Lamellar Keratoplasty

Essay

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Anatomy of the Cornea

The cornea is a transparent vascular tissue highly specialized to refract and transmit light with a smooth outer convex surface and an inner concave surface.

The cornea forms part of what is almost a sphere, but is usually' more curved in the vertical than the horizontal meridian-giving rise to astigmatism with rule. The cornea forms the principle refractive surface of the eye and accounts for about 70% (40-45 diopters (D)) of the total refractive power of the eye. This is caused by the regular anterior curvature of the cornea and optically smooth nature of the overlying tear film. Most of the refraction of the eye occurs at the front surface of the cornea at the tear-air interface.

The regularity of its collagen fibrils, closeness and homogeneity of their packing achieve the transparency of the corneal stroma. Water is constantly pumped out of the cornea by the endothelium, which maintains the optical homogeneity of the corneal layers and prevents their swelling and clouding.

* Dimensions

The axial thickness of the cornea is 0.52 millimeters (mm) centra1ly and 0.67 mm peripherally. The refractive index of the cornea is 1.4 compared to that of the air, which is 1.0. The front of the cornea appears elliptical, 11.7 mm wide in the horizontal meridian and 10.6 mm in the vertical meridian. On the other hand, the posterior surface is circular, 11.7 mm in diameter. This difference is due to greater overlap of sclera and conjunctiva above and below than laterally. The radius of curvature of the anterior surface is 7.8 mm and of the posterior surface are 6.5mm in the central third. ***(Maurice, 1969)***

*Structures

The cornea consists of 5 layers (Fig. 2), which are the epithelium, the stroma which consists of Bowman's membrane (BM), lamellar stroma and descemet's membrane (DM) then the endothelium.

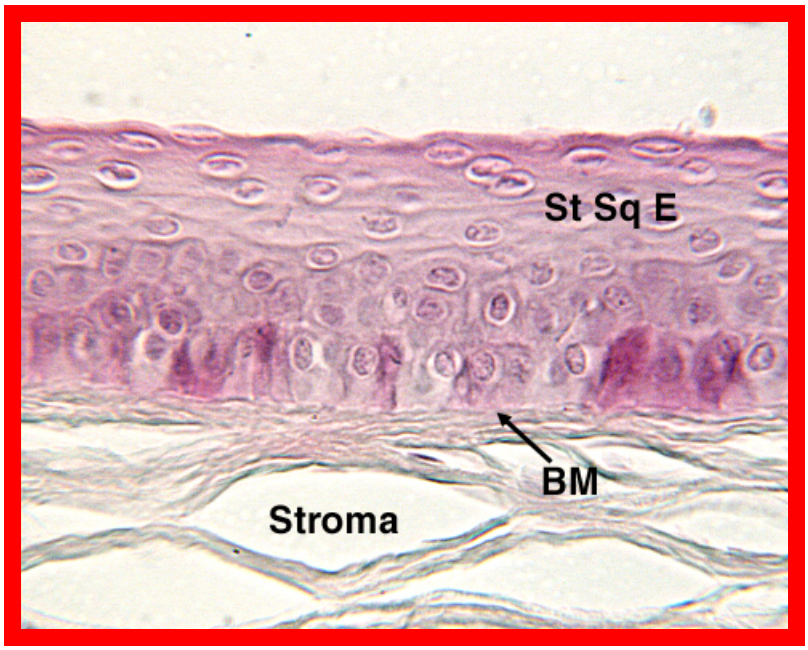

Fig. 1: Histology of the cornea. ***(Rodrigues, 1982)***

ST Sq E: Stratified Squamous. ***Epithelium BM: Basement membrane***

A) Epithelium

It is formed of stratified non-keratinized squamous epithelium. It is 5-7 cell layers, which is 50-52u thick. It is regular in thickness over the entire cornea and has an absolutely smooth, wet surface which acts as the major refractive surface of the eye. The cell layers of the epithelium include three to four outer flattened squamous cells "the superficial cells", 1-3 layers of mid epithelial cells" the wing cells" and a single layer of columnar cells " the basal cells".

The superficial cells ate flat with horizontal nuclei and are attached to one another by desmosomes. Electron microscopy of the outer surface of superficial cells shows microvilli and microplicate that extend into the microvilli while other darker cells have fewer microvilli and are centrally located. The microvilli and microplicae of these surface cells assist in retaining the tear film thus keeping the cells moist.

The wing cells are called so as they have lateral, thin, wing like extensions from a rounded cell body. They are polyhedral in shape with a convex anterior surface and a concave posterior surface. Their nuclei are oval or rounded in shape. They are attached by desmosomes. The deepest basal cells are tall, columnar cells attached by desmosomes. Hemidesmosomes attach the basal plasma membrane to the basement membrane, which project into the Bowman's zone creating strong adhesions to this zone.

The major components of the cytoplasm of basal, wing and superficial cells are intermediate filaments composed of proteins known as keratin. Actin filaments and microtubules are also present. There is sparse accumulation of cytoplasmic organelles in these cells as Golgi apparatus, endoplasmic reticulum, and mitochondria to keep the epithelium transparent. The epithelium exists over an avascular connective tissue.

It acts as a barrier to fluid loss, pathogens entrance and resistance to abrasions that's why the cells of epithelium are tightly adherent to one another and to their underlying extracellular matrix. The corneal epithelium like all stratified squamous epithelium is self-renewing and in the cornea complete turnover occurs in 5-7 days. The basal cells are the mitotically active cells, they adhere to their basement membrane and to their underlying stroma through an adhesion complex. ***(Hoffman, 1972)***

B) Stroma

The human corneal stroma is the middle connective tissue layer that is approximately 500 um thick and forms about 90% of the cornea. It is arranged in three clearly defined layers of extracellular matrix which includes "Bowman's layer" next to the epithelium, a middle lamellar stroma which is

the major portion and Descemet's membrane, the thickened membrane secreted by corneal endothelium.

1. Bowman's Membrane

It is 8-10 um thick and consists of collagen with associated proteoglycans and soluble glycoproteins. Its function is not clear, it may act as a smooth, rigid base for maintaining epithelial uniformity thus appropriate refractive power. Its presence is also necessary to prevent close contact between the epithelium and the stromal cells. In minor abrasions this layer is left intact. If however trauma or infection structurally damages this layer, there may be poor adhesion to this membrane resulting in recurrent corneal erosion. ***(Rodrigues, 1982)***

2. Lamellar Stroma

It is the major layer composed of collagen fibrils, a ground substance and keratocytes. It's 8-12 um thick. The collagen fibril lamellae are oriented in a parallel manner and are at right angle to one another. The lamellae act as a diffraction grating in which the light rays are separated from each other by less than one wavelength of light and interfere with scattered light by eliminating it by destructive interference. The lamellar stroma is highly organized and the most transparent of all connective tissue in the body. It acts as a window for light passage and also it meshes with the surrounding scleral connective tissue to form a rigid framework to maintain intraocular pressure (lOP). Individual fibrils have a diameter larger than that of Bowman's membrane, it's secreted and maintained by stromal fibroblasts; the keratocytes. The collagen bundles are 200-300 centrally and 500 in the periphery. They vary between 9 and 260 um in width and 1.15 and 2 um in height. The bundles are separated from each other by mucopolysaccharides, the ground substance that is hydrophilic. The adsorption fluid keeps the bundles of collagen separated by a set distance which if changed by accumulation of fluid, the transparency is reduced.

The keratocytes are mesoderrnal in origin lying between the lamellae. They are very flat with many long attenuated processes extending from a

central cell body in all directions .The tips of their processes touch the processes of the adjacent cells forming gap junctions. The cytoplasm of these cells is rich in rough endoplasmic reticulum and golgi apparatus keeping its function as synthesizer and maintenance of stromal lamellae. ***(Hogan et al, 1971)***

3. Descemet's Membrane

It is the basement membrane of the endothelium by which it is synthesized. It appears first at the second month of gestation and continues throughout life. It is 2 um at birth but it reaches up to 12 um thick by late adulthood and in between it reaches to 5 um during childhood. Although it appears homogenous under light microscopy, it has a laminated structure demonstrated by polarization, dark field and electron microscope. This reflects a structural difference between its foetal and postnatal components.

It is formed mainly by the protein type I collagen. It is a strong resistant sheet closely applied to the back of the corneal stroma. It is sharply defined from the stroma unlike Bowman's membrane. The plane of separation is used at lamellar keratoplasty. It thickens with age and degenerative conditions of the cornea. The peripheral rim of Descemet's membrane is the internal landmark of the limbus and marks the anterior limit of the drainage angle (Schwalbe's line). After traumatic interruption of DM and endothelium as in penetrating injures, stretching of the cornea in buphthalmos or rupture of hydrops in keratoconus; the endothelial layer will resurface the defect. This can be achieved by spread of its cells and synthesis of fresh basal lamina identical to normal DM, in contrast to Bowman's membrane where it is replaced by a *scar.* ***(Hogan et al, 1971)***

C) Endothelium

It is single layer of hexagonal, cuboidal cells applied to the posterior aspect of DM. Although mitosis can occur in young human endothelial cells, it is infrequent in adults and it seems that the cornea has a fixed number of 500,000 cells which are replaced in a limited way after injury so it has a very limited power of regeneration. Young cells are hexagonal but with age they

become increasingly polymorphic. Endothelial cell density is 6000-cells/mm at birth and fall 26% at first year and 26% is lost over next 11 years but the rate stabilizes around middle age. The cell contains an oval nucleus located centrally about 7 um in width. The corneal endothelium plays a major role in maintaining stromal hydration through Sodium-Potassium (Na+- K+) activated adenosine triphosphatase (ATPase) in the basolateral borders of cells. In contrast to corneal epithelium, the human endothelium is not a self-renewing cell layer as cells decrease in number and become thinner and attenuated. Myelinated nerves pass from the trigeminal nerve through anterior stroma below Bowman's layer in-groups. ***(Laule, 1978)***

Introduction

Lamellar keratoplasty is an operation in which diseased corneal tissue is removed and replaced by donor corneal material the procedure is performed to provide structural support for the cornea or to improve vision. It is defined as removal and replacement of less than the total thickness of the cornea **(*Amayem and Anwar, 2000)***.

There are different types of lamellar keratoplasty either therapeutic to remove a certain corneal pathology or refractive to correct an error of refraction or tectonic in cases of corneal thinning disorders to restore corneal thickness and to maintain the integrity of the globe ***(Chen et al, 2004).***

It is indicated in superficial corneal dystrophies that involve the epithelium or the basement membrane, also in corneal dystrophies that involve the stroma and in superficial corneal opacities, cases of dermoids, pterygium some cases of bolus keratopathy and corneal perforation ***(Van Dooren et al, 2004).***

Refractive LKP is indicated for correction of myopia and to treat cornel cap complications related to keratomileusis (***Amayem and Anwar,2000)***.

There are different techniques used in LKP including deep lamellar, deep stromal anterior and posterior keratoplasty and sutureless lamellar keratoplasty ***(Casebeer et al, 2000)***.

Lamellar keratectomy can be performed either manually or with an instrument. Dissection can be done either with viscoelastic air or saline to facilitate dissection after the initial cut is made the lamellar dissection is then performed using a cyclodyalisis spatula or stainless steel blade or a microkeratome***(Chen et al,2004).***

With improved techniques for LKP, the visual outcome closely mimics that of PKP. The obvious advantage of a procedure that is extra ocular with greatly reduced morbidity that's why it is the procedure of choice in selected cases as young patients with keratoconus ***(Dooren et al,2004)***.

Aim of the work:

To study the different techniques, indications, contraindications, complications, and recent advances in lamellar keratoplasty.

This work will include details on:

1- Corneal Anatomy
2- Corneal Physiology
3- Eye Banking and donor material
4- Lamellar keratoplasty
    a. Advantage of LKP on PKP.
    b. Indications, contraindications.
    c. Types.
    d. Complications.
5- Recent techniques
6- Complications

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مقدمة

عملية ترقيع القرنية الطبقي هي استبدال نسيج القرنية المريض بنسيج قرنية جديد من المعطي، إما لإعطاء تدعيم للقرنية أو لتحسين الإبصار، والتعريف العلمي لها هو أنها استبدال جزء من القرنية أقل من السمك الكلي.

ولها أنواع مختلفة، إما علاجي لإزالة مرض معين بالقرنية، أو إبصاري لإصلاح عيب من عيوب النظر، أو مؤقت في حالات الرُفع الشديد للقرنية لإعادة سمك القرنية إلى طبيعته.

تجرى هذه الجراحات لمرضى تلف القرنية السطحي، والذي يحدث للنسيج الطلائي أو النسيج السفلي، وفي حالات تلف النسيج الضام للقرنية، وحالات عتامات القرنية السطحية، وأيضاً حالات عيوب القرنية الخلقية أو الظفرة وتكيسات القرنية.

وتستخدم عملية ترقيع القرنية الطبقي لعلاج قصر النظر وحالات مضاعفات عمليات القرنية المختلفة.

ويوجد عدة طرق مختلفة لإجراء عملية ترقيع القرنية الطبقي، منها الترقيع الأمامي والخلفي العميق، ومنها ما يتم إجراءه بدون غرز جراحية.

يمكن إجراء تشريح القرنية يدوياً أو بواسطة أجهزة مساعدة، ويتم استكماله عن طريق مادة لزجة أو هواء أو محلول ملحي، ثم استخدام نصل من مادة غير قابلة للصدأ.

نتائج هذه الجراحة باستخدام الأساليب الحديثة استطاعت أن تعطي نتائج بصرية تقارب نتائج ترقيع القرنية النافذ مع مضاعافات أقل، ولهذا فهي من العمليات المفضلة في المرضى صغار السن والذين يعانون من القرنية المخروطية وعيوب الإبصار الأخرى.