

THE CLINICAL METHODS OF EXAMINATION OF
THE CORNEA

THESIS

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By

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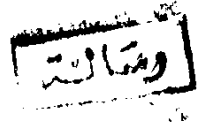
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(A) MACRO - AND MICROANATOMY
OF THE CORNEA.

Macroanatomy of the cornea :

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The cornea is the most anterior part of the globe whose outer tunic is formed from the sclera and the cornea, separated from each other by a slight furrow called sulcus sclerae. The shape of the cornea is elliptical if looked of from front, being 12mm in the horizontal meridian and 11 mm in the vertical meridian, but, is circular if looked of from behind being 11.5mm in diameter. This difference is due to that the sclera and conjunctiva overlap the cornea anteriorly more above and below than laterally.

Being the first and the most powerful lens of the optical system of the eye, the cornea must be transparent and of appropriate refractive power, which depends upon the corneal curvature and its refractive index, while, the maintenance of transparency is mainly the function of the corneal epithelium which is replaced by growth from its basal cells within few days if it is exposed to minor trauma.

The corneal curvature changes somewhat with the advance of age, thus, it is spherical in infancy and becomes astigmatic with the rule during childhood and adolescence and again becomes spherical in middle age and astigmatic against the rule in senility. The average radius of

curvature of adult cornea is 7.8mm of the anterior surface and 6.5mm of the posterior surface. These radii are only confined to the central third of the cornea because its peripheral portion being more flattened and thicker (the thickness of the cornea is 0.67mm & 0.52mm at the periphery and the centre respectively).

The refractive index of the cornea is 1.37 while its refractive power is 42 dioptries

Micro-anatomy of the cornea :
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In section of the cornea, it consists of 5 layers which are from without inwards :

1. The epithelium : This is stratified squamous epithelium, of 5-6 layers of cells, whose 2 surfaces are parallel to each other. This layer is about 50 μ m thick. The deepest or basal layer is columnar cells which are lying on what is called the epithelial basal membrane and arranged in a palisade like manner. These columnar cells have oval nuclei near their rounded heads while their bases are flat and have processes connected with the basal membrane . The basal cells are the germinal layer, and are continuous at the limbus with the same layer in the conjunctiva.

The next layer is the wing cells which consists of polyhedral cells whose rounded heads directed anter-

iorly while their concave bases fit over the heads of the basal cells and send processes, wings, between them. Each cell contains an oval nucleus whose long axis is parallel with the surface of the cornea.

The next 2 - 3 layers, which are the most superficial, are polyhedral, flattened, and have nuclei, but, do not show keratinization.

Electron microscopy showed that these superficial cells display microvilli and microplicae extending into the tear film and that cell bridges occur between these cells.

The epithelial basal membrane, as shown by electron microscope, separates the basal cells of epithelium from Bowman's membrane. It extends through the whole cornea also through the limbus where it becomes thicker, irregular and is prolonged into the bulbar conjunctiva. This membrane has posterior smooth surface, but, its anterior surface is broken into a mosaic pattern due to imprints of the attaching basal cells.

The corneal epithelium, including its basal membrane, has a very active power after abrasion also it controls the admission of water, salts and respiratory gases to substantia propria.

2. Bowman's membrane = Anterior elastic lamina.

It is a homogenous sheet about 10-14 μ m thick and is situated between the basal membrane of the corneal epithelium and substantia propria. Its anterior surface is parallel with the surface of the cornea and it is sharply separated from the epithelium, while, posteriorly the line of demarcation from the substantia propria is ill-defined. Peripherally at the limbus it ends in a rounded border . Bowman's membrane is not a true elastic tissue but is formed of irregular collagen fibrils, as shown by electron microscopy, and if injured by trauma or ulcer it does not regenerate and an opacity is produced.

3. Substantia propria : It is a form of modified connective tissue and forms about 90% of the corneal thickness, about 0.5mm thick, and is continuous with that of sclera at the limbus.

It is composed of about 200-250 alternating lamellae of collagenous tissue the planes of which are mostly parallel to the surface of the cornea. These lamellae are multiple bands composed of collagenous fibrils and the bands of each lamella are parallel to each other but at right angle with those of the alternate layers. The lamellae branch but there is

union between the neighbouring bands making separation of the cornea into lamellae impossible without tear taking place.

Within, and not in between, the lamellae there are the so called fixed cells (keratocytes or corneal fibroblasts) which are flattened cells with flattened nuclei and multiple processes which contact with the other cells in the same layer without forming a syncytium.

Wandering macrophages may also be seen, and occasional lymphocytes or polymorphonuclear leucocytes, among the lamellae of the stroma. Normally they are few in number and are escaping from the marginal loops of the corneal blood vessels.

4. Descemet's membrane - Posterior elastic lamina.

It is a strong, homogenous and very resistant membrane and is thinner than B.M., being 10-12 μ m thick. It is sharply defined from substantia propria, in contrary to B.M., but specialized contact are present between it and the endothelium.

Although the Descemet's membrane has the physical property of elasticity, it is not formed of elastin but composed of regular layers of fine collagenous fibres (Duke Elder 1961, and Eugene Wolff 1976).

It is normally in a state of tension so that if torn it tends to curl up into the anterior chamber.

It has the power of regeneration and it tapers at its edge where it ends at the ligamentum pectinatum iridis forming a part of the trabecular meshwork, as believed by the most recent observations (Eugene Wolff 1976).

At the periphery of the cornea the posterior surface of the Descemet's membrane presents round wart like elevations, the Hassall Henle bodies, which increase with age.

5. Endothelium : It is the most posterior layer of the cornea and is composed of a single layer of flattened cells, being 5 μ high and 18 - 20 μ wide, arranged along D.M. In childhood the cells are higher and cuboidal, and with advance of age they become flatter.

The endothelium of the cornea can be seen by the slit lamp in the living eye, the only place in the body where this is possible.

Electron microscopy shows that the endothelium has no basement membrane, but, sometimes D.M. is considered as its basement membrane. The endothelial cell protoplasm has central oval nucleus, a prominent endoplasmic reticulum, and a complex arrangement of mitochondria indicating a high degree of metabolic activity and that the adjacent endothelial cells interlock by reciprocal tortuous surfaces.

The main function of the endothelium is the maint-

enance of the corneal deturgescence through an active mechanism by getting rid of water by a process of pinocytosis.

Embriologically all the layers of the cornea, except the epithelium, are derived from the mesoderm while the epithelium is derived from the surface ectoderm.

The LIMBUS (The Corneo - scleral junction).

It is an area of 1mm wide which makes transition between the conjunctiva, episclera, and sclera on one hand, and the cornea on the other hand. It appears as a gray, semitransparent area with a well defined corneal edge and merging inconspicuously into the sclera. The surface is not uniform, but, is broken by white digitations, which run radially from the sclera to lose themselves in the clear cornea.

The epithelium of the limbus is thicker than elsewhere in the cornea, irregularly arranged, and containing ten or more layers of cells which project downwards and radially in ridge like thickenings. The basal cells of the epithelium become smaller and more closely packed. The epithelial basal membrane becomes thickened and wavy, and continues with the basal membrane of the conjunctiva.

Bowman's membrane stops short at the limbus in a rounded edge and is replaced by a thin layer of

connective tissue on which the conjunctival epithelium rests. This layer of subepithelial connective tissue continues with the episcleral tissue and forms sub-epithelial papillae containing blood vessels and lymphatics, both of which are absent from cornea proper.

The fibres of corneal lamellae, which are transparent and regular, run directly into the fibres of sclera which are opaque and less regularly arranged.

At the limbus also Descemet's membrane appears to taper to a point but actually shares in the formation of the trabecular meshwork, and the endothelium is continuous with the epithelium present at the angle of anterior chamber and on the iris.

Vessels and nerves of the cornea :

The cornea is avascular, except linn of its periphery is invaded by small loops of blood vessels derived from the anterior ciliary vessels. These vessels are actually not in the cornea but in the subconjunctival tissue which overlaps the cornea.

The nutrition of the cornea is derived from diffusion from the limbal capillaries, aqueous and tear film. This nourishment is obtained by lymphatic permeation through spaces between lamellae, but no actual lymphatic vessels are found.

The nerves of the cornea are derived from the long ciliary nerves (of the nasociliary of the ophthalmic of the trigeminal nerve), and the conjunctival nerves.

All the nerve fibres supplying the cornea, except for 2 - 4 mm at the periphery, are non myelinated to preserve the corneal transparency.

All layers of the cornea, except Descemet's membrane, are richly supplied by nerves through 2 groupes, the anterior and posterior group. The anterior group of nerves gives subepithelial and intraepithelial plexuses to supply the anterior part of the cornea while the posterior group passes to the posterior part of the cornea.

The cornea has sensations of touch, cold, and pain but pain is more superficial than cold as it disappears first under local anaesthesia.

(B) THE METHODS OF EXAMINATION
OF THE CORNEA.