Dept-Shalakyatantra

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Date- 15-4-2020

Topic of presentation- Netra Sharir and modern concept of eye anatomy

NETRA SHARIR

A separate branch namely Shalakya Tantra has been dedicated in Ayurveda to care the precious parts above the clavicles and eye is one of them. The history of Ayurveda reveals that this branch has witnessed phenomenal growth in the ancient era since Vedas to Samhita period. Shalakya Tantra being a surgical discipline has been taken up by Sushruta Samhita and is mentioned in Uttara Tantra part of the text. The beginning of the Uttara Tantra with vivid description of eye, its anatomy, classification of its diseases and their management shows the importance of this organ of sight.

शलाका,तस्या: कर्म तत्प्रधानं तन्त्रं शालाक्यं
शलाकाया यत्कर्म क्रियते तच्छालाक्यम्॥ सु.सू.१-१० टिका पान ३

Netra:

SYNONYMS OF THE EYE : Akshi, Chakshu, Drishti, Netra, Nayana, Lochana etc.

The meanings of each of the synonyms as per Ayurvedic classics are as follows :

• Akshi :–This means source of reaching or seeing, which grasps objects.

• Chakshu : Which means darshanendriya, Which is responsible for sight.

• Drishti : to see ,Means source or tool with which one sees.

• Netra : Means which takes or drives one towards knowledge

• Nayana : means ruling, governing or obtaining.

PANCHABHAUTIKA CONCEPT OF NETRA :

The Netra, like all other organs of the body is built up of 5 basic elements – the Panchamahabhutas.

For the Indriyas, Sushruta has mentioned the contribution of Panchamahabhutas as follows:

२.पलं भुवोअग्नितो रक्तं वतात् कृष्णं सितं जलात्।
आकाशाद्श्रुमर्गाश्च् जायन्ते नेत्रबुदबुदे॥ सु. उ. १-११

1	पलं	Muscular portion (Mamsabhaga)	Prithvi
2	रक्तं	Red portion	Tejas (Agni)

3	कृष्णं	Black portion	Vayu
4	सितं	White portion	Jala
5	द्श्रुमर्गा	Tear channels (Srotas)	Akasha

CHARAK Samhita panchamahabhut of netra

Agneya rupa darshanam

	Panchamahabhuta	Parts of eye(modern interpretation
1	Prithwi	Skin,solid parts
2	Jala	Fluid tears,exudates
3	Agni	Visual acuty
4	Vayu	Eye movements, eye lid mvements
5	Akasha	Lacrimal apparatus, channels in eye

VAGBHATTA (Ashtang Sangrah)

described that developmental origin of different structures is attributed to various Bhavas. The development of senses according to Vagbhatta is attributed to Kapha and Raktavaha srotas.

३. कफरक्तवहिनां स्तोतसां महाभुतानां च प्रसादादिन्द्रियणि।
तेष्वपि च नेत्रे श्लेष्मण्: प्रसादाच्छुक्लमंडलं तत् पितृजं।
असृजः कृष्णमंडलम् तन्मतृजम् । मध्ये दृष्टिमंडलं तदुभयात्मकम्। अ.सं. शा.५ पान ३२०

Eyeball Structure Bhava

		Dosha	Bhava
1	Shweta Mandala	kapha	Pitruj
2	Krishna Mandala	Rakta	Matru
3	Drishti mandala	Kapha and Rakta	Matru and Pitru

ANATOMY OF NETRA :

विद्यात् द्व्यंगुलबाहुल्यं स्वाङ्.गुष्ठोदरसंमितम्।
द्व्यंगुलं सर्वत: सार्धं भिषङ्नयनबुदबुदम्।।१०॥
सुवृत्तं गोस्तनाकारं सर्वभूतगुणोद्भवम्।सु.उ.१-९,१०

• Situation : Head is the supreme part of the human body, when compared to all other parts. All the senses are situated in and supported by the head .Two eye orbits are situated in the head, which are the shelters of two Netras, but one Chakshurindriya.

•Netraguhas are the two among the seven external openings of the Shirah

• Shape: Suvrittam, Gostanakaram and Nayana Budbudam, which denotes the shape and consistency of the Netra
a)Suvrittam : means eye is spherical from all sides.

b) Gostanakaram: Eye is shaped like the teat of cow i.e. oblong shaped or oval shaped.

c) Nayana Budbudam: Like a bubble floating on the water i.e. round in shape and soft in consistency and glossy/glistening in character, this term suggestive of external appearance of the eye in the eye orbit.

DIMENSIONS OF NETRA: The measurements of the eyeball were described by Sushruta in terms of Anguli like any other organ but, Anguli in context to measurement of Netra is equal to Swangushtodara in the words of Sushruta,

Sushruta had given two dimensions –

1. 2 Angula Bahulya- According to some scholars, the word Bahulya means antero-posterior diameter or depth of the eyeball and it is 2 Angula.
2. 2½ Angula Sarvata -The word ‘Sarvata’ can be considered as the side-to-side measurement or circumference of the eyeball; and it is 2½ Angulas. (But the exact measurement of 2½ Angula is better applicable to the side to side distance of the eye [i.e. the distance from inner canthus to outer canthus.)

ANAT0MICAL PARTS OF THE NETRA :

The anatomical parts of the eye were described by Sushruta as

5 Mandalas, 6 Sandhis and 6 Patalas.

मण्डलानि च सन्धींश्च पटलानि च लोचने ।
यथाक्रमं विजानीयत पण्च षट् च षडवे च ।। सु.उ.१-१४

Mandala The five Mandalas of the eye are :

पक्ष्मवर्त्मश्वेतकृष्णदृष्टीनां मण्डलानि तु ।
अनुपुर्वं तु ते मध्यात् चत्वारोड्न्त्या यथोत्तरम्॥ सु.उ. १-१५

1. Pakshma Mandala : This is the first and outermost Mandala of the eye formed by the Pakshma or the eyelashes.
2. Vartma Mandala : Upper and lower eyelids jointly form a circle in front of the eyeball, which is termed as Vartma Mandala.
3. Shweta Mandala : : It present just inside the Vartma Mandala and beyond the black circle. This portion appears as whitish and therefore known as Shukla Mandala
4. Krishna Mandala :The black portion of the eyeball is called as Krishna Mandala. This Mandala can be compared with the cornea.
5. Drishti Mandala : Last and innermost circular structure of the Netra encloses Drishti

Measurement

The size of krishna Mandala is 1/3rd of the whole Netra .

Taraka’ which is also 1/3rd of the total Netra.

Drishti Mandala is 1/7th of the Krishna Mandala in the opinion of Videha and Dalhana

Drishti Mandala is ‘1/9th part of the “Taraka”.

नेत्रायामत्रिभागं तुं कृष्णमण्डलमुच्यते। सु.उ.१-१३
नयनत्रिभगपरिनहा तारका । सु.सु ३५-१२
कृष्णात् स्प्तममिच्छन्ति दृष्टीं दृष्टिविशारदा:॥सु.उ.१-१३
नवमस्तारकांशो दृष्टि: ।सु.सु.३५-१२

The 6 Sandhis:

Sandhis are the junctional areas between two Mandalas.

1. Pakshma – Vartma gata Sandhi : The Union line of Pakshma Mandala and Vartma Mandala is called as the Pakshma Vartma gata Sandhi
2. Vartma – Shukla gata Sandhi : The union line of Vartma and Shukla Mandala is called as Vartma Shukla gata Sandhi.

3. Shukla – Krishna gata Sandhi :Junctional area can be considered as the sclero-corneal junction

4. Krishna – Drishti gata Sandhi : The union line of Krishna and Drishti Mandala is called as Krishna-Drishtigata Sandhi.

5. Kaneenika Sandhi : Dalhana describes this Sandhi as ‘Nasasameepasthita Sandhi’

6. Apanga Sandhi : Dalhana describes Apanga Sandhi as “Bhrupucchantah Sthitah Sandhi”.

पक्ष्मवर्त्मगत: सन्धिर्वर्त्मशुक्लगतोऽपर:।शुक्लकृष्णगतस्त्वन्य: कृष्णदृष्टिगतोऽपर:।।
तत: कनीनकगत: षष्ठश्चापाङ्.ग: स्मृत: ॥सु.उ.१-१६॥

The 6 Ptalas:

The thickness of each Patala is 1/5th of the Drishti Mandala.

There are 6 Patalas in the eyeball – 2 Vartma Patalas and 4 Akshi Patalas

The Vartma Patalas can be considered as the layers of the Vartma.

Akshi Patalas

1st Patala -Tejas + Jala (Tejojala Raktashrita - Dalhana)

2nd Patala Mamsa (Pisita or Mamsashrita)

3rd Patala Medas (Medoashrita)

4th Patala Asthi (Asthyashrita)

Dalhana Describes ‘Kalakasthi Ashrita’ Patala as the first Patala and considers it as innermost. According to him, the second Patala is Medoashrita, third Patala is Mamsashrita and the fourth Patala is Tejojalashrita

व्दे वर्त्मपटले विद्यात चत्वार्यन्यानि चाक्षिनि ।
जायाते तिमिरं येषु व्याधि: परमदारुण: ।।१७॥
तेजोजलाश्रितं बाह्यं तेष्वन्यत् पिशिताश्रितम्।
मेदस्तृतीयं पटलमाश्रितं त्वस्थि चापरम्॥
पंचमांशसमं दृष्टिस्तेष बाहुल्यमिष्यते ।सु.उ. १-१७,१८

AKSHI BANDHANA :

Siras, Kandaras, Meda and Kalkasthi with their excellent properties, which they attain inherently keep both eyes in their normal position. Shleshma along with Siras take part in the Bandhana karma of the eye .

सिराणां कण्डराणां च मेदस: कालकस्य च॥१९॥
गुणा: कालात् पर: बन्धनेड्ःक्ष्णो: सिरायुत:। सु. उ १-१९

SIRA AND DHAMANI :

There are 38 Siras, Number of siras which transport Vata – 8, Pitta -10, Kapha-10, Rakta-10 to the eyes.

अष्टौ नेत्रयो:

नेत्रर्योदश,एवं रक्तवह: कफवहाश्च। सु.शा.७-७

According to Vagbhatta sira-65,

Dhamanis- 2 in number one in each eye for transmission of Rupa (visual impulse) to mind.

Two other Dhamanis are there to drain tears

शब्दरुपरसगन्धानष्टाभिर्गृहीते,व्दे चाश्रुवाहिन्यौ,सु.शा.९-५

PESHI AND SNAYU :

There are 2 Peshis and 30 Snayus in both the eyes

REVIEW OF MODERN LITERATURE

ANATOMY OF EYE BALL

The bulb of the eye is contained in the cavity of the orbit, where it is protected from injury and moved by the ocular muscles. Associated with it are certain accessory structures, viz., the muscles, fascia, eyebrows, eyelids, conjunctiva, and lacrimal apparatus.

Eye ball has three tunic layers.

A. The Fibrous Tunic

The sclera and cornea form the fibrous tunic of the bulb of the eye;

The sclera is opaque, and constitutes the posterior five-sixths of the tunic.It is dense and hard, white in colour, firm membrane, serving to maintain the form of the bulb

The cornea is transparent, and forms the anterior one sixth. It is the projecting transparent part of the external tunic. It is almost circular in outline, occasionally a little broader in the transverse than in the vertical

The sclero-corneal junction (limbus) - In front, the sclera is directly continuous with the cornea, the line of union being termed the sclero-corneal junction.

B. The Vascular Tunic/ Uveal tract

Consists of three parts

Two posterior: the choroid and ciliary body

Anterior: The iris-free circular diaphragm.

Iris

The plane of the iris is approximately coronal: the aperture of the diaphragm is the pupil. The iris divides the anterior segment of the eye into anterior and posterior chambers, which contain aqueous humor secreted by the ciliary body.

The measurement of the pupil is about 4 mm. and it regulates the amount of light rays reaching the retina. The pupillary margin slides to and fro upon the lens capsule. When the pupil is constricted, more of the posterior surface of the iris is in contact with the lens capsule. When pupil is fully dilated, the iris may not touch the lens.

Anterior surface of the iris can be divided into two zones by a zigzag line called the collarette.

1. Ciliary zone.

2. Papillary zone.

The iris consists of three layers:

1. Endothelium:It contains crypts or tissue spaces, which communicate freely with the anterior chamber.

2. Stroma: Consists of loosely arranged connective tissue, blood vessels, nerves and two unstripped muscles – sphincter pupillae and dilator pupillae.

3. Pigment epithelium.

Two layers of pigment epithelium are situated on the posterior surface of iris.

Ciliary body

It has two parts

(i) Pars plicata: forms the anterior 1/3rd of the ciliary body (about 2 mm.).It is part of the ciliary body secretes aqueous humour.

(ii) Pars plana: Forms the posterior 2/3rd of the ciliary body (about 4 mm). It is relatively avascular

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The ciliary body consists of four layers namely,

(i) Ciliary muscles: are flat bundles of non-striated muscle fibres which are helpful in accommodation of the lens.

(ii) Stroma: of loose connective tissue of collagen and fibroblasts, nerves, pigments and blood vessels.

(iii) Ciliary processes: contains blood vessels and loose connective tissue. These are the main site of aqueous production.

(iv) Epithelium: consists of two layers of pigmented and nonpigmented epithelial cells

Nerve supply

The ciliary body: Sensory nerve fibres derived from the trigeminal nerve.

The ciliary muscle : Motor fibres from the oculomotor and sympathetic nerves.

The choroid

It is an extremely vascular membrane in contact everywhere with the sclera. It is dark brown and extends from the ora serrata up to the optic nerve aperture.

The choroids consists of three layers namely

1. Supra choroidal lamina.

2. Vascular layer or stroma. Its main bulk is formed by blood vessels, which are arranged in three layers(i) Layer of large vessels

(ii) Layer of medium vessels

(iii) Layer of chorio - capillaries.

3. Bruch's membrane.

The blood supply: posterior ciliary and anterior ciliary arteries.

C.) Nervous tunic, the retina.

The retina is a delicate nervous membrane, upon which the images of external objects are received. Its outer surface is in contact with the choroid; its inner with the hyaloid membrane of the vitreous body.

The retina consists of 10 layers namely,

1. Layer of pigment epithelium: A single layer of hexagonal cells containing melanin pigment is situated on the outer aspect of retina.

2. Later of rods and cones: These are end organs for visual sensation.

3. External limiting membrane: It lies between rods and cones and outer nuclear layers.

4. Outer nuclear layer: It consists of nuclei of rods and cones.

5. Outer plexiform layer: It consists of arborisations of the axons of rods and cones nuclei with dendrites of the bipolar cells.

6. Inner nuclear layer: It consists of nuclei of bipolar cells.

7. Inner plexiform layer: It consists of synapses of the axons of the bipolar cells with the dendrites of ganglion cells.

8. Layer of ganglion cells: Large ganglion cells are present in this layer.

9. Nerve fibre layer: These are axons of the ganglion cells. These fibres are non-medullated and are continued as optic nerve fibres.

10. Internal limiting membrane: It separates the retina from vitreous.

ANATOMY OF EYELID

The Eyelids are two thin, movable folds, placed in front of the eye.

The upper eyelid is the larger is furnished with an elevator muscle, the Levator palpebræ superioris.

When the eyelids are open, an elliptical space, the palpebral fissure (rima palpebrarum), is left between their margins,

Canthi: the angles of which correspond to the junctions of the upper and lower eyelids.

The lateral palpebral commissure/external canthus: is more acute than the medial, and the eyelids here lie in close contact with the bulb of the eye

The medial palpebral commissure/internal canthus: is prolonged for a short distance toward the nose,

Lacus lacrimalis : the two eyelids are separated by a triangular space

At the basal angles of the lacus lacrimalis, on the margin of each eyelid, is a small conical elevation, the lacrimal papilla, the apex of which is pierced by a small orifice, the lacrimal punctum , the commencement of the lacrimal duct.

Structure of the Eyelids—

The eyelids are composed of the following structures from without inward: the skin, areolar tissue, fibers of the Orbicularis oculi, tarsus, orbital septum, tarsal glands and conjunctiva. The upper eyelid has, in addition, the aponeurosis of the Levator palpebræ superioris .

Skin- The skin is extremely thin and continuous at the margins of the eyelids with the conjunctiva.

The subcutaneous areolar tissue-It is very lax and delicate, and seldom contains any fat.

The palpebral fibers of the Orbicularis oculi -are thin, pale in color, and possess an involuntary action.

Tarsal plates - are two thin, elongated plates of dense connective tissue, about 2.5 cm. in length; one is placed in each eyelid, and contributes to its form and support.

The superior tarsus - the larger, is of a semilunar form, about 10 mm. in breadth at the center, and gradually narrowing toward its extremities. To the anterior surface of this plate the aponeurosis of the Levator palpebrae superioris is attached.

The inferior tarsus - is thin, elliptical in form, and has a vertical diameter of about 5 mm. The attached or orbital margins are connected to the circumference of the orbit by the orbital septum. The lateral angles are attached to the zygomatic bone by the lateral palpebral raphé. The medial angles of the two plates end at the lacus lacrimalis, and are attached to the frontal process of the maxilla by the medial palpebral ligament. The eyelids are richly supplied with blood.

Glands of eyelid

Meibomian glands (Tarsal Glands)-The tarsal glands are situated upon the inner surfaces of the eyelids, between the tarsi and conjunctiva.There are about thirty in the upper eyelid, and somewhat fewer in the lower. They are imbedded in grooves in the inner surfaces of the tarsi. Their ducts open on the free magins of the lids by minute foramina.

Structure.—the tarsal glands are modified sebaceous glands, each consisting of a single straight tube or follicle, with numerous small lateral diverticula. The tubes are supported by a basement membrane, and are lined at their mouths by stratified epithelium.

Glands of zeis

These are modified sebaceous glands which open into the follicles of eyelashes.

Glands of Moll

These are modified sweat glands situated near hair follicles ,opens into the hair follicle or into the ducts of zeis glands.?

Accessory lacrimal glands of wolfring

These are presents near the upper border of tarsal plate.

Blood supply to eye lid

Artery –marginal arterial arcade

Vein-Arranged in two plexus,a posterior tarsal which drain into ophthalmic veins and pre-tarsal opening into subcutaneous vein.

Lymphatic –lateral half of the lids drain into pre-auricular and medial half of the eyelids drain into submandibular lymph nodes.

Nerve supply to eye lid

Motor nerve supply-Facial nerve Occulomotor nerve and sympathetic fibers

Sensory nerve supply –by branches of trigeminal nerve

ANATOMY OF CONJUNCTIVA

The conjunctiva is the mucous membrane of the eye. It lines the inner surfaces of the eyelids or palpebrae, and is reflected over the forepart of the sclera where its epithelium becomes continuous with that of cornea.

The Palpebral Portion - is thick, opaque, highly vascular, and covered with numerous papillae, its deeper part presenting a considerable amount of lymphoid tissue. At the margins of the lids it becomes continuous with the lining membrane of the ducts of the tarsal glands, and, through the lacrimal ducts, with the lining membrane of the lacrimal sac and nasolacrimal duct. At the lateral angle of the upper eyelid the ducts of the lacrimal gland open on its free surface; and at the medial angle it forms a semilunar fold, the plica semilunaris.

3parts

a.marginal conjunctiva-It is 2mm on the back of lid, extend from lid margin

b.tarsal conjunctiva-It is firmly adhe

c.orbital conjunctiva

Conjunctiva of Fornix- The line of reflection of the palpebral conjunctiva from the upper eyelid on to the bulb of the eye is named the superior fornix, and that from the lower lid the inferior fornix.

Bulbar conjunctiva—Upon the sclera the conjunctiva is loosely connected to the bulb of the eye; it is thin, transparent, destitute of papillae, and only slightly vascular. Upon the cornea, the conjunctiva consists only of epithelium, constituting the epithelium of the cornea.

In and near the fornices, but more plentiful in the upper than in the lower eyelid, a number of convoluted tubular glands open on the surface of the conjunctiva. Other glands, analogous to lymphoid follicles, and called by Henle trachoma glands, are found in the conjunctiva. Chiefly situated near the medial palpebral commissure.

The caruncula lacrimalis -It is a small, reddish, conical-shaped body, situated at the medial palpebral commissure, and filling up the lacus lacrimalis. It consists of a small island of skin containing sebaceous and sudoriferous glands, and is the source of the whitish secretion which constantly collects in this region. A few slender hairs are attached to its surface.

Plica semilunaris - Lateral to the caruncula is a slight semilunar fold of conjunctiva, the concavity of which is directed toward the cornea; it is called the plica semilunaris. Müller found smooth muscular fibers in this fold; in some of the domesticated animals it contains a thin plate of cartilage.

HISTOLOGY

Histology of conjunctiva consist of 3 layer

a. Epithelium –It is non-keratinizing layer and has various number of layers in different region.
   Marginal conjunctiva -5 layers of stratified squamous epithelium
   Tarsal conjunctiva -2layer of epithelium
   Bulbar and fornix conjunctiva -3 layer of epithelium
   Limbal conjunctiva – multi layered stratified squamous epithelium.

b.The stroma (substantia propria)It consist of richly vascularized loose connective tissue and adenoid layer

Adenoid layer-this layer does not develop until about 3 months of birth, hence the inability of new born to produce a follicular conjunctival reaction.

Accesory lacrimal glands of Krause and Wolfring are located in stroma.

c. Fibrous layer –It consist of meshwork of collagenous and elastic fibers. It also contains vessels and nerves of conjunctiva.

GLANDS OF CONJUNCTIVA

Conjunctiva has two types of glands

1 Mucin secretory glands

Goblet cells are located within the epithelium and are densest inferonasally and in the fornices

Crypts of Henle - are located along the upper third of the superior tarsal conjunctiva and lower third of the inferior tarsal conjunctiva.

Glands of Manz- Present in limbal conjunctiva.

2 Accesory Lacrimal glands

Glands of Krause –Present in subconjunctival connective tissue. About 42 are present in upper fornix and 8 in lower fornix.

Gland of Wolfrig – Present along the upper border of superior tarsus and along the lower border of inferior tarsus.

Blood supply to Conjunctiva-

Arterial supply- from three sources

1. Peripheral arterial arcade of the eye lid.

2. Marginal arcade of the eyelid made up from posterior conjunctival artery.

3. Anterior conjunctival artery branch of anterior ciliary arterie.

Venous drainage-

Veins from conjunctiva drain into venous plexus of conjunctiva, and some around the cornea into the anterior plexus.

Lymphatics of conjunctiva: It is arranged in two layers - Superficial layer and deep layer. The lymphatic drainage is into submandibular nodes which drain the medial one third of the superior conjunctiva and the medial two third of the inferior conjunctiva .The preauricular nodes which drain the lateral two third of superior conjunctiva and lateral one third of inferior conjunctiva.

Nerve supply –It consist of branches of fifth cranial nerve

1. Branches of Opthalmic division

2. Branches of maxillary division

ANATOMY OF CORNEA

The Cornea — The cornea Is most important refractive medium of the eye. It is the projecting transparent part of the external tunic. It is convex anteriorly and projects like a dome in front of the sclera.

Dimensions –

It forms the anterior sixth of the surface of the bulb.

Its degree of curvature varies in different individuals and in the same individual at different periods of life, being more pronounced in youth than in advanced life.

Average radius of curvature , Anteriorly-7.8mm and posteriorly-6.8mm.

Anterior surface is elliptical with vertical diameter of 11mm and horizontal diameter 11.7 mm.

Its posterior surface is perfectly circular in outline with average diameter of 11.5mm, and exceeds the anterior surface slightly in diameter.

Refractive power of cornea is about 45D which is about ¾ refractive power of total eye.

Refractive index of cornea-1.376

Immediately in front of the sclero-corneal junction the cornea bulges inward as a thickened rim, and behind this there is a distinct furrow between the attachment of the iris and the sclero-corneal junction.

Histology

Vertical section of human cornea (Waldeyer)consist of 5 layer

1. Epithelium.

The corneal epithelium –It covers the front of the cornea and consists of several about 5-6 layers of cells. The cells of the deepest layer are columnar; then follow two or three layers of polyhedral cells, the majority of which are prickle cells Lastly, there are three or four layers of squamous cells, with flattened nuclei.

2. Anterior elastic lamina/ anterior limiting layer/ Bowman's membrane-This layer consist of accellular mass of condense collagen fibrils. It is about 12micromm in thickness and binds the corneal stroma anteriorly with basement membrane of epithelium.It has resistance to infection but once dystroyed ,it does not regenerate.

. 3. substantia propria(Stroma)

The thickest layer of cornea about 0.5 mm in thickness..It is fibrous, tough, unyielding, and perfectly transparent. It is composed of about sixty flattened lamellae, superimposed one on another. These lamellae are made up of bundles of modified connective tissue, the fibers of which are directly continuous with those of the sclera. The fibers of each lamella are for the most part parallel with one another, but at right angles to those of adjacent lamellae.It also consist Keratocytes, macrophages, histiocytes,leucocytes.

4. The posterior elastic lamina /membrane of Descemet/ membrane of Demours-It covers the posterior surface of the substantia propria, and is an elastic,

transparent homogeneous membrane, of extreme thinness, which is not rendered opaque by either water, alcohol, or acids. When stripped from the substantia propria it curls up, or rolls upon itself with the attached surface innermost.It can regenerate.

5. Endothelium of the anterior chamber/endothelium camerae anterioris/ corneal endothelium- covers the posterior surface of the elastic lamina, is reflected on to the front of the iris, and also lines the spaces of the angle of the iris; it consists of a single stratum of polygonal, flattened, nucleated cells. The cell density of endothelium is around 3000 cells/mm square in young adult. Endothelial cells contain active pump mechanism.

Blood supply —The cornea is a non-vascular structure; the capillary vessels ending in loops at its circumference are derived from the anterior ciliary arteries.

The nerves are numerous and are derived from the anterior ciliary nerves branch of fifth cranial nerve. Around the periphery of the cornea they form an annular plexus, from which fibers enter the substantia propria. They lose their medullary sheaths .

Corneal transparency-

1. Typical arrangement of stromal lamellae.
2. Relative state of dehydration which maintain by endothelium.
3. Avascularity of cornea

Source of neutrients-

1. Solutes (Glucose and others) from aqueous by diffusion or active transport
2. Oxygens –directly from air through tear film.

Metabolism of cornea-

Epithelium and endothelium are most active layers. Epithelium is 10 time thicker than the endothelium, so requires large supply of metabolic substracts. Epithelium can metabolize glucose aerobically or anaerobically in to water, carbon-di-oxide, lacticacid.

Permeability of cornea

The action of only topically applied drug depends upon the permeability of cornea to these pharmacological drugs. Permeability of drug depends upon their lipid and water solubility. Epithelium and endothelium have 100 times more lipid contents than that of stroma. So the fat soluble drug readily penetrates these layers. However, only water soluble drugs readily penetrates the stroma .

ANATOMY OF LACRIMAL APPARATOUS

The Lacrimal Apparatus consists of the

(a) Lacrimal gland, which secretes the tears, and its excretory ducts, which convey the fluid to the surface of the eye;
(b) Lacrimal passage which include-

The lacrimal ducts,

The lacrimal sac,

The nasolacrimal duct, by which the fluid is conveye into the cavity of the nose.

(c) Accesory lacrimal glands

The Lacrimal Gland -The lacrimal gland is lodged in the lacrimal fossa, on the medial side of the zygomatic process of the frontal bone. It is of an oval form, about the size and shape of an almond.

It consists of two portions

a.The superior lacrimal glands/Orbital part-It is connected to the periosteum of the orbit by a few fibrous bands, and rests upon the tendons of the Recti superioris and lateralis, which separate it from the bulb of the eye.

b.The inferior lacrimal gland/ Palpebral part-It is separated from the superior by a fibrous septum, and projects into the back part of the upper eyelid, where its deep surface is related to the conjunctiva.

The ducts of the glands- from 6 to 12 in number, run obliquely beneath the conjunctiva for a short distance, and open along the upper and lateral half of the superior conjunctival fornix.1/2 ducts open into lower fornix.

Structures of the Lacrimal Gland—In structure and general appearance the lacrimal resembles the serous salivary glands. In the recent state the cells are so crowded with granules that their limits can hardly be defined. They contain oval nuclei, and the cell protoplasm is finely fibrillated.

Blood supply to lacrimal gland- Lacrimal artery branch of ophthalmic artery .

Nerve supply

1. Sensory supply- Lacrimal Nerve branch of ophthalmic division of Trigeminal nerve.

2. Symphathetic supply-Carotid plexus of cervical sympathetic chain.

3Secretomotor fibers –from greater petrusal nerve branch of facial nerve(?????????????)

Accesory Lacrimal glands

Glands of Krause –Present in subconjunctival connective tissue. About 42 are present in upper fornix and 8 in lower fornix.

Gland of Wolfrig – Present along the upper border of superior tarsus and along the lower border of inferior tarsus.

Lacrimal passage-

lacrimial punctum- seen on the margins of the lids at the lateral extremity of the canaliculii.These are respectively 6 and 6.5 mm temporal to inner canthus.

Lacrimal canaliculii-One in each eyelids-The superior duct, the smaller and shorter of the two, at first ascends, and then bends at an acute angle, and passes medialward and downward to the lacrimal sac.

The inferior duct at first descends, and then runs almost horizontally to the lacrimal sac. At the angles they are dilated into ampulla; their walls are dense in structure and their mucous lining is covered by stratified squamous epithelium, placed on a basement membrane. Outside the latter is a layer of striped muscle, continuous with the lacrimal part of the Orbicularis oculi; at the base of each lacrimal papilla the muscular fibers are circularly arranged and form a kind of sphincter.

The Lacrimal Sac—The lacrimal sac is the upper dilated end of the nasolacrimal duct, and is lodged in a deep groove formed by the lacrimal bone and frontal process of the maxilla. It is oval in form and measures from 12 to 15 mm. in length; its upper end is closed and rounded; its lower is continued into the nasolacrimal duct. Its superficial surface is covered by a fibrous expansion derived from the medial palpebral ligament, and its deep surface is crossed by the lacrimal part of the Orbicularis oculi , which is attached to the crest on the lacrimal bone.

Structure.—The lacrimal sac consists of a fibrous elastic coat, lined internally by mucous membrane: the latter is continuous, through the lacrimal ducts, with the conjunctiva, and through the nasolacrimal duct with the mucous membrane of the nasal cavity.

The Nasolacrimal Duct—The nasolacrimal duct is a membranous canal, about 18 mm. in length, which extends from the lower part of the lacrimal sac to the inferior meatus of the nose, where it ends by a somewhat expanded orifice, provided with an imperfect valve, the plica lacrimalis (Hasner), formed by a fold of the mucous membrane. It is contained in an osseous canal, formed by the maxilla, the lacrimal bone, and the inferior nasal concha; it is narrower in the middle than at either end, and is directed downward, backward, and a little lateralward. The mucous lining of the lacrimal sac and nasolacrimal duct is covered with columnar epithelium, which in places is ciliated.

BLOOD SUPPLY TO THE EYE:

Arterial supply: The eye is supplied by the short (about 20 in number) and long ciliary (2 in number) arteries and the central retinal artery. These are the branches of the ophthalmic artery, one of the branches of the internal carotid artery.

Venous drainage: Venous drainage is done by the short ciliary veins, anterior ciliary veins, four vortex veins and the central retinal vein. These eventually empty into the cavernous sinus.

NERVE SUPPLY TO THE EYE:

The eye is supplied by three types of nerves,

1. The motor nerves:

(i) The 3rd cranial nerve (Oculomotor)

It has two division Superior and inferior division .

Superior division supply to 1.Levator palpebrae superioris

2.Superior rectus

Inferior division supply to 1. Medial rectus

2.Inferior rectus

3.Inferior oblique

4.Branch to ciliary ganglion which suppy to Sphincter papillae and Ciliary muscle.

(ii) The 4th cranial nerve (Trochlear): Supplies the superior oblique muscle.

(iii) The 6th cranial nerve (Abducent): It supplies the lateral rectus muscle.

(iv) The 7th cranial nerve (Facial): It supplies the orbcularis oculi muscle.

2. The sensory nerves:

The 5th cranial nerve (Trigeminal): The ophthalmic division supplies the whole eye.

3. The autonomic nerves:

(1) The sympathetic nerve supply is through the cervical sympathetic fibres to:

(i) Iris – Dilator pupillae muscle (ii) Ciliary body (iii) Muller's muscle in the lids (iv) Lacrimal gland

(2) The parasympathetic nerve supply originates from the nuclei in the mid brain. It gives branches to: i) Iris – Sphincter pupillae muscle ii) Ciliary body iii) Lacrimal gland