other chemicals, wash the affected eye with clean, cold water thoroughly. It is important to get medical attention for all significant eye injuries and problems

- Many eye problems that are not due to injury still need urgent medical attention.

- A chemical injury to the eye can occur due to a work related accident or by common household products, such as cleaning solutions, garden chemicals, solvents, etc.

- Furness can also cause chemical burns. In the cause of acidic burns, the hazing of the cornea often clears and there is a good chance of recovery. However alkaline substances – such as lime, commercial drain cleaners and sodium hydroxide found in refrigeration equipment can cause permanent damage to the cornea.

- At times, ongoing damage may continue to occur if there is no prompt treatment. Dust, sand and other debris can enter the eye any time. Do not rub

the eyes when any small particles like charcoal, wood, sand etc fall in the eye. Open the eyes wide and wash with lots of clean, cold water.

- Continuous pain and redness indicate that professional attention and treatment is required. A foreign body may threaten your vision if the object is likely to damage the cornea or lens.

- Foreign bodies propelled at high speed by machining, grinding, or hammering metal on metal present the highest risk.

- Bleeding inside the eye can reduce vision, lead to glaucoma, or damage the cornea.

Take preventive Steps

- Protect the eyes while performing all hazardous and sporting activities at home, while travelling and on the job.
- Stock a first aid kit at your house and workplace.
- Do not assume that any eye injury is harmless. If in doubt, see a doctor immediately.

Summary

Screening of school children plays a vital role for a good academic progress of the child and avoids vision disturbance caused by poor vision while seeing the black board. Periodic vision screening at regular time intervals shows the vision progress in case of amblyopia and keeps check on the nutritional disorders effecting eyes, any kinds of squints and various eye problems caused in childhood. So regular vision screening of school children must be followed by each and every institute by government qualified optometrists

Short Answer Type Questions

1. What is the purpose of school screening?
2. What are the objectives to be followed in screening school children?
3. What are the characteristics of children with visual impairment?
4. What are the social problems of screening at schools?
5. What are the causes for childhood blindness?
6. What are good eye health habits?
7. What is the role of teachers in screening and survey of school children?

Long Answer Type Questions

1. How to conduct camps at schools?
2. What is the importance of screening and survey of school children?
3. What is the role of optometrists and teachers in conducting school camps?
4. Which vision charts are used in screening of children for distance and near? Explain with diagram?

UNIT 3

Industrial Eye Screening

The importance of providing a safe and comfortable work environment is very important for industrial employees, to enable them to perform with good vision. You would be surprised to know that there are many people in the companies who have never had their eyes tested. Not only may their visual performance be compromised but they could be putting themselves and others at risk of injury.

Blurred vision is a major hazard in the workplace as workers with blurred vision are often unaware of their problem. If employees are sending or receiving wrong orders, having accidents with company vehicles, refusing to do certain job tasks, having headaches or feeling fatigue, Then Poor eyesight can be the major cause for these problems with otherwise excellent workers. An optometrist/ ophthalmologist can identify these problems with a simple vision screen, which is the most cost effective way.

AN eye examination after 40 years of age is a must, more so for people who work in an industrial setting. Eye problems affect not only the individual but also industry as a whole in terms of loss of man-hours and affecting quality control, resulting in a loss of the credibility for the company. Thus an honest effort may be made by the company to help its employees and provide spectacles, surgery for cataract laser therapy for diabetes and glaucoma.

The major aim of any occupational vision screening is to detect visual ability that is below the standard expected to produce a safe, effective and efficient level of productivity.

People are screened for distance and near vision, phorias, redness, dry eye, health of the eye, colour vision and people currently wearing glasses are screened to ensure their existing prescription is correct. People with visual impairment will be identified and recommendations made on corrective glasses and/or related eye exercises.

Improvements have been recorded in the productivity of people at electronic plants and industries after visual screening assessment and the supply of prescription eyewear for use at the workplace.

The major benefits of an Industrial Vision Screening and Prescription Safety Eyewear can include:

- Drastic reduction of injuries to workers
- Improved productivity
- Active participation of employees
- Reduced eye complaints e.g. giddiness and headaches.

Industrial eye screening not only includes an eye check up but also Information, Education and Communication.

The three components of an eye care programme include screening vision, determining vision requirement and choosing appropriate protective and corrective eye wear.

In industrial eye screening programmes, a comprehensive eye examination is undertaken to detect problems and suitable remedies are suggested. Eye diseases that are common in the industrial work force are cataract, glaucoma, diabetic (eye disease) retinopathy, and dry eye because of working before a computer for long hours.

It also includes review of patients with these specific problems.

Procedure for screening

The work force is divided into batches and the screening is done for a week or a couple of days depending on the strength of workers, probably in Industry working hours. An introductory lecture is given by the optometrist/ ophthalmologist with a slide show, with important topics to make the talk more interesting and informative.

The ophthalmologist is assisted by optometric and ophthalmic optician staff to check visual acuity, power and colour vision to enable a faster screening process. The doctor does a comprehensive eye examination, which includes slit

lamp examination, Applanation Tonometry (to check eye pressure), cover-uncover test (to check the presence of squint) and an undilated *fundus* examination. The doctor diagnoses presence of lid infections, dry eyes, cataract, glaucoma, squint and diabetic eye disease. The whole examination takes about five minutes.

Fig 3.1 Preliminary Test

Fig 3.2 Visual Acuity Check up

Fig. 3.3 Mydriatics (For dilated pupil test)

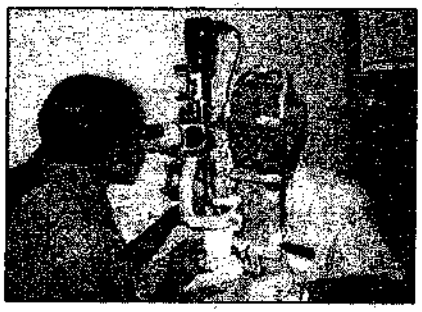

Fig 3.4 Slit-lamp Examination

In case the pupils are small or where there is a manifestation of cataract, a dilated pupil examination can be done. In case the patient needs surgery, he is referred to the base hospital. Topical eye medications are also prescribed for eye infections and dry eye.

The need for regular follow up in patients with glaucoma and diabetic eye disease is stressed. The patient is told of the importance of using topical eye medications for eye pressure without fail and the resulting loss it could cause to the visual field. Regarding diabetic eye disease, the importance of maintaining

stable blood sugar levels and the parallels between diabetic eye disease and renal function is made known.

Occupational hazards to the eye include

Injury to the eye by active moving parts

Thermal injuries

Chemical injuries - fumes / vapour - liquids

Protective goggles are necessary in an industrial environment, and may be corrective or non-corrective. Corrective ones concern the refractive error of the patient.

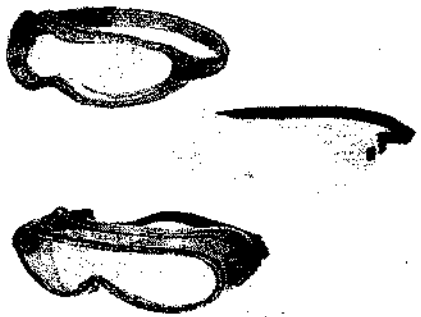

Fig. 3.5 Protective glasses
(Used in chemical Industries)

Fig 3.6 Whole face mask
(To save from sudden flying objects)

Fig 3.7 : Protective glasses for grinding and lathe machine operators

The visual skills of the worker should always meet the visual requirements of his job. The need to wear protective goggles when using moving parts is stressed. If there is a superficial foreign body inside the eye as a result of a glass/ iron bit getting lodged in the eye, it needs to be removed as soon as possible. The need for immediate first aid in case of exposure to an alkali or acid or any other chemicals is made known to the work force. This includes flushing the eye with clean water for about 10-15 minutes and immediate referral to an eye specialist.

Brochures should be provided in English and the local language that highlights common eye disease and the need to be aware of a regular annual eye check up.

Summary

This unit includes the importance of good Eye sight at work place and also Periodic eye and vision examinations are an important part of preventive health care. Many eye and vision problems have no obvious signs or symptoms. As a result, individuals are often unaware that problems exist. Early diagnosis and treatment of eye and vision problems are important for maintaining good vision and eye health, and improving good production in Industries and, preventing vision loss.

Industrial eye screening may include evaluation of specific aspects of visual function and eye health such as depth perception, color vision, eye muscle movements, peripheral or side vision, and the way pupils respond to light.

A comprehensive adult eye and vision examination may include, but is not limited to, the following tests. Individual patient signs and symptoms, along with the professional judgment of the doctor, may significantly influence the testing done. Make sure that they have proper lighting when doing Industrial work and also while reading or working with computers .Don't strain your eyes too much. If you work on the computer all day every day, or spend long hours reading, for work, a certain degree of eye strain comes with the territory. Make sure to take breaks where you're looking away from the computer for a few minutes, and maybe optometrists should teach and advise them to follow ,eye exercises during these breaks.

Short Answer Type Questions

1. What is the importance of conducting eye camps for industrial workers?
2. What is the role of management while conducting eye camps at industries?
3. What are the disadvantages for industry if workers have poor vision?

4. What are the proper eye health practices at industries?

5. Commonly used safety eye wear at industries.

6. Prevalence and incidence of eye problems at industries.

Long Answer Type Questions

1. How do you conduct eye screening at industries.

2. What is the role of optometrists and staff while screening at industries?

3. What is the procedure for eye screening at industries?

4. How do you do visual acuity check up at camps.

UNIT 4

Industrial Hazards

An 'Industrial eye-accident' can be broadly stated as an unexpected event in an industrial process resulting in injury to the eyes of the employee and resulting in partial or total im-pairment of vision temporarily or permanently.

No other organ in the body is of greater importance than the eye, so tender and delicate.

Perhaps this is the reason why Mother Nature has given the eyes a special protection which no other limb enjoys. The hands or the legs, for example, by themselves, have no protection and they are exposed to the effects of an accident easily. But the eye-lids act fast and protect the eyes from direct impact.

Accidents, giving rise to injury to the eyes of operatives are frequent in mining operations and in grinding metals, stone-dress-ing and in some wood-working ope-rations. Welding and Casting hot metal are amongst the commonest Engineering operations in which acci-dents to eyes happen.

Types of injuries to eyes, resultant of accidents, vary from burns to small particles of molten metal actually getting into the eye or dust or foreign body entering the eyes while clean-ing with pressurised air as for exam-ple in Automobile industry.

If we analyse eye-accidents, we come to know that the causes there-of can be traced to one of the fol-lowing.

a. Heavy impact of large parti-cles chipping off from the process (splinters)

b. Moderate impact - dust and small flying objects (as in scaling or grinding of metals and stone-dress-ing processes), test - drivers of motor cycles and scooters and flour and condiment mill workers, are also affected if they avoid wearing safety spectacles,

c. Metal sparks and spatter (elec-tric, spot and butt welding pro-cesses).

d. Splashing metal (Metal-casting operations).

e. Splashing of liquids (Acids and caustics in chemical industries).

f. Effect of certain rays.

Those who work in Television and allied professions, sometimes get this. An instance can be cited. A senior Special Officer of the All India Radio, Delhi, whose work involved intimate access to his eyes to Television, al-most lost his eyesight totally for some months. He luckily regained normal vision with considerable difficulty after prolonged treatment.

Again, exposure of eyes to un-shielded welding arc causes acute irritation in the eyes and injury known as the 'arc-eye' results. This is due to the rays of the arc tempora-rily damaging the very delicate cor-neal epithelium.

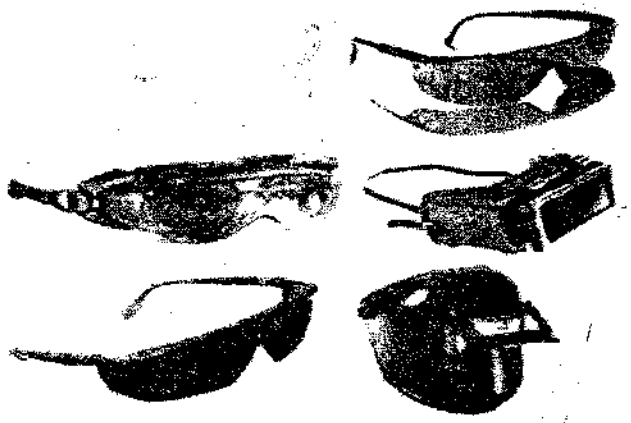

Fig 4.1 Safety Eye Masks and welders shield

g. Reflected light and glare from furnaces or from acetylene welding process).

h. Fumes and poisonous gas from certain processes cause acute irrita-tion and damage to eyes.

i. Proof readers and examiners, packers in carton-making industry, because of constant strain to their eyes that is involved in the nature of their work, develop "weak eyes" and are easily susceptible to fatigue.

In the case of an eye-accident, the extent of damage is greater than in any other accident. Because of the delicate and intricate nature of the eye, even a slight impact might im-pair vision. So, the need for emphasizing the preventive efforts in this regard is keenly felt.

Protection against eye-accidents can be obtained through the various protective gadgets like cup-goggles, side shield, spectacles, plastic eye-shield, plastic face-shield, wire-screen shield, filter lenses, welding helmets and the like.

It is not enough to just mention the need for protective equipment. Lack of appreciation of protective gadgets, on the part of the workers should be tackled.

The Supervisors must explain the purpose and the function of the pro-tective equipment. A demonstration of the impact strength of Safety glasses, and benefits of protection might help convince an employee that the glasses really will protect his eyes.

They must be properly educated on the hazards in the trade and on the safe practices that are to be adopted.

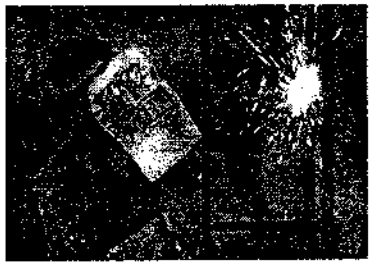

Fig 4.2 Welding Hazard

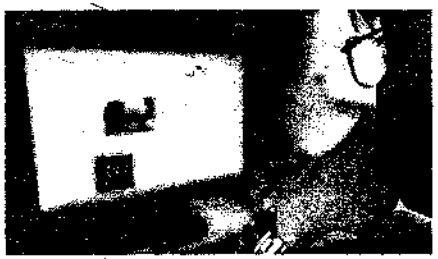

Fig 4.3 Constant working with computers can Lead to C.V.S (computer vision Syndrome)

It would be advisable that in each industry the job-hazard analysis is made and the results let known to each worker. There can be three basic approaches to this analysis

1. Job-hazard analysis by machine or equipment

2. Job-hazard analysis by jobs (welding etc).

3. Job-hazard analysis by Occupa-tion.

This special analysis involves list-ing of all jobs, analysing, them while those jobs are being performed, and of determining key job-steps, poten-tial hazards, and safe practices.

The results of the job-hazard ana-lysis, embodying the hazards and means for protecting against them, should be explained to the workers clearly. Unsafe work habits of work-ers should he corrected. The job-hazard analysis should be made available to the workers so that they may refer to it readily.

Generally, the workers do not rea-lise the importance of protective equipment. No systematic effort has been made to tell the employees on the need for eye-protection or to ex-plain the characteristics and benefits of safety glasses.

These days in all industries day in and day out also, working with computers has become compulsory. Hence persons working with computers must be educated to follow certain ethics at work station and also to wear, anti-reflection coated glasses (A.R.C) when viewing monitor. Supervisors should set an example. by themselves strictly adopting the safety practices. Lapses on their part would give room for unfavourable interpretation of the safety rules by the workers.

Infractions of rules regarding eye--protection must be dealt with seve-rely. When eye-protection is provid-ed, its use should become a condition of employment. Too often an eye is lost because the Safety glasses which should have been worn, are left in the tool-box or bench-drawer.

Those who are required to work in areas or to enter areas where eye-hazards exist, should not be permit-ted access to such areas until the eye-protection is provided. Visitors too, should not be permitted to enter such area without proper eye-protec-tion.

The attitude of workers has much to do in successfully implementing such programmes. - Medical consci-ousness, eagerness to use the protec-tive equipment, amenability to safety codes, - all should be motivated from the worker spontaneously.

Proper propaganda on eye-safety, a sound indpction and training pro-gramme, educating the supervisory staff in these practices - only these can achieve the desired goal of mini-mising industrial eye-accidents.

"Safety is a never ending Task"

"Next to creating a life, the greatest thing a man can do is to save eye-sight"

Summary

A **hazard** is **defined** as *"a condition, event or circumstance that could lead to or contribute to an unplanned or undesirable event."* Seldom does a single hazard cause an accident. More often, an accident occurs as the result of a sequence of causes. A hazard analysis will consider system state, for example operating environment, as well as failures or malfunctions.

Assessment of **risk** is made by combining the severity of consequence with the probability of occurrence in a table. Risks that fall into the "unacceptable" category (high severity and high probability) must be managed by some means to reduce the level of safety risk. While in some cases safety risk can be eliminated, in most cases a certain degree of safety risk must be accepted and different industries will have statutory guidelines.

It is therefore of great importance to understand the potential hazards involved in such activities, and to keep information and maps that illustrate the possible consequences of any accident that could happen at an industrial installation. Industrial hazards can also occur by, processing or storage of petroleum, petroleum products and other minerals; processing or storage of chemicals used in bulk to manufacture a wide variety of chemical-based products; manufacturing of the products themselves, e.g., cleaning agents, pharmaceuticals, cosmetics, textiles, paint and inks, plastics and resins, etc.; as well as energy production, and the manufacture and storage of food and beverages. Therefore this chapter briefly describes about the measures to be taken to reduce the risk of Hazards at Industrial environment.

Short Answer Type Questions

1. How do you define Industrial hazard?
2. What are the causes for accidents at Industry?
3. How is eye affected in case of exposure to welding arc?
4. What is computer vision syndrome (c.v.s) and how does it affect eyes?
5. What are occupational hazards?
6. What is the duty of optometrist in reducing Industrial hazards?

Long Answer Type Questions

1. What are the types of injuries to eyes of workers at various industries?
2. How do you protect the eyes of industrial workers?
3. What is the role of optometrists to save eye from industrial hazards?

UNIT 5

Eye Camps

Conducting eye camps plays a major role to detect ocular ailments in a group of people and also educating them.

in presence of significant refractive errors for providing treatment in the form of spectacle correction, medical treatment, therapy and reffering to base hospital in case of need for surgery.

Generally eye camps are conducted by opthalmological/optometricl teams from each hospital reach patients in rural areas by conducting free eye camps. Patients are screened for various eye diseases; those who require cataract surgery are transported to the base hospital, treated, returned to the camp site and followed up after four weeks – all free of cost.

Important steps involved in an eye camp are as follows:

Patient registration: The camp team, composed of ophthalmologists and paramedical staff, proceed to the campsite. With support from local community, local volunteers (usually students with legible handwriting) record the patient details - name, age and address - in the OP register and case sheet. Patients are given identity cards, which may be used for any future follow-up.

Preliminary vision test: Preliminary vision test is performed by ophthalmic assistants. Vision charts, such as the Snellen (in the local language) and E type charts, are used.

Fig. 5.1 Patient Registration Counter

Fig. 5.2 Preliminary Vision Text

Preliminary examination: Ophthalmologists perform the preliminary examination.

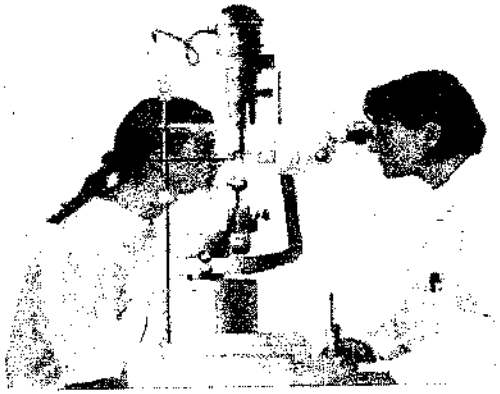

Fig. 5.3 Slit-lamp Examination

Clinical conditions such as external eye infections, vision loss caused by nutritional deficiency and the incurably blind are examined. After this basic examination with the help of torch light and direct ophthalmoscope, the patients are directed to further steps.

Tension and duct examination: Patients above the age of 40 have their intraocular pressure tested. Senior level ophthalmic assistants administer topical anaesthetic drops and measure the intraocular pressure with a Schiotz tonometer. Lacrimal passage is also tested by syringing for the patients with cataract in operable condition. Facilities for the patients to lie on, additional benches for waiting patients, and adequate lighting are ensured.

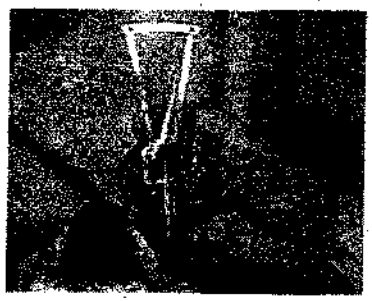

Fig. 5.4 I.O.P. Measurement

Refraction: Refraction is performed on patients who have refractive errors, presbyopia, outdated glasses, or pseudo-aphakia. This process occurs in a simple, prefabricated, dark cubicle which is equipped with one or more foldaway partitions, trial lens sets, and mirrors. Well-trained optometric staff conduct refraction while volunteers control the patient flow.

Final examination: Senior Ophthalmologists evaluate the test findings, perform the final examination (which includes fundus examination on needy patients), review the patient records, make the final diagnoses and prescribe required management which could be , medication, eye glass prescription, surgery or treatment. (In a small camp, one doctor conducts both the preliminary and the final examination.)

Counselling: Patients advised for surgery or further specialty interventions are educated by the counsellors to uptake the relevant eye care. Patients who are advised for cataract surgery undergo blood pressure measurement and sugar test. Those who fit for surgery are counselled at the campsite are registered in Inpatients register and transported to the base hospital for surgery. These patients

receive surgery, postoperative care, meals, and round-trip transportation all free of cost.

Optical Services : Opticians (sales person and technicians from optical division) also attend the screening camp as part of the medical team. A set of frames and required indent of power glasses are taken to the camp venue. Patients advised to wear eye glasses may use this opportunity as it is available at affordable price and receive eye glasses in the camp venue itself. The optician finishes the lens on a grinding machine, mounts the lens in the frames chosen by the patient.

The outreach department manned by a Manager governs the outreach programme throughout the year. Camp organizer, the employee of the hospital bridges the community and the base hospital to carry out the outreach programmes. The organizers work in the community in association with service organization for the fool proof conduct of the outreach programmes. The outreach department shares the results of camp, viz., patients screened, number of surgeries performed, patient discharged etc. with Government and the associates who support the camp in the community.

Cataract is the leading cause of blindness in India. The management of cataract will remain surgical extraction until preventive methods are developed to reduce the progression of lens opacification. One of the accepted ways to increase uptake of cataract services is by extending ophthalmic care facilities to the rural areas through mobile eye units, thereby providing cataract surgical services close to where the majority of the people live. There is little published information on the outcome of cataract surgery in eye camps although several authors have reported their experiences with various methods of conducting camps.

Summary

In this chapter we discuss about Eye camps, their management and specific measures to be taken in a step by step procedure, wherein to summarize In these camps patients were checked for common eye problems, short and long sightedness, and were given spectacles and eye drops free of charge. Patients identified with problems such as Glaucoma, Cataract etc. were counseled and suggested surgery. Eye camps plays a major role for a group of people or community to, screen and treat ocular ailments and to maintain good vision and proper eye health. Whenever Eye camps are conducted a few statistics are to be recorded , such as, Total number of patients seen and their ocular health, refractive status, Number of free spectacles given, Number of operative cases for cataracts or any other eye problems. This measure helps us to maintain proper statistical evaluation of data and in future proper management of Eye camps.

Short Answer Type Questions

1. What is a eye camp?
2. How do you counsel a patient at eye camp?
3. How do you do refraction at eye camp?
4. How do you do visual acuity check up at eye camp?
5. What is the duty of optometrist at eye camp?
6. What is the importance of maintaining statistics at eye camps?

Long Answer Type Questions

1. How do you conduct eye camps?
2. What is the role of optometrist and staff at camps?
3. What are the important steps involved while conducting eye camps?
4. What are the general eye problems at eye camps and how do you diagnose?

UNIT 6

Blindness

Refers to a condition where a person suffers from any of the following conditions, namely:

1. Total absence of sight; [P.L.(-)] or
2. Visual acuity not exceeding 6/60 or 20/200(snellen) in the better eye even with correction lenses; or limitation of the field of vision subtending an angle of 20 degree or worse.

Causes of Blindness	Percentage of Contribution
Cataract	81%
Trachoma and Associated infections	0.2%
Corneal Opacity	3.0%
Vitamin A Deficiency	0.04%
Refraction Error	7.0%
Glaucoma	2.0%
Other Causes	6.76%

Low Vision

"Low vision are those who suffer visual acuity between 6/60 to 6/18 or 70/200 to 20/200 (snellen) in the better eye after the best possible correction or a field of vision between 20 to 30 degrees".

The WHO working definition of low vision (WHO, 1992):

"A person with low vision is one who has impairment of visual functioning even after treatment, and/or standard refractive correction, and has a visual acuity of less than 6/18 to light perception or a visual field of less than 10 degrees from the point of fixation, but who uses, or is potentially able to use, vision for the planning and/or execution of a task".

For a person with low vision, there is significantly reduced vision, visual performance is affected but that there still is vision that can be used. If there is usable vision, training to use that vision might be possible. In addition that person is not labeled blind.

Generally, the impairment of 40% or more is considered a handicap. As percentage of impairment in the case of one-eyed person is only 30%, according to the approved definition in medical regulations, a person with one good eye is not a blind person

The main diseases recognized as responsible for visual impairment and blindness in India. The three great eye health problems are: malnutrition, trachoma and cataract.

• Malnutrition – Malnutrition is due to deficiency of Vitamin A. It can result in permanent blindness.

• Trachoma – Trachoma cases alone are estimated to number .86 million in India. Trachoma and associated bacterial conjunctivitis are an important cause of blindness in India. They are gradually being brought under control.

• Cataract – The main cause of blindness in India today is cataract which is responsible for between fifty to ninety percent of all cases depending upon the area. Cataract occurs more frequently with advancing age. Senile cataract occur a decade earlier in India relative to Europe and America. Blindness caused by cataract is easily curable by minor surgery.

The most frequent causes of blindness in developed countries are diabetes, glaucoma, accidents, and vascular diseases, degeneration of ocular tissues especially of the retina, cataract, and hereditary conditions.

Prevention of Blindness

The concept of avoidable blindness has gained increasing recognition during recent years. A great many of the causes of blindness lend themselves to prevention and control whether by improving nutrition, by treating cases of infectious diseases, or by controlling the organisms which cause infection, or by improving safety conditions particularly on the roads, at work or in the home.

The components of action in national programs for the prevention of blindness comprise the following:

• Initial assessment – The first step to assess the magnitude, geographic distribution and causes of blindness within the country or region by prevalence surveys. This knowledge is essential for setting priorities and development of appropriate intervention programs.

• Methods of intervention – Primary eye care, Secondary care, Tertiary care, specific programmes like Trachoma control, School eye health services, Vitamin A prophylaxis, Occupational eye health services.

• Long term measures – Long term measures also have a part to play in controlling eye infections.

• Evaluation – Evaluation should be an integral part of intervention programmes to measure the extent to which ocular diseases and blindness have been alleviated, assess the manner and degree to which programme activities have been carried out and determine the nature of the other changes that may have been produced.

Low vision and Rehabilitation

Low vision emphasizes that, there is significantly reduced vision, visual performance is affected but that there still is vision that can be used. This last point is very important: if there is usable vision, training to use that vision might be possible. In addition, this person is not labeled blind.

Visual impairment in general affects four main functional areas:

1. Orientation/mobility
2. Communication
3. Activities of daily living
4. Reduced near vision.

Early check up and counseling by low vision specialists, can balance the negative effects of visual impairment. In many cases environmental adaptations, vision training, follow up for ensuring compliance, coordinating with care takers, removing myth and misconception and counseling would help in empowering the individual and/or enhancing functional residual vision.

The effect of low vision is not same for all people and the following assessment needs to be done for each individual before categorizing him/her under low vision.

- Extent of vision : Near and distance visual acuity
- Size of the visual field
- Effect of light and glare
- Extent of recognition and naming of colors
- Extent to which contrast affects their activities
- Extent of use of vision for different activities and purpose in the environment
- Extent to which a person sees and recognizes an object depends, amongst other on: Familiarity of the object; light; size; distance; contrast; color; detail or simplicity of the object
- Age, socioeconomic conditions, literacy status, and level of motivation

Rehabilitation involves combined and coordinated use of medical, social, educational, and vocational measures for training or retraining the individual to the highest possible level of functional ability. The three main strategies for rehabilitation of disabled are institution-based, outreach, and community-based.

In general, rehabilitation encompasses the following:

- Early detection, diagnosis, and intervention
- Improve, facilitate, stimulate and/or provide services for people with disabilities, their families and attendant
- Medical rehabilitation i.e., management of curable disability and lessening the disability to the extent possible
- Social, psychological, and other types of counseling and assistance
- Training in self-care activities including social graces, life style, mobility, communication, and daily living skills with special provisions as needed

- Provision of technical, mobility and other devices
- Specialized education services
- Vocational rehabilitation services including vocational guidance, training, open placement, and self-employment
- Certification of degree of disability and provision of available concessions/ benefits
- Community awareness
- Follow-up

Low vision rehabilitation devices

Mobility devices

- Canes (symbol canes; guide canes; long canes; electronic travel devices), mobility show-card, mini beeper.
- Vocational devices
- Goniometer, attachment to lathe, spot welding, continuity tester, Braille micrometer.
- Daily living devices
- Daily living devices can be further classified into five broad categories namely, clocks and watches, games and puzzles, sports, kitchen equipment and personnel devices.
- Low vision devices
- Low Vision devices can be further divided into two types : Optical devices, which use lenses to magnify objects and non-optical devices and techniques, which make objects easier to use. A third category is electronic magnifier which is sometimes assumed under non-optical devices. These devices include telescopes (telescopic spectacles, hand held, tele-bifocal spectacles), visualtek, schmidt reader, magnifying lenses (fixed focus; variable focus stand; half cylindrical rod; hand magnifier; folding; high plus spectacle; half eye spectacle-prism glasses; clip on magnifier), microscopic spectacles, fluorescent reading lamps, tinted lenses. Electronic magnifier/adaptive technology in the form of closed circuit television (CCTV), computer software (JAWS, MAGIC, text Braille software), speech synthesizer, talking books, overhead projector.

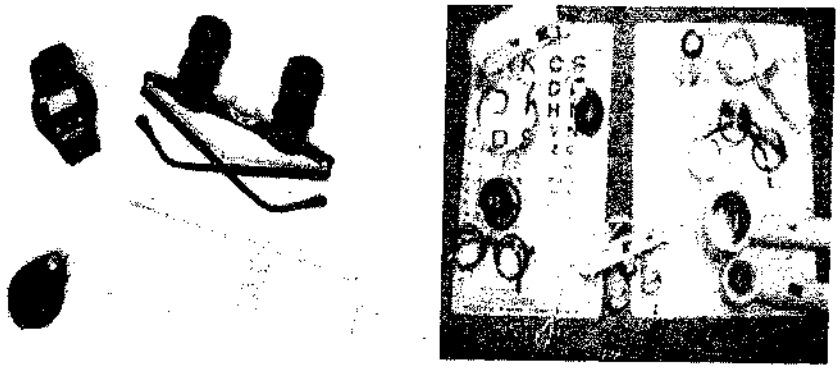

Fig. 6.1 Low vision Aids

Fig. 6.2 Orientation Mobility

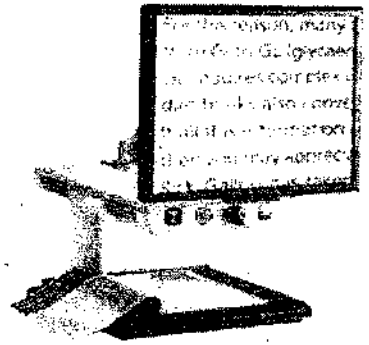

Fig. 6.3 CCTV For low vision

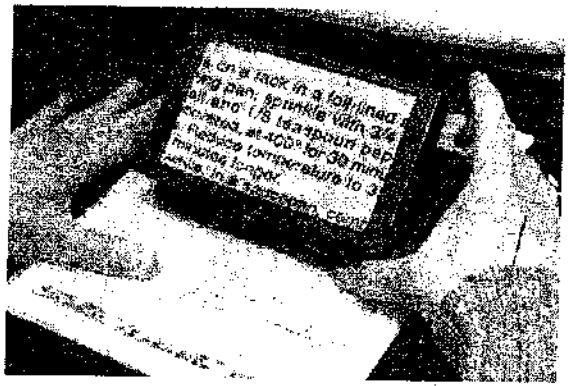

Fig. 6.4 Hand held Electronic magnifier

Summary

VISION 2020 is a global initiative that aims to eliminate avoidable blindness by the year 2020. It was launched on 18 February 1999 by the World Health Organization together with the more than 20 international non-governmental organizations involved in eye care and prevention and management of blindness that comprise the International Agency for the Prevention of Blindness (IAPB). VISION 2020 is a partnership that provides guidance, technical and resource support to countries that have formally adopted its agenda.

The mission of the VISION 2020 Global Initiative is to eliminate the main causes of all preventable and treatable blindness as a public health issue by the year 2020.

The Right to Sight accomplishes its mission as it attains the three major objectives:

- Raise the profile, among the key audiences, of the causes of avoidable blindness and the solutions that will help to eliminate the problem.
- Identify and secure the necessary resources around the world in order to provide an increased level of prevention and treatment programmes.
- Facilitate the planning, development and implementation of the three core Vision 2020 strategies by National Programmes.

The most common causes of blindness in older adults were retinal disorders, followed by cataract and glaucoma. In school children, the prevalence of uncorrected visual impairment was 4.82% decreasing to 0.41% with refractive correction. The most common cause of visual impairment in school children was uncorrected refractive error. Visual impairment and blindness in India is an important public health problem. It is a significant problem in older Indians, reinforcing the need to implement prevention of blindness programs for elderly people with emphasis on those without schooling. In school-children cost-effective strategies are needed to address a readily treatable cause of vision impairment - prescription and provision of glasses. Visual impairment and blindness have a significant impact on the socioeconomic development of individuals and societies. Their consequences are an important public health issue with greater impact in the developing countries.

Short Answer Type Questions

1. Define blindness.
2. Define low-vision.

3. What are the causes for blindness?
4. What do you mean by vision 2020?
5. What is malnutrition?
6. What is trachoma?

Long Answer Type Questions

1. Explain briefly the difference between low-vision and blindness.
2. What are the rehabilitation programmes for low-vision and blind?
3. What are the different low-vision aids available?
4. What are the main causes for blindness and their prevention?

UNIT 7

Reading Problems in Children

Reading requires the integration of a number of different vision skills: visual acuity, visual fixation, accommodation, binocular fusion, convergence, field of vision, and form perception. Of these, only one is checked by the typical school eye chart test. Limited eye examinations may cover only one or two. And symptoms of reading related vision problems are often not noticeable to parent, teacher or child. A comprehensive optometric examination, however, does cover these vision skills. It is a must for every child who is having trouble reading.

Visual Acuity: Visual acuity is the ability to see objects clearly. It is usually the only skill assessed in a school vision screening. The typical school eye chart is designed to be seen at 20 feet and measures how well or poorly the child sees at that distance. If a problem is discovered in the screening, the child should be referred for a thorough optometric examination.

Visual Fixation: Fixation is the skill utilized to aim the eyes accurately. Static fixation is the ability to focus on a stationary object when reading a word or working a math problem. Saccadic fixation is the ability to move the eyes quickly and accurately across a page to read a line of print. Pursuit fixation is the ability to follow a moving object with the eyes. These complex operations require split second timing for the brain to process the information received and to track the path of the moving object.

Accommodation: Accommodation is the ability to adjust the focus of the eyes as the distance between the individual and the object changes. Children frequently use this vision skill in the classroom as they shift their attention (and

focus) between their book and the chalkboard for sustained periods of time. Being able to maintain focus at near for sustained periods of time is important for reading, writing and also taking tests.

Binocular Fusion: Binocular fusion refers to the brain's ability to gather information received from each eye separately and form a single, unified image. A child's eyes must be precisely aligned or blurred or double vision, discomfort, confusion or avoidance may result. If that occurs, the brain often subconsciously suppresses or inhibits the vision in one eye to avoid confusion. That eye may then develop poorer visual acuity **(amblyopia or lazy eye).**

Convergence: Convergence is the ability to turn the two eyes toward each other to look at a close object. School desk work is one instance in which a child depends on this vision skill.

Field of Vision: Field of vision is the wide area over which vision is possible. It is important that a child be aware of objects in the periphery (left and right sides and up and down) as well as in the center of the field of vision. Near central or Para-central vision is important for reading ability.

Perception: Visual perception is the total process responsible for the reception and understanding of what is seen. Good visual perception is necessary for successful school achievement. Form perception is the ability to organize and recognize visual images as specific shapes. The shapes the child encounters are remembered, defined and recalled when development of reading skills begin. Regular optometric care can help assure that a child will have the visual skills necessary for successful classroom performance.

Treating reading-related vision problems: The optometrist examines these vision skills and determines how well the child is using them together. When a vision problem is diagnosed, he or she can prescribe glasses, vision therapy or both. Vision therapy has proved quite effective in treating reading-related vision problems. It involves an individualized program of training procedures designed to help a child acquire or sharpen vision skills that are necessary for reading.

Treating reading problems: Because reading problems usually have multiple causes, treatment must often be multidisciplinary. Educators, psychologists, optometrists and other professionals must confer and work together to meet each child's needs. The optometrist's role is to help the child overcome the vision problems interfering with the ability to read. Once this is accomplished, the child is then more capable of responding to special education efforts aimed at treating the reading problem itself.

Proper Reading Postures

Infant's Vision

Your baby has a whole lifetime to see and learn. But did you know your baby also has to learn to see? As a parent, there are many things that you can do to help your baby's vision develop. First, proper prenatal care and nutrition can help your baby's eyes develop even before birth. At birth, your baby's eyes should be examined for signs of congenital eye problems. These are rare, but early diagnosis and treatment are important to your child's development.

At about age 6 months, you should take your baby to your doctor of optometry for his or her first thorough eye examination. Things that the optometrist will test for include excessive or unequal amounts of nearsightedness, farsightedness, or astigmatism and eye movement ability as well as eye health problems. These problems are not common, but it is important to identify children who have them at this stage. Vision development and eye health problems can be more easily corrected if treatment is begun early. Unless you notice a need, or your doctor of optometry advises you otherwise, your child's next examination should be around age 3, and then again before he or she enters school.

Between birth and age 3, when many of your baby's vision skills will develop, there are ways that you can help.

During the first 4 months of life, your baby should begin to follow moving objects with the eyes and reach for things, first by chance and later more accurately, as hand-eye coordination and depth perception begin to develop.

To help, use a nightlight or other dim lamp in your baby's room; change the crib's position frequently and your child's position in it; keep reach-and-touch toys within your baby's focus, about eight to twelve inches; talk to your baby as you walk around the room; alternate right and left sides with each feeding; and hang a mobile above and outside the crib.

Between 4 and 8 months, your baby should begin to turn from side to side and use his or her arms and legs. Eye movement and eye/body coordination skills should develop further and both eyes should focus equally.

You should enable your baby to explore different shapes and textures with his or her fingers; give your baby the freedom to crawl and explore; hang objects across the crib; and play "patty cake" and "peek-a-boo" with your baby.

From 8 to 12 months, your baby should be mobile now, crawling and pulling himself or herself up. He or she will begin to use both eyes together and judge distances and grasp and throw objects with greater precision. To support

development don't encourage early walking - crawling is important in developing eye-hand-foot-body coordination; give your baby stacking and take-apart toys; and provide objects your baby can touch, hold and see at the same time.

From 1 to 2 years, your child's eye-hand coordination and depth perception will continue to develop and he or she will begin to understand abstract terms. Things you can do are encourage walking; provide building blocks, simple puzzles and balls; and provide opportunities to climb and explore indoors and out.

There are many other affectionate and loving ways in which you can aid your baby's vision development. Use your creativity and imagination. Ask your doctor of optometry to suggest other specific activities.

Preschool Vision

During the infant and toddler years, your child has been developing many vision skills and has been learning how to see. In the preschool years, this process continues as your child develops visually guided eye-hand-body coordination, fine motor skills and the visual motor skills necessary to learn to read.

As a parent, you should watch for signs that may indicate a vision development problem, including a short attention span for the child's age; difficulty with eye-hand-body coordination in ball play and bike riding; avoidance of coloring and puzzles and other detailed activities.

There are everyday things that you can do at home to help your preschooler's vision develop as it should.

These activities include reading aloud to your child and letting him or her see what you are reading; providing a chalkboard, finger paints and different shaped blocks and showing your child how to use them in imaginative play; providing safe opportunities to use playground equipment like a jungle gym and balance beam; and allowing time for interacting with other children and for playing independently.

By age 3, your child should have a thorough optometric eye examination to make sure your preschooler's vision is developing properly and there is no evidence of eye disease. If needed, your doctor can prescribe treatment including glasses and/or vision therapy to correct a vision development problem.

Here are several tips to make your child's optometric examination a positive experience:

School-Age Children

A good education for your child means good schools, good teachers and good vision. Your child's eyes are constantly in use in the classroom and at play. So when his or her vision is not functioning properly, learning and participation in recreational activities will suffer.

The basic vision skills needed for school use are:

Near vision. The ability to see clearly and comfortably at 10-13 inches.

Distance vision. The ability to see clearly and comfortably beyond arm's reach.

Binocular coordination. The ability to use both eyes together.

Eye movement skills. The ability to aim the eyes accurately, move them smoothly across a page and shift them quickly and accurately from one object to another.

Focusing skills. The ability to keep both eyes accurately focused at the proper distance to see clearly and to change focus quickly.

Peripheral awareness. The ability to be aware of things located to the side while looking straight ahead.

Eye/hand coordination. The ability to use the eyes and hands together.

If any of these or other vision skills are lacking or not functioning properly, your child will have to work harder. This can lead to headaches, fatigue and other eyestrain problems. As a parent, be alert for symptoms that may indicate your child has a vision or visual processing problem. Be sure to tell your optometrist if your child frequently.

Loses their place while reading

Avoids close work

Holds reading material closer than normal

Tends to rub his or her eyes

Has headaches

Turns or tilts head to use one eye only

Makes frequent reversals when reading or writing

Uses finger to maintain place when reading

Omits or confuses small words when reading

Consistently performs below potential.

Because vision changes can occur without you or your child noticing them, your child should visit the optometrist at least every two years, or more frequently, if specific problems or risk factors exist. If needed, the doctor can prescribe treatment including eyeglasses, contact lenses or vision therapy.

Remember, a school vision or pediatrician's screening is not a substitute for a thorough eye examination.

1. Make an appointment early in the day. Allow about one hour.
2. Talk about the examination in advance and encourage your child's questions.
3. Explain the examination in your child's terms, comparing the E chart to a puzzle and the instruments to tiny flashlights and a kaleidoscope.

Unless your doctor of optometry advises otherwise, your child's next eye examination should be at age 5. By comparing test results of the two examinations, your optometrist can tell how well your child's vision is developing for the next major step into the school years.

Summary

Reading problems contribute to difficulties with homework efficiency, test taking skills, and other learning skills. In addition, Understanding your child's learning problems. Reading is essential to success in our society. The ability to read is highly valued and important for social and economic advancement. Of course, most children learn to read fairly well. In this report, we are most concerned with the large numbers of children in America whose educational careers are imperiled because they do not read well enough to ensure understanding and to meet the demands of an increasingly competitive economy. Current difficulties in reading largely originate from rising demands for literacy, not from declining absolute levels of literacy. In a technological society, the demands for higher literacy are ever increasing, creating more grievous consequences for those who fall short. First treat the underlying cause of reading problems, followed by exercises that build reading fluency and comprehension skills. The purpose of providing extra instructional time is to help children achieve levels of literacy that will enable them to be successful through their school careers and beyond. It is not simply to boost early literacy achievement. Given the focus of this volume, we restrict our discussion to the primary grades; however, it is likely that children who have had interventions in the primary grades will need

additional supplementary experiences in the upper grades as well. We know that the literacy demands are of a different nature for older children; as children proceed through the grades, they are expected to learn from informational text with which they may have had few experiences in the primary grades they are expected to use text independently; and they are expected to use text for the purpose of thinking and reasoning.

Short Answer Type Questions

1. How do you check visual acuity in children.
2. How do you treat reading related vision problems.
3. What happens if school age children have poor vision?
4. Define field of vision.
5. What is visual perception?
6. How does eye exercises helps to improve vision in children.

Long Answer Type Questions

1. What are the reading problems in children?
2. What is the importance of binocular vision in children?
3. What is amblyopia?
4. What is the vision status of the child from birth to schooling age?

UNIT 8

Statistical Evaluation of the Surveys

For a good statistical evaluation and surveys, maintaining of medical records plays a major role and medical record is an important document meant basically for recording the treatment procedure for a

patient. It is very important for both patient as well as ophthalmologist for future reference and treatment plan. According to1995 act and orders given by Supreme Court That Doctors also come under the law of the Consumer Protection Act 1986, the medical records have become an important aspect of the written evidence.It is important for doctors and staff to realize that Medical

Medical Records have become the effective weapon in their hands to counter the false claims of the consumers, when they file a case for compensation.

All case history reports, prescriptions and consent for surgery should be recorded carefully.

Introduction

Medical Records include the findings on the patient, who have visited the doctor on that day and drug prescription which have been continued or changed.

Dosage and the drugs used must be legibly written.

Importance of the Medical Records

Can be simply divided into four parts:

1. Consultant ophthalmologist

Records are the daily check up papers,which the consultant has to refer time and again while patient undergoing treatment until the completion of the disease. Even in future, records help for follow-up and further treatment plan. Like in case of any surgery ,to plan the operation date and systemic condition status of the patient and treat accordingly. Also plan for operation of next eye. Records even help when the patient is examined by another doctor. Storage of records, in this modern days where the data should be stored in the computers itself and another hard copy should be maintained.

2. When referred

According to the medical ethics a optometrist must do primary examination of eye, refraction, non-invasive external eye examination, muscle balance, cover un cover test and ortho-optic assessment and should give ophthalmic prescription for eye wear if necessary. In case of any ocular problem other than this, the patient should be referred to the concerned ophthalmologist and if a patient is to be referred to, the optometrist must:

- Write down the brief history in detail.
- His whole of examination procedure.
- His findings and conclusion

To help the doctor in further to treat the patient accordingly.

3. Staff

Medical records are written evidence, to check the concerned staff whether they are following in time instructions given by the doctor to the patient or not.

4. For the Law

Law requires written evidence along with the date and signature of the physician, during the course of treatment and proper maintenance of case sheets. And the case sheets should be presented to the patient on demand. With all details regarding the course of treatment should be documented correctly.

These are the single most important document that

Can be used in medico legal cases.

Medical records also help in case of medical insurance reimbursement claims for the patients.

According to the law medical records should be maintained up to three (3) years by the hospital authorities.

Summary

To summarize, this chapter this chapter tells us the future importance of maintaining records, for the sake of the patient and also for practioner and staff. Records are the important written documents, used for future referrals, mode of treatment given, prognosis, any side reactions to antibiotics and also for claiming health insurance policies. So proper maintenance of records is must for each and every hospital and individual practitioners.

Short Answer Type Questions

1. Importance of statistical evaluation of surveys.
2. Why should we maintain medical records.
3. What is the role of optometrist in maintaining medical records?
4. How does old prescription of spectacles help in refraction.
5. What are all the details to be written for a referral patient?
6. How does a medical record help in future.

Long Answer Type Questions

1. Write in detail procedure for statistical evaluation of the surveys.
2. What is the importance of maintaining medical records ?
3. How can we co-relate medical records with statistics
4. How are medical records helpful for the opthalmologist, patient and staff.

UNIT 9

Nutritional Disorders

Introduction

Of all organs in our body eyes are the most precious and, the value of healthy eyes and eyesight, and what happens when that eyesight suffers due to malnutrition, like there's no substitute for the quality of life good vision offers. Adding certain nutrients to your diet every day – either through foods or supplements – can help save your vision. Researchers have linked eye-friendly nutrients such as lutein/zeaxanthin, vitamin C, vitamin E, and zinc to reducing the risk of certain eye diseases, including macular degeneration and cataract formation.

Lutein & Zeaxanthin

Lutein and zeaxanthin are important nutrients found in green leafy vegetables, as well as other foods, such as eggs. Many studies have shown that lutein and zeaxanthin reduce the risk of chronic eye diseases, including age-related macular degeneration and cataracts.

Vitamin C

Vitamin C (ascorbic acid) is an antioxidant found in fruits and vegetables. Scientific evidence suggests vitamin C lowers the risk of developing cataracts, and when taken in combination with other essential nutrients, can slow the progression of age-related macular degeneration and visual acuity loss.

Fig. 9.1 Green Leafy vegetables and Eggs

Fig 9.2 Fruits & Vegetables rich in Vitamin C

Vitamin E

Vitamin E in its most biologically active form is a powerful antioxidant found in nuts, fortified cereals and sweet potatoes. It is thought to protect cells of the eyes from damage caused by unstable molecules called free radicals which break down healthy tissue.

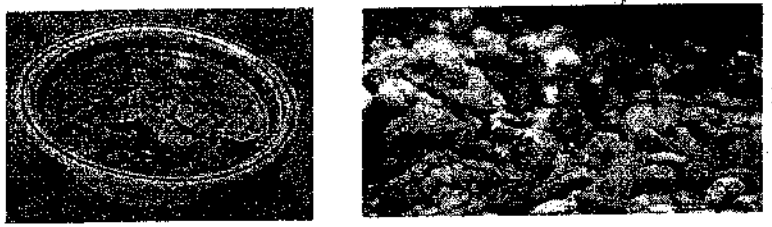

Fig 9.3 Forified cereals and Nuts

Essential Fatty Acids

Fats are a necessary part of the human diet. They maintain the integrity of the nervous system, fuel cells and boost the immune system. Two omega-3 fatty acids have been shown to be important for proper visual development and retinal function.

Fig 9.4 Diet of essential fats

Zinc

Zinc is an essential trace mineral or 'helper molecule.' It plays a vital role in bringing vitamin A from the liver to the retina in order to produce melanin, a protective pigment in the eyes. Zinc is highly concentrated in the eye, mostly in the retina and choroid, the vascular tissue layer lying under the retina.

Emerging Research

In the last 20 years, eye health research has linked diet and nutrition with a decreased risk of age-related macular degeneration (AMD).

Food and nutritional disorders

Blindness due to lack of Vitamin – A

1. Blindness due to Vitamin A deficiency

Vitamin A is essential for normal vision and variety of bodily functions. Considerable amounts of vitamin A can be stored in the liver and made available for use as the need arises.

For children, lack of vitamin A causes severe visual impairment and blindness and significantly increases the risk of severe illness and even death, from such common childhood infections as diarrhoeal disease and measles.

Deficiency of Vitamin A deficiency is one of the most serious nutritional deficiency diseases in the world today. It is one of the most prevalent deficiencies in India and is seen among children.

- Between 100 and 140 million children is vitamin A deficient.
- A estimated 2,50000 to 5,00,000 vitamin A deficient children become blind every year, half of them dying within 12 months of losing their sight.
- Nearly 6,00,000 women die from child birth-related causes each year, the vast majority of them from complications which could be reduced through better nutrition, including provision of vitamin A.

Causes of Deficiency

Inadequate intake of vitamin A, and protein energy malnutrition can cause vitamin A deficiency.

Signs and Symptoms

One of the earliest symptoms of vitamin A deficiency is night blindness and more severe deficiencies include ocular changes leading to blindness, particularly in young children.

Night blindness is the most recognizable manifestation of vitamin A deficiency. The first symptom of Xerophthalmia is a child cannot see to get around after dark or in a dark room.

Bitot's Spots

Bitot's spots are accumulation of foamy, cheesy material on the white part of the eye, often in association with night blindness. Bitot's spots differ in size, location and shape but they have a similar appearance.

Corneal Xerosis / Ulceration

The cornea becomes dry. If the disease is not treated, the xerosis can progress within hours to an ulcer of the cornea.

Keratomalacia

- The final stage is keratomalacia, which is softening of the cornea. Keratomalacia destroys the cornea, which results in permanent blindness which is incurable.
- The presence of keratomalacia indicates a poor prognosis of health and life.

Corneal Scar

- A dry corneal epithelium is sensitive to infection by bacteria. A corneal ulcer due to infection of bacteria / virus will likely result in scarring of the cornea.
- Visual acuity may be considerably affected.
- The eye can shrink and become atrophic (phthisis bulbi)
- Keratomalacia can lead to perforation of the cornea and corneal ulcer. If treated earlier the corneal scar will remain small and does not cause significant loss.

Measles

- Visual disability and blindness from measles occurs due to vitamin malnutrition.
- Children who suffer from diarrhea, acute respiratory infections and measles should be monitored carefully and given usual preventive dose of Vitamin A.

Prevention of blindness due to Vitamin A deficiency

- Early identification, accurate diagnosis, and proper management, along with comprehensive vaccination programs will reduce blindness due to vitamin A deficiency.
- Corneal scars and blindness can be prevented if identified and treated early.
- Vaccination programs would controlled measles.
- Pre school children are to be encouraged to include dairy products, curd, butter, liver, eggs, oil and fat in the daily diet who are liable to develop vitamin A deficiency.
- Promotion of dietary intake of vitamin A rich foods, which are cheap and locally available.
- Regular consumption of vitamin A rich foods such as dark green leafy vegetables, yellow vegetables and fruits must be added in the regular diet to prevent deficiency due to lack of vitamin A.
- Nutrition education, cultivating a home garden with crops which will ensure adequate availability of vitamin a rich vegetables and fruits.

Pregnant women should take nutritious food that contains vitamin A. This helps the child in the womb to get vitamin A from its mother.

Growing children need sufficient nutritious food. When there is lack of proteins and calories in a child's body (malnutrition), diseases like marasmas and kwashorkor occur.

Marasmas and Kwashiorkor

Malnourished children in the age group of 1-5 years will get affected by marasmas and kwashiorkar

Symptoms of Marasmas

This disease starts with the swelling of legs followed by hands and the whole body. Rough skin, less hair on head with hair colour changing to reddish brown are symptoms of marasmas. Affected children look pale and lack enthusiasm.

Symptoms of kwashiorkor

Children affected by the disease are very weak and thin. Children may get diarrhea during initial stages. The skin looks dry.

Treatment tips for children with the above diseases

Nutritious food rich in calories and proteins need to be given to the children in adequate quantities in frequent intervals. Children with severe deficiency symptoms need to be taken to the doctor imediately.

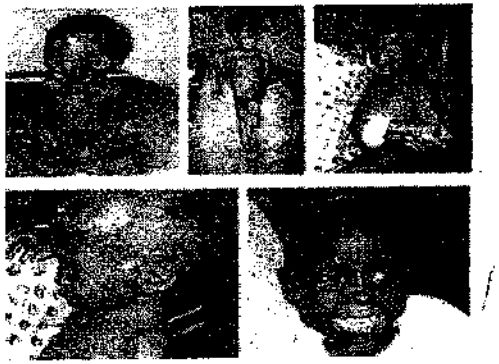

Fig 9.5 : Children affected by Marasmas and kwashiorkor

Diet for children affected by Marasmas and kwashiorkor

National Institute of Nutrition, Hyderabad has developed nutritious food called MIX with the mixture of all nutrients. The mixture can be prepared in the house. Ingredients in the Nutritious Mixture

Fried wheat - 40grams

Putnal grain - 16 gr

Fried ground nuts - 10 gr

Jaggery - 20 gr

Powder the ingredients and mix them. The m consists of 330gr of calories and 11.3 gr of proteins.

This mixture is fed with milk or water. It has been experimented to feed the children who are suffering with Marasmas and kwashiorkor diseases.

Summary

This unit mainly describes about the Eye diseases caused by malnutrition. During the developing ages of the human beings , if they lack proper nutritious diet, it may lead to various eye problems like, vitamin A deficiency leading to night blindness, marasmas and kwashiorkor to name some. So good hygienic food is must for eye health and good vision. The general physical health well development of immune system depends on the nutrition food taken during the growing years.

Short Answer Type Questions

1. What do you mean by nutritional disorder?
2. What kinds of proteins and vitamins are important to eyes?
3. What do you mean by age related macular degeration?
4. What do you mean by marasmas?
5. Malnutrition leads to which eye problems.
6. Define night blindness and cause for it.

Long Answer Type Questions

1. How do you detect eye diseases caused by malnutrition?
2. What is a healthy diet for eyes?
3. Explain nutritional disorders leading to eye problems?

UNIT 10

Nutrition

Introduction

Nutrition, nourishment, or aliment, is the supply of materials - food - required by organisms and cells to stay alive. In science and human medicine, nutrition is the science or practice of consuming and utilizing foods.

In hospitals, nutrition may refer to the food requirements of patients, including nutritional solutions delivered via an IV (intravenous) or IG (intragastric) tube.

Nutritional science studies how the body breaks food down (catabolism) and repairs and creates cells and tissue (anabolism) - catabolism and anabolism = metabolism. Nutritional science also examines how the body responds to food. In other words,"nutritional science investigates the metabolic and physiological responses of the body to diet".

As molecular biology, biochemistry and genetics advance, nutrition has become more focused on the steps of biochemical sequences through which substances inside us and other living organisms are transformed from one form to another - metabolism and metabolic pathways.

Nutrition also focuses on how diseases, conditions and problems can be prevented or lessened with a healthy diet.

Nutrition also involves identifying how certain diseases, conditions or problems may be caused by dietary factors, such as poor diet (malnutrition), food allergies, metabolic diseases, etc.

Difference between a dietician and a nutritionist

A dietician studied dietetics, while a nutritionist studied nutrition. The two terms are often interchangeable, however they are not 100% identical.

Dietetics: the interpretation and communication of the science of nutrition so that people can make informed and practical choices about food and lifestyle, in both health and disease. Part of a dietician's course includes both hospital and community settings. The majority of dieticians work in health care, education and research, while a much smaller proportion also work in the food industry. A dietician must have a recognized degree (B.Sc. or M.Sc), or postgraduate degree in nutrition and dietetics to work as a dietician.

Nutrition: the study of nutrients in food, how the body uses nutrients, and the relationship between diet, health and disease. Major food manufacturers employ nutritionists and food scientists. Nutritionists may also work in journalism, education and research. Many nutritionists work in the field of food science and technology.

There is a lot of overlap between what nutritionists and dieticians do and studied. Some nutritionists work in health care, some dieticians work in the food industry, but a higher percentage of nutritionists work in the food industry and food science and technology, and a higher percentage of dieticians work in health care.

Malnutrition is a broad term which refers to both **under nutrition** (subnutrition) and **overnutrition**. Individuals are malnourished, or suffer from under nutrition if their diet does not provide them with adequate calories and protein for maintenance and growth, or they cannot fully utilize the food they eat due to illness. People are also malnourished, or suffer from overnutrition if they consume too many calories.

Malnutrition can also be defined as the insufficient, excessive or imbalanced consumption of nutrients. Several different nutrition disorders may develop, depending on which nutrients are lacking or consumed in excess.

According to the World Health Organization (WHO), malnutrition is the gravest single threat to global public health.

This text will focus more on the undernutrition aspect of malnutrition, rather than overnutrition.

Subnutrition occurs when an individual does not consume enough food. It may exist if the person has a poor diet that gives them the wrong balance of basic food groups.

Obese people, who consume more calories than they need, may suffer from the subnutrition aspect of malnutrition if their diet lacks the nutrients their body needs for good health.

Poor diet may lead to a vitamin or mineral deficiency, among other essential substances, sometimes resulting in scurvy - a condition where an individual has a vitamin C (ascorbic acid) deficiency. Though scurvy is a very rare disease, it still occurs in some patients - usually elderly people, alcoholics, or those that live on a diet devoid of fresh fruits and vegetables. Similarly, infants or children who are on special or poor diets for any number of economic or social reasons may be prone to scurvy.

According to the National Health Service (NHS), UK, it is estimated that over two million people are affected by malnutrition (subnutrition).

Summary

This unit mainly emphasizes on the importance of nutritional food, and its ill effects caused by under nutrition. Malnutrition is the condition that results from taking an unbalanced diet in which certain nutrients are lacking, in excess (too high an intake), or in the wrong proportions. A number of different nutrition disorders may arise, depending on which nutrients are under or overabundant in the diet. In most of the world, malnutrition is present in the form of under nutrition, which is caused by a diet lacking adequate calories and protein. While malnutrition is more common in developing countries, it is also present in industrialized countries. In wealthier nations it is more likely to be caused by unhealthy diets with excess energy, fats, and refined carbohydrates. A growing trend of obesity is now a major public health concern in lower socio-economic levels and in developing countries as well. Because it contributes to both over nutrition and under nutrition, malnutrition is said to be a "double burden."

Short Answer Type Questions

1. Define nutrition.
2. Who is a dietician.
3. Who is a nutritionist.
4. What are the side effects of over nutrition?
5. What do you mean by metabolism?
6. What do you mean by a balanced diet?

Long Answer Type Questions

1. Importance of nutritious food.
2. What is the difference between a dietician and a nutritionist?
3. Explain the disease scurvy.
4. What is the relation of nutrition with eyes?

UNIT 11

Environmental Sanitation

Introduction

Environmental sanitation is a set of actions geared towards improving the quality of the environment and reducing the amount of disease. By doing so, the hope is that living conditions will improve and health problems will decrease. The management of water, solid waste, and industrial waste, as well as the topic of pollution and noise control, all fall under the umbrella of environmental sanitation.

Water Management

The water supply can directly impact pollution and the spread of disease. The most common sources of water include groundwater and surface water; the main sources of groundwater are usually wells and springs, while surface water comes from fresh water sources like lakes and rivers. Both require treatment before being consumed because various chemicals, particles, and biological contaminants, like bacteria, can enter the water.

Many developed countries have water treatment plants where drinking water is cleaned of dirt and particles, disinfected, and stored until needed. This water may be run through pipes directly to homes and business. Other methods of treating water include boiling it or treating it with chemicals to kill harmful bacteria.

In addition to other sources, water can become contaminated from household trash and human waste. If waste is not disposed of properly, it can

mix with water in the ground or with surface water that might be collected for drinking and cooking. When people drink tainted water, it can spread disease or even cause new outbreaks.

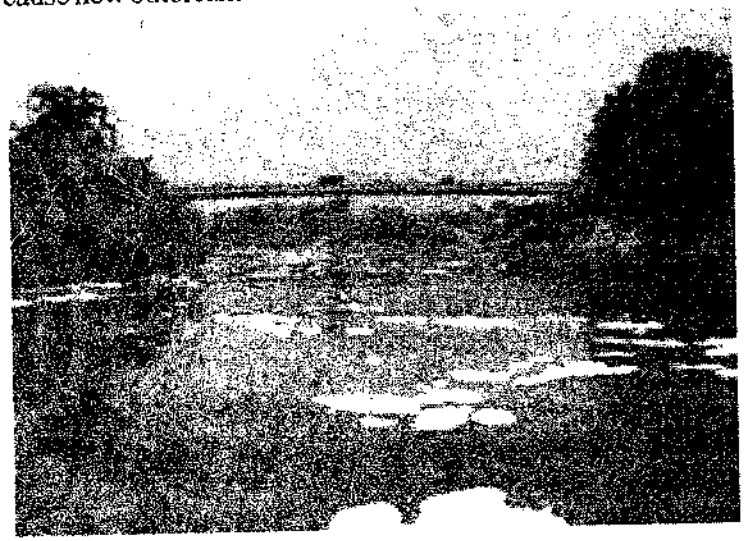

Fig 11.1 Polluted water

Waste Management

The environmental conditions of a given area may be affected by waste management, the process used to dispose of garbage. How waste is disposed of varies based on living conditions and the accepted standard of living in a geographical area. While some communities provide wastewater treatment and trash collection, others do not, which reduces the ability to control the well-being of the environment and its people. When waste is not removed and treated properly, pollution may lead to the spread of disease; when proper disposal and treatment methods are followed, disease and pollution can usually be reduced.

Solid Waste Management

Every day, people throw away a large amount of garbage, which is usually referred to as solid waste. In many countries, some form of solid waste management system has been put in place. Some common ways to dispose of the garbage include incarceration, which is the burning of waste, or landfills, which are places to store waste. In the United States and Europe, both of these methods are commonly used to manage solid waste.

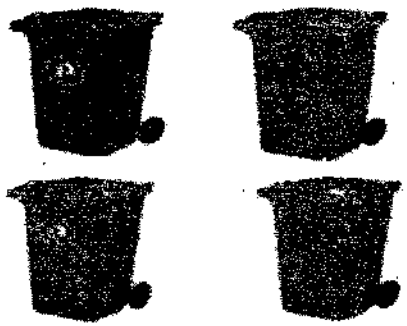

Fig. 11.2 Proper disposal of waste

Industrial Waste Management

Environmental sanitation is not limited to the pollution of water and the improper disposal of household waste. When factories or businesses dispose of chemical and physical waste in ways that directly affect the environment, it is often referred to as industrial pollution. For example, while the actual dumping site may occur several miles away from a main source of water, drainage and rainfall can cause chemicals and physical waste to mix with the water supply and pollute it. Some countries have developed a system to properly dispose of industrial waste and help protect the environment; as with household waste, some of these systems incorporate incarceration and landfills into their management strategies.

Air Pollution and Noise Control

Another factor of a healthy environment is air pollution; many studies have shown the negative effects of air pollution on the environment.

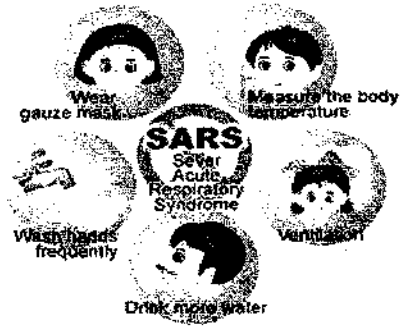

Fig. 11.2 Proper disposal of waste

Air pollution can also affect a person's ability to breathe, which can potentially increase the number of lung and heart problems in the members of a community. Irritating and excessive noise in the environment can also cause anxiety attacks or lead to distractions, among other things, which can lead to accidents and other potentially hazardous situations.

Ways to Help

There are a number of ways to help keep the environment clean and help improve people's overall health status:

1. Individuals should avoid wasting water. They can do this by taking shorter showers, not leaving the water running, and using only what water is needed.
2. People should recycle as much as possible to reduce waste. Many major cities offer recycling for plastic, paper, and glass products.
3. Individuals can walk, ride a bike, or carpool to reduce air pollution.
4. Each person can educate others on ways to help improve the environment.

According to the World Health Organization (WHO), there are four areas that must be reviewed in order for environmental sanitation to be effective: planning, water supply,sanitation, and hygiene education. The WHO offers guidelines for these steps on their website to help implement environmental hygiene programs nationwide and improve overall health.

Trachoma

Trachoma is an eye disease caused by ocular infection with Chlamydia trachomatis, which can result in blindness after cycles of repeated infections. The evidence is substantial that trachoma transmission is associated with poor personal hygiene and environmental sanitation risk factors. In southern Sudan, the nomadic nature of most communities has been suggested to be associated with flies, poor hygiene, and poor sanitation. It is estimated that only 27% and 16% of the population in southern Sudan has access to improved water sources and sanitation facilities, respectively. Trachoma risk-factor studies are needed to investigate the relative importance of transmission mechanisms in different communities because these may vary, reflecting differences in environment and cultures.

Trachoma is a major cause of preventable blindness. This infectious eye disease typically affects people in impoverished communities lacking adequate access to clean water, sanitation, hygiene and healthcare. If left untreated, trachoma leads to total blindness.

The World Health Organization recommends the SAFE strategy encompassing Surgery, Antibiotics, Facial cleanliness and Environmental improvement—for preventing trachoma.

Since 1995, World Health Organization's have strived for development of a trachoma curriculum to encourage the teaching of health and hygiene behaviors to prevent trachoma. This curriculum is now integrated into the health education programs of numerous schools in trachoma-endemic regions of the world.this program is building national capacity to eliminate trachoma, providing surgical correction of trichiasis (the advanced, blinding stage of trachoma), distributing antibiotics, and facilitating eye health education and environmental sanitation improvement. And also targets for antibiotic distribution and latrines, and is close to achieving its targets for surgeries and eye health.

Conjunctivitis

Conjunctivitis is one of the most common and treatable eye infections in children and adults. Often called "pink eye," it is an inflammation of the conjunctiva, the tissue that lines the inside of the eyelid. This tissue helps keep the eyelid and eyeball moist.

Conjunctivitis can be caused by a virus, bacteria, irritating substances (shampoos, dirt, smoke, and especially pool chlorine), allergens (substances that cause allergies) or sexually transmitted infections (STIs). Pink eye caused by bacteria, viruses, and STIs can spread easily from person to person, but is not a serious health risk if diagnosed promptly.

Symptoms

- Redness in the white of the eye or inner eyelid
- Greater amount of tears
- Thick yellow discharge that crusts over the eyelashes, especially after sleep (in conjunctivitis caused by bacteria)
- Other discharge from your eye (green or white)
- Itchy eyes (especially in conjunctivitis caused by allergies)
- Burning eyes (especially in conjunctivitis caused by chemicals and irritants)
- Blurred vision
- Increased sensitivity to light

See your ophthalmologist , if you have any of these persistent symptoms. Ear infections also commonly occur in children who have bacterial conjunctivitis. The ophthalmologist will examine your eyes and possibly take a sample of fluid from the eyelid with a cotton swab. Bacteria or viruses that may have caused conjunctivitis can then be seen through a microscope.

How is conjunctivitis treated?

- **Bacteria**

Conjunctivitis caused by bacteria is treated with antibiotics, a type of medicine prescribed by your doctor. The antibiotic can be given as eye drops, ointments, or pills. Eye drops or ointments may need to be applied to the inside of the eyelid three to four times a day for five to seven days. It may be difficult to apply ointments inside of a child's eye. If the ointment gets as far as the eyelashes, it will most likely melt and enter the eye. Pills may need to be taken for several days. The infection should improve within a week. Take the medicine as instructed by your doctor, even if the symptoms go away.

- **Virus**

Medicine cannot treat conjunctivitis caused by a virus. This type of conjunctivitis often results from a common cold. Just as a cold must run its course, so must this form of conjunctivitis, which will last from 4 to 7 days. You may, however, help relieve symptoms by applying a cold compress.

- **Irritating substance**

To treat this type of conjunctivitis, use warm water for five minutes to wash the irritating substance from the eye. You should also avoid further exposure to the irritating substances. Your eyes should begin to improve within four hours after washing away the substance. If they do not, call your doctor.

- **Allergies**

Allergy-associated conjunctivitis should be evaluated by your ophthalmologist and an allergist. It may disappear completely when the allergy is treated with antihistamines or the when the allergen is removed. Relieve symptoms temporarily by applying a cold compress on closed eyes.

- **Ophthalmia neonatorum and STIs**

The same bacteria that causes the sexually transmitted infections chlamydia and gonorrhea can also infect the conjunctiva. This is called ophthalmia neonatorum and is most commonly spread during birth as the infant passes through the birth canal of an infected mother. Newborns are usually given eye drops immediately after birth to treat any possible infection.

Conjunctivitis can also be spread through hand contact when rubbing the eyes or touching contact lenses after touching infected genitals. Oral antibiotics in the form of pill, eye drops, or ointment are usually prescribed for treatment. Washing hands thoroughly can help prevent the spread of this type of conjunctivitis.

Being around a person who has conjunctivitis and wearing contact lenses may increase your risk of getting conjunctivitis, but the outcome is usually very good with treatment. The eyes can become re-infected. Call your doctor if symptoms last for more than three days after treatment.

What can I do to help relieve symptoms?

- Protect your eyes from dirt and other irritating substances.
- Remove contact lenses, if you wear them.
- Place cold compresses on your eyes.
- Wash your face and eyelids with mild soap or baby shampoo and rinse with water to remove irritating substances.

How can I prevent spreading the infection?

- Don't touch or rub the infected eye(s).
- Wash your hands often with soap and warm water.
- Wash any discharge from your eyes twice a day using a fresh cotton ball or paper towel. Afterwards, discard the cotton ball and wash your hands with soap and warm water.
- Wash your bed linens, pillowcases, and towels in hot water and detergent.
- Avoid wearing eye makeup.
- Don't share eye makeup with anyone else.
- Never wear another person's contact lens.
- Wear glasses instead of contact lenses. Throw away disposable lenses or be sure to clean extended wear lenses and all eyewear cases.
- Avoid sharing common articles such as unwashed towels, cups, and glasses.
- Wash your hands after applying the eye drops or ointment to your eye or your child's eye.
- Do not use eye drops in a non-infected eye that were used for an infected one.

If your child has bacterial or viral conjunctivitis, keep him or her home from school or day care until he or she is no longer contagious.

Summary

This chapter briefly describes about the water management, Waste management, Solid waste management, Industrial waste management, and Air pollution. Ignoring this description and by polluting the environment can lead to severe health hazard and various eye problems like trachoma, conjunctivitis e.t.c. So prior knowledge and with proper management we can save our mother earth from pollution, thereby improving our health standards.

Short Answer Type Questions

1. Importance of water management
2. What do you mean by waste and solid waste management?
3. How do you reduce air pollution.
4. Improper environomental sanitation leads to which eye problems.
5. Expand SARS, and what do you mean by it.
6. What is conjunctivitis?

Long Answer Type Questions

1. What do you mean by environomental sanitation? Explain briefly?
2. What are the eye problems caused by polluting the environoment?
3. What are the main causes for environomental pollution?
4. What is the role of optometrist in environomental sanitation?

UNIT 12

Cataract

A **cataract** is a clouding that develops in the crystalline lens of the eye or in its envelope (lens capsule), varying in degree from slight to complete opacity and obstructing the passage of light Early in the development of age-related cataract, the power of the lens may be increased, causing near-sightedness (myopia), and the gradual yellowing and opacification of the lens may reduce the perception of blue colors. Cataracts typically progress slowly to cause vision loss, and are potentially blinding if untreated. The condition usually affects both eyes, but almost always one eye is affected earlier than the other.[1]

A **senile cataract**, occurring in the elderly, is characterized by an initial opacity in the lens, subsequent swelling of the lens and final shrinkage with complete loss of transparency. Moreover, with time the cataract cortex liquefies to form a milky white fluid in a **Morgagnian cataract**, which can cause severe inflammation if the lens capsule ruptures and leaks. Untreated, the cataract can cause phacomorphic glaucoma. Very advanced cataracts with weakzonules are liable to dislocation anteriorly or posteriorly.

Some children develop cataracts, called **congenital cataracts**, before or just after birth; these are usually dealt with differently from cataracts in adults.

Cataract derives from the Latin cataracta meaning "waterfall"

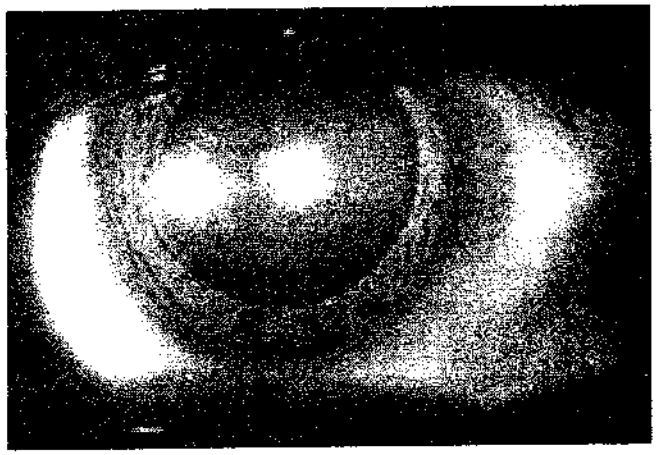

Fig. 12.1 Magnified view of cataract

Signs and Symptoms

As a cataract becomes more opaque, clear vision is compromised. A loss of visual acuity is noted. Contrast sensitivity is also lost, so that contours, shadows and color vision are less vivid. Veiling glare can be a problem as light is scattered by the cataract into the eye. The affected eye will have an absent red reflex. A contrast sensitivity test should be performed, and if a loss in contrast sensitivity is demonstrated, an eye specialist consultation is recommended.

It may be advisable to seek medical opinion, particularly in high-risk groups such as diabetics, if a "halo" is observed around street lights at night, especially if this phenomenon appears to be confined to one eye only.

Causes

Several factors can promote the formation of cataracts, including long-term exposure to ultraviolet light, exposure to ionizing radiation, secondary effects of diseases such as diabetes, hypertension and advanced age, or trauma (possibly much earlier); they are usually a result of denaturation of lens protein. Genetic factors are often a cause of congenital cataracts, and positive family history may also play a role in predisposing someone to cataracts at an earlier age, a phenomenon of "anticipation" in presenile cataracts. Cataracts may also be produced by eye injury or physical trauma. A study among Icelandair pilots showed commercial airline pilots are three times more likely to develop cataracts than people with nonflying jobs. At least 39 former

astronauts have developed cataracts, of whom 36 were involved in high-radiation missions such as the Apollo missions.

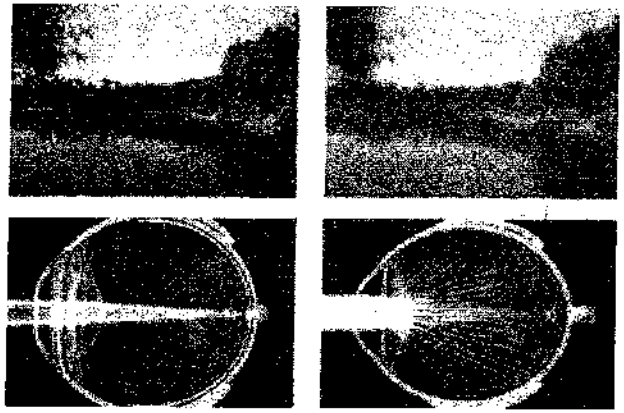

Fig. 12.2 Vision in Cataract

Vision in Cataract

Cataracts are also unusually common in persons exposed to infrared radiation, such as glassblowers, who suffer from exfoliation syndrome. Exposure to microwave radiation can cause cataracts!

Atopic or allergic conditions are also known to quicken the progression of cataracts, especially in children. Cataracts can also be caused by iodine deficiency.

Cataracts may be partial or complete, stationary or progressive, hard or soft.

Some drugs can induce cataract development, such as corticosteroids and the anti-psychotic drug quetiapine (sold as Seroquel, Ketipinor, Quepin).

There are various types of cataracts, e.g. nuclear, cortical, mature, and hypermature. Cataracts are also classified by their location, e.g. posterior (classically due to steroid use) and anterior (common (senile) cataract related to aging).

Classification

The following is a classification of the various types of cataracts. This is not comprehensive, and other unusual types may be noted.

Fig. 12.3 Bilateral caract in a kid

Classified by etiology

Age-related cataract

- Cortical senile cataract
- Immature senile cataract (IMSC): partially opaque lens, disc viewhazy
- Mature senile cataract (MSC): completely opaque lens, no disc view
- Hypermature senile cataract (HMSC): liquefied cortical matter:

Morgagnian cataract

- Senile nuclear cataract
- Cataracta brunescens
- Cataracta nigra
- Cataracta rubra
- Congenital cataract
- Sutural cataract
- Lamellar cataract
- Zonular cataract
- Total cataract

Secondary cataract

- Drug-induced cataract (e.g. corticosteroids)
- Traumatic cataract
- Blunt trauma (capsule usually intact)
- Penetrating trauma (capsular rupture and leakage of lens material calls for an emergency surgery for extraction of lens and leaked material to minimize further damage)

Prevention

Although cataracts have no scientifically proven prevention, wearing ultraviolet-protecting sunglasses may slow the development of cataracts It has been suggested that regular intake of antioxidants (such as vitamins A, C and E) is helpful, but taking them as a supplement has not been shown to have a benefit.

Although statins are known for their ability to lower lipids, they are also believed to have antioxidant qualities. Oxidative stress is believed to play a role in the development of nuclear cataracts, which are the most common type of age-related cataracts.

Management

The most effective and common treatment is to make an incision (capsulotomy) into the capsule of the cloudy lens to surgically remove it. Two types of eye surgery can be used to remove cataracts: extracapsular cataract extraction (ECCE) and intracapsular cataract extraction (ICCE).

ECCE surgery consists of removing the lens, but leaving the majority of the lens capsule intact.High frequency sound waves (phacoemulsification) are sometimes used to break up the lens before extraction.

Intra-capsular (ICCE) surgery involves removing the lens and lens capsule, but it is rarely performed in modern practice.

In either extracapsular surgery or intracapsular surgery, the cataractous lens is removed and replaced with a plastic lens (an intraocular lens implant) which stays in the eye permanently.

Summary

Cataracts

Overview

Cataract is clouding of the eye lens that reduces the amount of incoming light and results in deteriorating vision. Cataract is often described as being similar to looking through a waterfall or waxed paper. Daily functions such as reading or driving a car may become difficult or impossible. Eyeglass prescriptions may require frequent changes. An estimated 200 million people worldwide have cataracts.

Minor lens opacities at birth may never progress to cataract in adulthood, while others progress to a degree requiring surgery or causing blindness. Many factors influence vision and cataract development including age, nutrition, heredity, medications, toxins, health habits, sunlight exposure, and head trauma. Hypertension, kidney disease, diabetes, or direct trauma to the eye can also cause cataract.

There are three main types of cataracts. The most common is nuclear cataract. Nuclear cataract occurs when proteins of the nucleus (center) degenerate and darken, causing light to scatter. The second most common type, cortical cataract, occurs in the cortex (or periphery) of the lens. Cortical cataract forms when the order of fibers in the cortex is disturbed and the gaps fill with water and debris, thus altering the pathophysiology of light by scattering and/or absorbing it. The least common type affects the back of the lens and is called posterior subcapsular cataract.

This protocol provides information about cataracts; its nature, etiology, physiology, pathophysiology, and current treatments.

Nutritional approaches to protecting the eye and preventing or slowing cataract progression of cataracts is provided. This information On cataracts and nutritional supplements should enable the reader to understand the beneficial effects of nutrition on cataract prevention.

Scientific Summary

The most widely accepted conventional surgical treatment is removal of the lens and implantation of an artificial lens (IOL). Surgical treatment is recommended when a cataract progresses to the point that it impairs visual function. Before this point is reached, conventional medicine often takes a "watchful waiting" approach, considering cataracts to be an age-related, unfortunate, but inevitable, fact of life. In contrast are a growing contingent of

physicians, researchers, and nutritional scientists who have a more proactive view of cataract prevention and treatment. This holistic approach to maintain healthy lens function and eye health includes awareness of risk factors (e.g., smoking, alcohol, and sunlight), compliance with a sensible diet (e.g., low-fat, high-fiber), exercising, and nutritional therapy specifically for the eye.

Lifestyle Changes

Wear protective eyewear and avoid the following risk factors:

- Avoid smoking, excessive alcohol consumption, exposure to sunlight (particularly UV radiation), and excessive exposure to Xray and gamma irradiation.
- Life Extension's Solarshield sunglasses to protect from:
- Blue and UV radiation
- Preservation of essential macular pigment

Short Answer Type Questions

1. Define cataract.
2. What are the causes for cataract?
3. What is secondary cataract?
4. What is the meaning of the name "cataract"?
5. What is the vision status in cataract?
6. What is the retinoscopy result in cataract?

Long Answer Type Questions

1. What are the signs and symptoms of cataract?
2. What are the different types of cataract?
3. What are the causes for formation of cataract?
4. What is the treatment for cataract?

UNIT 13

Governement & Non-Government Agencies in Eye Care

Government and Non-government Agencies serving the community in the field of ophthalmology

Government Agencies

1.Gandhi Hospital

2.Sarojini Devi Eye Hospital

3.All E.S.I Hospitals

4.Railway Hospitals for Central Government Employees

5.Defence eye hospitals for central government defence employees.

Private Agencies

1. L V Prasad eye institute
2. Sadhuram eye hospital and its satellite centers
3. All Lions eye hospitals
4. Malla Reddy eye hospital
5. Medicity eye hospital
6. Narayana hridayalaya eye hospital
7. Dr.Aggarwals eye hospital
8. Aravind eye hospital
9. Vasan eye care E.T.C

Glossary

Aberration: Distortions, related to astigmatism , that cause the inability of light rays entering the eye to converge (come together) to a single focus point on the retina . Aberration are divided into two main categories: higher-order and lower-order.

Ablation: Surgical removal of tissue, typically using a cool beam laser .

Ablation zone: The area of tissue that is removed during laser surgery.

Accommodation: Ability of the eye to change its focus between distant objects and near objects.

Acuity: Sharpness, acuteness, or keenness of vision.

Acute: Occurring suddenly.

Adnexa: Accessory structures of the eye, including the eyelids, lacrimal apparatus, etc.

AK: Astigmatic Keratotomy , modified form of Radial Keratotomy (RK).

Amblyopia: Dullness or obscurity of sight for no apparent organic reason, therefore not correctable with glasses or surgery. Sometimes called a lazy eye, wherein one eye becomes dependent on the other eye to focus, usually developed in early childhood. Often associated with strabismus .

Amsler grid: Hand held chart featuring horizontal and vertical lines, usually white on black background, used to test for central visual field defects.

Angle: Drainage area of the eye formed between the cornea and the iris , named for its angular shape, which is why you see the word "angle" in the different glaucoma names.

Anisometropia: Condition of the eyes in which they have unequal refractive power .

Anterior chamber: Space between the cornea and the crystalline lens , which contains aqueous humor .

Anterior ocular segment: Part of the eye anterior to the crystalline lens , including the cornea , anterior chamber , iris and ciliary body .

Antioxidants: Micronutrients that destroy or neutralize free radicals, molecules that have been implicated as one causative factor in the stimulation of abnormal cellular reproduction (cancer) and cellular destruction (aging).

Antireflective coating: Coating on the front or back of glasses lenses, which minimizes the glare for patients who are extremely bothered by glare.

Aphakia: Absence of the lens of the eye.

Aqueous humor: Transparent fluid occupying the anterior chamber and maintains eye pressure.

Argon laser: device used to treat glaucoma (usually open angle) and diabetic retinopathy using a thermal beam.

ARMD: age related macular degeneration: Destruction and loss of the photoreceptors in the macula region of the retina resulting in decreased central vision and, in advanced cases, blindness.

Asthenopia: Eyestrain.

Astigmatic Keratotomy (AK): Treats astigmatism by flattening the cornea with arc-shaped incisions in its periphery, similar to RK.

Astigmatism: Structural defects of the eye in which the light rays from a viewed object do not meet in a single focal point, resulting in blurred images being sent to the brain. An astigmatic cornea is not perfectly rounded like a basketball but has an irregular shape more like the side of a football. Astigmatism is most often combined with myopia or hyperopia .

Automated Lamellar Keratoplasy (ALK): Procedure that predates LASIK eye surgery and is not generally used any more.

Automated perimeter: Computer-driven device used to plot defects in the visual field (peripheral vision or side vision). Usually, this is a large hemisphere shell into which the patient's head is placed. Various points of lights, sometimes of different sizes, intensities and colors are projected onto the screen. The patient then indicates whether the light is seen and the response is recorded. The computer then plots the effective visual thresholds within the targeted visual field.

Axis: Optical - a straight line through the centers of both surfaces of a lens. Visual - a straight line from the object of vision to the fovea of the eye.

BCVA: Best corrected visual acuity.

Best corrected visual acuity (BCVA): Best possible vision a person can achieve with corrective lenses, measured in terms of Snellen lines on an eye chart .

Beta-carotene: Member of the carotinoid family of vitamins, a precursor to vitamin A, thought to be beneficial to the eyes, helpful in treating diseases such as glaucoma.

Bifocals: Lenses containing two focal lengths, usually arranged with the focus for distance above and near focus below.

Binocular vision: Simultaneous use of the two eyes. Normal binocular vision yields a stereoscopic image and parallax-induced depth perception.

Blepharitis: Inflamation of the eyelids, a common problem which tends to be reoccuring in nature.

Blind spot: The area of the optic disk where the optic nerve fibers exit the eye and where there are no light-sensitive cells. This small area can be measured and in glaucoma, as the nerve fibers die, the blind spot tends to enlarge and elongate. This is one of the diagnostic hallmarks of glaucoma.

Bowman's membrane: Extremely thin second layer of the cornea , situated between the epithelium and stroma , thought to be responsible for epithelium adhesion.

Capsular haze: A thin film of scar tissue that occasionally forms on the posterior capsule behind the intraocular lens implant following cataract surgery and removed with a Nd:Yag laser.

Caruncle: Small, red portion of the corner of the eye that contains modified sebaceous and sweat glands.

Cataract: Gradual clouding of the crystalline lens resulting in reduced vision or eventual blindness, correctable by cataract surgery .

Cataract surgery: Removal of a cataract , replacing it with an intraocular lens implant .

Central islands: Central islands are a small mound of central tissue, which can interfere with vision and occur when the laser beam does not uniformly remove tissue in the center of the treatment.

Choroid membrane: Dark, vascular , thin skin-like tissue, situated between thesclera and the retina , forming the middle coat of the eye. The choroid membranenourishes the outer portions of the retina and absorbs excess light.

Chronic: Of long duration, going on for some time.

Closed angle glaucoma: Glaucoma conditions occurring suddenly (acute).

Ciliary body: Part of the eye that connects the choroid membrane to the iris . Produces aqueous humor that fills the front part of the eye and maintains eye pressure.

Ciliary muscle: Muscle attached to the crystalline lens responsible for focus (the same as ciliary body , but used in a different context).

Clear Lens Extraction (CLE): Procedure in which the eye's natural clear crystalline lens is removed and replaced with an intraocular lens implant , using the same technique as cataract surgery.

Colorblindness: Inaccurate term for a lack of perceptual sensitivity to certain colors. Absolute color blindness is almost unknown.

Color vision: Ability to perceive differences in color, including hue, saturation and brightness.

Comprehensive eye exam: Evaluation of the complete visual system.

Conductive Keratoplasty (CK): Procedure in which a radio frequency probe, rather than a laser , is used to reshape the cornea . It is approved for low to moderatehyperopia in patients over age 40, however it does not appear to have the precision ofLASIK .

Cones: One of the two types of light-sensitive cells, concentrated in the center of theretina (also see rods). There are about 6.5 million cones in each eye - 150,000 cones in every square millimeter - responsible for detailed visual acuity and the ability to see in color.

Conjunctiva: Mucous membrane lining the inner surface of the eyelids and covering the front part of the sclera (white part of eye), responsible for keeping the eye moist.

Conjunctivitis: Inflammation or irritation of the conjunctiva . Symptoms can be present in just one eye, or it can affect both eyes and include redness of the eyes or the edges of the eyelids, swelling of the eyelids or itching.

Contact lens: Small, thin removable plastic lens worn directly on the front of the eyeballs, usually used instead of ordinary eyeglasses for correction or protection of vision.

Convergence: Turning of the eyes inwards so that they are both "aimed" towards a nearobject being viewed. Normally works in harmony with divergence which is used for more distant objects.

Cornea: Transparent tissue that forms the front part of the eyeball, covering the irisand pupil. The cornea is the first part of the eye that bends (or refract s) the light and provides most of the focusing power.

Corneal curvature: Shape of the front of the eye.

Corneal mapping, topography: A tool used to see the refractive problems that might be present in the cornea. Corneal topography is used not only for screening all patients before refractive surgery like LASIK but also for fitting contacts.

Corneal relaxing incisions (CRIs): True corneal incisions, such as RK and AK .

Corneal transplant (penetrating keratoplasty): Surgical operation of grafting a replacement cornea onto an eye.

Crystalline lens: Double convex, transparent part of the eye, located behind the irisand in front of the vitreous body. Serves in conjunction with the cornea to refractincoming rays of light onto the retina .

Cylinder: Refers to the degree of astigmatism (uneven roundness) present in the cornea.

Depth perception: Ability of the vision system to perceive the relative positions of objects in the visual field.

Detached retina: A retinal detachment occurs when the retina is pulled away from its normal position in the back of the eye.

Diabetes mellitus: Chronic metabolic disorder characterized by a lack of insulin secretion and/or increased cellular resistance to insulin, resulting in elevated blood levels of simple sugars (glucose) and including complications involving damage to the eyes, kidneys, nervous system and vascular system

Diabetes type I (IDDM): Insulin dependent, resulting from destruction of the insulin producing pancreatic islet cells

Diabetes type II (NIDDM): Non-insulin dependent, resulting from tissue resistance to insulin

Diabetic retinopathy: Deterioration of retina l blood vessels in diabetic patients, possibly leading to vision loss.

Dilated, dilation: Enlargment of the pupil (space in the middle of the iris).

Diopter: Unit of measure of the refractive power of an optical lens (equal to the power of a lens with a focal distance of one meter). A negative diopter value (such as -3D) signifies an eye with myopia and positive diopter value (such as +3D) signifies an eye with hyperopia .

Diplopia: Condition in which a single object is perceived as two; also called double vision.

Divergence: Turning of the eyes outwards so that they are both "aimed" towards the object being viewed. Normally works in harmony with convergence.

Double vision: Same as diplopia.

Dry eye: A common condition that occurs when the eyes do not produce enough tears to keep the eye moist and comfortable.

Emmetropia: Six/six vision.

Endothelium: Cellular tissue that covers the inner surface of the eye within the closed cavity, typically referring to the cornea .

Enhancement: An additional LASIK procedure, used in the refinement of Personal Best Vision.

Epithelium: Cellular tissue that covers the outer surface of the eye. Consists of one or several layers of cells with only little intercellular material.

Esophoria: Position of the eyes in an over-converged position compensated by the external eye muscles so that the eyes do not appear turned inward.

Esotropia: Position of the eyes in an over-converged position so that non-fixating eye is turned inward. One eye looks straight; one looks inward.

Excimer laser: Laser used in LASIK surgery that operates in the ultraviolet wavelength, producing a cool beam.

Exophoria: Position of the eyes in an over-diverged position compensated by the external eye muscles so that the eyes do not appear turned outward.

Exotropia: Position of the eyes in an over-diverged position so that non-fixating eye is turned outward. One eye looks straight ahead and one turns outward.

Extracapsular cataract surgery: Surgery in which the cataract is removed in one piece through a larger incision, which usually requires several stitches.

Extraocular muscles: Six muscles that control eye movement. Five originate from the back of the orbit; the other one originates from the lower rim of the orbit. Four move the eye up, down, left and right, the other two control the twisting motion of the eye when the head tilts. All six muscles work in unison; when they do not function properly, the condition is called strabismus .

Eye chart: Technically called a Snellen chart, a printed visual acuity chart consisting of Snellen optotypes, which are specifically formed letters of the alphabet arranged in rows of decreasing letter size.

Eyelid: Either of two movable, protective, folds of flesh that cover and uncover the front of the eyeball.

Farsighted: Common term for hyperopia .

FDA: Abbreviation for the Food and Drug Administration. It is the United States governmental agency responsible for the evaluation and approval of medical devices.

Femtosecond laser: Used in the IntraLASIK procedure to make a safer and more precise flap than the older mechanical microkeratome technology, it uses a longer wavelength, smaller spot, and shorter duration per pulse than the excimer laser used to reshape the cornea .

Field of vision: Entire area which can be seen without shifting the gaze.

Flap: Part of the cornea consisting of epithelium , Bowman's membrane and somestroma , cut with a remaining hinge and lifted up as part of the LASIK procedure.

Flashes & floaters: Light spots or streaks and dark moving specks due to the vitreous traction on the retinal (light flashes) and solid vitreous material or blood (floaters).

Fluorescein angiography: Diagnostic test by which the veins deep inside the eye are examined. Dye is injected into a vein in the arm and circulated by the blood to the back of the eye, allowing for visual examination.

Fovea: Small depression in the retina , the point where vision is most acute.

Fundus: Furthest point at the back of the eye, consisting of the retina , choroid membrane , sclera , optic disc and blood vessels, seen by means of the ophthalmoscope.

Ghost image: Faint second image of the object you are viewing.

Giant papillary conjunctivitis: Type of conjunctivitis wherein bumps or ridges form on the inside of eyelids, which make wearing contact lenses uncomfortable; in fact, this condition is often caused by overwearing of certain contact lenses

Glare: Scatter from bright light that decreases vision.

Glaucoma: Painless disease of the eye characterized by increased pressure within; left untreated it leads to a gradual impairment of sight often resulting in blindness.

Gonioscopy: Viewing procedure utilizing a mirror/lens device placed directly upon thecornea that is used to view the drainage area called "the angle" through which aqueous fluid exits the eyeball.

Halos: Rings around lights due to optical imperfections in, or in front of, the eye.

Haptics: The arms of an intraocular lens , which holds it in place once inserted inside the eye.

Haze: Corneal clouding that causes the sensation of looking through smoke or fog.

Heterophoria: Constant tendency of one eye to deviate in one or another direction due to imperfect balance of ocular muscles.

Holmium laser: A laser which operates in the infrared wavelength, producing a hot beam. It is used in Laser Thermokeratoplasty surgery and more commonly in surgical procedures involving the disintegration of stones and fibrous tissue ablation .

Hyperopia: Also called farsightednesss, hyperopia is the inability to see near objects as clearly as distant objects, and the need for accommodation to see distant objects clearly.

Hypoxia: Deficiency of oxygen supply to a tissue.

Image: Light reflected into the eye, off objects in front of the eye. This light contains all the information about the objects (such as color, shadow. motion and detail) that are translated to the brain and allow you to "see" (know about the objects).

Inflammation: Body's reaction to trauma, infection, or a foreign substance, often associated with pain, heat, redness, swelling, and/or loss of function.

Informed Consent Form: Document disclosing the risks, benefits, and alternatives to a procedure.

In Situ: Term meaning "in place".

Intracapsular cataract surgery: Cataract surgery in which both the lens and capsule are completely removed, a rarely used procedure.

Intraocular lens implant (IOL): Permanent, artificial lens surgically inserted inside the eye to replace the crystalline lens following cataract surgery or clear lens extraction .

Intraocular pressure (IOP): Fluid pressure within the eye created by the continual production and drainage of aqueous fluid in the anterior chamber .

Iridotomy: Treatment for closed-angle glaucoma, one of the many types of glaucoma, usually done with a laser .

Iris: Colored part of the eye. Elastic, pigmented, muscular tissue in front of thecrystalline lens that regulates the amount of light that enters the eye by adjusting the size of the pupil in the center.

Ischemia: Restriction or blockage of blood flow through a blood vessel. Ischemia is a causative agent of certain heart attacks and strokes and is involved in various types of visual field losses.

Intacs: Surgically implanted plastic half rings that change the shape of the cornea .

Keratectomy: Surgical removal of cornea l tissue.

Keratitis: Inflammation of the cornea

Keratotomy: Surgical incision (cut) of the cornea . .

Keratoconous: Rare, serious, degenerative cornea l disease, in which the corneathins and assumes the shape of a cone.

Keratomileusis: Carving of the cornea to reshape it.

Keratoplasty: Surgical reshaping of the cornea .

Lacrimal apparatus: Part of the eye that produces tears.

LASEK: Laser Epithelial Keratomileusis, a refractive surgery in which the epithelium is cut with a fine blade, called a trephine, and involves displacing the cornea l epithelium as a sheet and then replacing it to (theoretically) act as a natural bandage.

Laser: Device that generates an intense and highly concentrated beam of light. Acronym for: Light Amplification by Simulated Emission of Radiation. (Also see:holmium laser , argon laser , Nd:YAG laser , femtosecond laser , and excimer laser)

Laser Thermokeratoplasty (LTK): Holmium 'hot' beam laser, instead of the 'cool' beam excimer laser, is used to treat farsighted patients and is very limited in its application; the effects are not long lasting.

LASIK: Laser Assisted In-Situ Keratomilieusis, a refractive surgery in which Excimer laser ablation is performed under a flap on the cornea to correct refractive errors .

Lazy eye: Amblyopia, an eye condition noted by reduced vision not correctable by glasses or contact lenses and is not due to any eye disease.

Lens: Same as the crystalline lens . Double convex, clear part of the eye, behind theiris and in front of the vitreous humor. Serves to refract the various rays of light so as to form an image on the retina .

Lenticular: Special non- cataract lenses for patients who have cataracts.

Lid speculum: A surgical tool that holds the eyelids open and which allows the surgeon to gain access to the eye with minimal pressure on the globe.

Limbal relaxing incisions (LRI): Small incisions placed on the far peripheral aspect of the cornea resulting in a cornea that is more round, for correcting astigmatism .

Limbus: Thin area that connects the cornea and the sclera .

Low vision: Condition occurring when ordinary eyeglasses or contact lenses are unable to bring a patient's sight up to normal sharpness.

LTK (Laser Thermal Keratoplasty): Holmium 'hot' beam laser, instead of the 'cool' beam excimer laser, is used to treat farsighted patients and is very limited in its application; the effects are not long lasting.

Lutein: Member of the carotinoid family of vitamins, similar to beta-carotene, thought to be beneficial to the eyes, helpful in treating diseases such as glaucoma.

Macula: Yellow spot on the retina , where the photoreceptors are most dense and responsible for the central vision. Has the greatest concentration of cones, responsible for visual acuity and the ability to see in color.

Macular edema: Collection of fluid in and under the macular portion of the retina .

Macular degeneration: Disease of the macula, which results in the loss of central vision.

Meridian: Orientation of a particular curve, often used in relation to the cornea .

Microkeratome: Mechanical surgical device that is affixed to the eye by use of a vacuum ring. When secured, a very sharp blade cuts a layer of the cornea at a predetermined depth.

Miosis: Pupillary constriction.

Monovision: Purposeful adjustment of one eye for near vision and the other eye for distance vision.

Mydriasis: Pupillary dilation.

Myopia: Also called nearsightedness or shortsightedness, the inability to see distant objects as clearly as near objects.

Near point of accommodation: Closest point in front of the eyes that an object may be clearly focused.

Near point of convergence: Maximum extent the two eyes can be turned inwards.

Nearsighted: Common term for myopia .

Neodymium YAG Laser: Laser used to treat Posterior Capsular Opacification (PCO) as well as open angle glaucoma Selective Laser Trabeculoplasty

Neovascularization: Often associated with diabetes, involves the formation of new blood vessels, often fragile and inappropriate for the location.

Nerve fibers/axons: Extensions of photoreceptors that form the nerve bundle that is called the optic nerve.

Neuro-ophthalmology: Subspecialty that treats the nervous and vascular systems that involve the eye.

Normal vision: Occurs when light is focused directly on the retina rather than in front or behind it.

Ocular herpes: A recurrent viral infection caused by the herpes simplex virus. Ocular herpes represents the most common infectious cause of corneal blindness in the United States.

Ocular hypertension: Elevated fluid pressure. The normal pressure is about 10 to 21mmHg, with the majority of people falling between 13 and 19. Over 21 is consideredsuspicious. Over 24 cautiously concerned - warranting immediate investigation. Over 30 is considered urgent and a potential emergency situation.

OD: Abbreviation standing for "oculus dextrum" meaning: right eye.

ONH: Optic nerve, optic nerve head. A bundle of nerve fibers about the diameter of pencil that passes through the back of the eyeball, and connects to the nerve fiber layer of the retina . It can be observed directly with an instrument called an ophthalmoscope.

Open angle glaucoma: Glaucoma conditions of long duration (chronic).

Ophthalmologist: An ophthalmologist is either a medical doctor (MD) or an osteopathic physician (D.O.) who is qualified and especially trained to diagnose and treat all eye and visual system problems, both medically and surgically, as well as diagnose general diseases of the body.

Ophthalmoscope: Instrument used to examine the interior of the eye: it consists of a perforated mirror arranged to reflect light from a small bulb into the eye.

Ophthalmoscopy: Examination of the internal structures of the eye using an illumination and magnification system.

Optic disc: The head of the optic nerve that is formed by the meeting of all retina l nerve fibers.

Optic nerve: Bundle of nerve fibers that connect the retina with the brain. The optic nerve carries signals of light to the area of the brain called the visual cortex, which assembles the signals into images called vision.

Optician: Expert who designs, verifies and dispenses lenses, frames and other fabricated optical devices upon the prescription of an ophthalmologist or an optometrist.

Optometrist: Eye care professional, graduate of optometry school, provides non-surgical visual care. Specifically educated and trained to examine the eyes, and determine visual acuity as well as other vision problems and ocular abnormalities. An optometrist prescribes glasses and contact lenses to improve visual acuity.

Orbit: Boney socket containing the eyeball, fat, extraocular muscles, nerves and blood vessels.

Orthokeratology (OK): Non-surgical procedure using contact lenses to alter the shape of the cornea to effect a change in the refractive error .

Orthoptics: Exercises designed to help the eye muscles work together to improve visual perception.

OS: Abbreviation standing for "oculus sinistrum" meaning: left eye

Overcorrection: Occurence in refract ive surgery where the achieved amount of correction is more than desired; in LASIK , typically due to a patent's over-response to the laser ablation.

Pachymeter: Instrument that measures the distance between the top of the cornea lepithelium and the bottom of the cornea l endothelium used as diagnostic testing device measuring for cornea l thickness.

Pachymetry: Exam for measuring cornea l thickness.

Papilledema: Non-inflammatory swelling/elevation of the optic nerve often due to increased intracranial pressure or space-occupying tumor.

PD: Used on prescriptions to indicate the distance between the pupils of both eyes.

Pellucid marginal degeneration: A bilateral, noninflammatory, peripheral corneal thinning disorder, which is characterized by a peripheral band of thinning of the inferior cornea.

Peripheral vision: Ability to perceive the presence, motion, or color of objects outside the direct line of vision.

Personal Best Vision: Best possible vision for each individual as corrected.

Phacoemulsification cataract surgery: Cataract removal procedure which involves making a tiny incision, about 1/8" long. A pen-like instrument, inserted through the opening, is used to emulsify and aspirate the clouded lens material, using gentle sound waves. Then an intraocular lens is inserted into place.

Phacofracture cataract surgery: Cataract surgery in which the lens is removed through a small incision by "fracturing" it into several small segments, rarely used today.

Phakic Intraocular Lenses (IOLs): Placed inside the eye without removing the natural lens, and performs much like an internal contact lens.

Phoropter: A common device found in most eye doctor's offices, with mulitple lenses, used to measure refractive errors. A phoropter calculates the prescription required for corrective lenses.

Photocoagulation: Focusing of powerful light rays onto tiny spots on the back of the eye, producing heat, which seals retina l tears and cauterizes small blood vessels.

Photophobia: Sensitivity to light.

Photoreceptors: Microscopic light-sensitive cells that are located in the retina calledrods and cones . There are approximately 7 million cones and 125 million rods

Photo Refractive Keratectomy (PRK): Surgery in which a small area on the corneal epithelium (surface cells) is gently polished away. The laser then reshapes the corneal surface in exactly the same way as for LASIK surgery.

Pingecula: Irritation caused degeneration of the conjunctiva resulting in a thickening and yellowing of the normally thin transparent tissue.

Pink eye: Type of conjunctivitis, commonly seen in children.

Posterior capsule: The thin membrane in the eye that holds the crystalline lens in place.

Posterior chamber: The back section of the eye's interior.

Posterior optical segment: Part of the eye posterior (behind) to the crystalline lens, including the vitreous, choroid retina and optic nerve.

Posterior Vitreous Detachment (PVD): Separation of the vitreous body from its attachment from the retina l surface due to shrinkage from degenerative or inflammatory conditions or trauma. An age-related condition.

Prelex: Surgical procedure that attempts to correct presbyopia.

Presbyopia: Inability to maintain a clear image (focus) as objects are moved closer. Presbyopia is due to reduced elasticity of the lens with increasing age.

Prescription: Amount of vision correction necessary, written in a form that can be utilized during the manufacture of corrective lenses or to configure a laser machine.

PRK: Acronym for Photo-Refractive Keratectomy, which is a procedure involving the removal of the surface layer of the cornea (epithelium) by gentle scraping and use of a computer-controlled excimer laser to reshape the stroma .

Progressive lenses: Bifocal or trifocal lenses which appear to be single vision with no distinct lines between the various focal lengths.

Punctal occlusion: Treatment for dry eye in which plugs are inserted into the punctum in order to retain lubricating tears naturally produced by the eye.

Punctum: The hole in the upper and lower eyelids through which tears exit the eye. In patients with dry eyes, temporary or permanent plugs may be inserted to help keep tears in the eye. Tears flow through the punctum to the nose, which is why people often experience a runny nose when crying.

Pupil: Black circular opening in the center of iris through which light passes into thecrystalline lens . It changes size in response to how much light is being received by the eye, larger in dim lighting conditions and smaller in brighter lighting conditions.

Pupillary response: Constriction and dilation of the pupil due to stimulation by light or accommodation.

Radial Keratotomy (RK): Outdated procedure once used to correct mild to moderatemyopia , whereby making a series of spoke-like incisions around its periphery flattens the cornea .

Refract: To bend aside, as in "the crystalline lens refract s the light as it passes through", or to measure the degree the eyes or lenses bend light, as in "the doctorrefract s a patient's eyes".

Refraction: Test to determine the refractive power of the eye; also, the bending of light as it passes from one medium into another.

Refractive errors: The degree of visual distortion or limitation caused by inadequate bending of light rays, includes hyperopia , myopia , and astigmatism .

Refractive power: Ability of an object, such as the eye, to bend light as light passes through it.

Refractive surgery: Type of surgery (such as LASIK) that affects the refract ion of vision.

Retina: Layer of fine sensory tissue that lines the inside wall of the eye, composed of light sensitive cells known as rods and cones . Acts like the film in a camera to capture images, transforms the images into electrical signals, and sends the signals to the brain by way of the optic nerve.

Retinal Detachment: Condition wherein retina breaks away from the choroid membrane , causing it to lose nourishment and resulting in loss of vision unless successfully surgically repaired.

RK: Abbreviation for " radial keratotomy ", an outdated procedure once used to correct mild to moderate myopia , whereby making a series of spoke-like incisions around its periphery flattens the cornea .

Rods: One of the two types of light-sensitive cells, located primarily in the side areas of the retina (also see cones). There are about 125 million rods , which are responsible for visual sensitivity to movement, shapes, light and dark (black and white) and the ability to see in dim light.

Routine eye exam: To test the overall condition of the eye and prescribe corrective measures such as glasses, contact lenses or LASIK .

Schirmer test: Test for dry eyes, which uses a thin strip of filter paper placed at the edge of the eye.

Sclera: White part of the eye. Tough covering that (with the cornea) forms the external, protective coat of the eye.

Scotoma: Area of partial or complete loss of vision surrounded by an area of normal vision, as what can occur in advanced ARMD or glaucoma.

Single vision: Lenses with only one focal length.

Slit-Lamp: Ophthalmic instrument producing a slender beam of light used to illuminate and examine the external and internal parts of the eye.

Sloan eye chart: A common chart used to test visual acuity with black letters of various sizes against a white background.

Snellen eye chart: Most common chart used to test visual acuity with black letters of various sizes against a white background.

Snellen lines: Snellen optotypes arranged in horizontal rows called "lines".

Snellen optotypes: Specifically formed letters of the alphabet arranged in rows of decreasing letter size on the Snellen chart.

Sphere: Focusing power of the corrective lens.

Stereoscopic vision: Ability to see in three-dimension.

Stereopsis: Ability to perceive three-dimensional depth.

Strabismus: Condition occurs when the muscles of the eye do not aligned properly and binocular vision is not present. Patients with a history of strabismus may develop double vision after refractive eye surgery.

Stroma: Middle, thickest layer of tissue in the cornea .

Suppression: Inability to perceive all of part of objects in the field of vision of one eye.

Suspensory ligament of lens: Series of fibers that connect the ciliary body of the eye with the lens, holding it in place; ; also known as zonules.

Sympathetic ophthalmia: Inflammation of one eye following inflammation in the other eye.

Tonometry: Procedure for the measurement of intraocular pressure. A test for glaucoma.

Topography: A tool used to see the refractive problems that might be present in the cornea. Corneal topography is used not only for screening all patients before refractive surgery like LASIK but also for fitting contacts.

Toric: Lens (eyeglasses, intraocular lens , or contact lens) that is the warped (astigmatic) opposite to that of the eye, thereby canceling out the error.

Trabecular meshwork: Drainage channels located inside the eye.

Trabeculoplasty: A procedure for the treatment of glaucoma, using a laser (Argonor Nd:YAG). Trabeculoplasty remodels the trabecular meshwork in order to increase drainage of aqueous and lower the intraocular pressure .

Trifocals: Lenses containing three focal lengths, usually arranged with the focus for distance above, intermediate distance in the middle, and near vision below.

Twenty-twenty, 20/20 vision: To have 20/20 vision means that when you stand 20 feet away from the Snellen eye chart you can see what the majority of people can see at that same distance.

UCVA: Uncorrected visual acuity.

Uveal tract: Pigmented, middle layers of the eye, which include the choroid , ciliary body and iris .

Uveitis: Inflammation of any portion of the uveal tract.

Ultrasound waves: Sound waves above 20,000 vibrations per second, above the range audible to the human ear, used in medical diagnosis and surgery.

Ultrasonography: Recordings of the echoes of ultrasound waves sent into the eye and reflected from the structures inside the eye or orbit. Ultrasonography is used to make measurements and to detect and localize tumors and retina l detachments.

Ultraviolet radiation: Radiant energy with a wavelength just below that of the visible light. UV-c is the shortest wavelength at 200-280 nm and is absorbed by the atmosphere before reaching the surface. UV-b, at 280-315 nm is the burning rays of the sun and damages most living tissue. UV-a, at 315-400 nm is the tanning rays of the sun and is somewhat damaging to certain tissues. UV radiation has been described as a contributing factor to some eye disease processes, which result in ARMD andcataract s and causes exposure keratitis.

Uncorrected visual acuity (UCVA): Best possible vision a person can achieve without corrective lenses measured in terms of Snellen lines on an eye chart .

Undercorrection: Occurence in refract ive surgery where the achieved amount of correction is less than desired; in LASIK , typically due to a patient under-responding to the laser treatment.

Vascular: Having to do with transporting blood.

Vision: The ability of the brain to see and interpret what is in front of the eyes.

Vision therapy: Orthoptics, vision training, eye exercises. Treatment process for the improvement of visual perception and/or coordination of the two eyes, for more efficient and comfortable binocular vision.

Visual acuity: Clearness of vision; the ability to distinguish details and shapes, which depends upon the sharpness of the retina l image.

Visual cortex: That part of the brain responsible for vision.

Visual field: Area or extent of space visible to an eye in a given position of gaze. There is a central visual field - the area directly in front of us, and a peripheral visual field - our "side vision". The fields of each eye partly overlap. We do not perceive the blind spots from each eye because the area that is missing in one eye is present in the other.

VISX CustomVue Procedure: WaveScan-driven laser vision correction with the potential to produce better vision than is possible with glasses or contact lenses, and enable surgeons to measure and correct unique imperfections in each individual's vision.

VISX STAR S4 Excimer laser System: Highly advanced laser technology platform, the VISX STAR S4 combines Variable Spot Scanning (VSS) and ActiveTrak 3-D Active Eye Tracking along with the WavePrint.

Vitreous humor, fluid, or body: Jelly-like, colorless, transparent substance occupying the greater part of the cavity of the eye, and all the space between thecrystalline lens and the retina .

Vitrectomy: Surgical removal of vitreous humor that is diseased or has lost its transparency.

Wavefront: Wavefront technology produces a detailed map of the eye. The information is transferred to the laser via computer software.

YAG laser surgery: Properly called Nd:Yag laser capsulotomy, a procedure using a Nd:YAG (neodymium-yttrium-aluminum-garnet) laser, used primarily to treat secondary cataract s (capsular haze) that occur subsequent to the primary cataractprocedure, or to relieve increased pressure within the eye from acute angle-closure glaucoma via a peripheral iridotomy. It can also be used to treat open angle glaucoma in a procedure called selective laser trabeculoplasty.

Notes