# Recent Trends in Lamellar Keratoplasty

Theses

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# الطرق المستحدثه فى الترقيع الطبقى للقرنيه

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# List of Abbreviation.

| Abb. | Description |
|---|---|
| ALK | Anterior Lamellar Keratoplasty. |
| ATP | Adenosine Ttriphosphate. |
| BSCVA | Best Spectacle Corrected Visual Acuity. |
| BSS | Balanced Salt Solution. |
| CH | Corneal Hysteresis. |
| CS | Chondroitin Sulphate . |
| DALK | Deep Anterior Lamellar Keratoplasty. |
| DLEK | Deep Lamellar Endothelial Keratoplasty. |
| DM | Descemet's Membrane. |
| DMEK | Descemet's Membrane Endothelial Keratoplasty. |
| DNA | Deoxy Nucleic Acid. |
| DS | Dermatan Sulphate. |
| DSAEK | Descemet's Stripping Automated Endothelial Keratoplasty. |
| DS-PGS | Dermatan Sulphate-Proteoglicans. |
| FED | Fuch's Endothelial Dystrophy. |
| FS Laser | Femto Seconed Laser. |
| GAGS | GlycosAminGlycans. |
| ICE | Irido-Corneal Endothelial Syndrome. |
| IOP | Intra Ocular Pressure. |
| KS | Keratain Sulphate. |
| KS-PGS | Keratain Sulphate-Proteoglycans. |
| LASIK | Laser in Situ keratomalesis. |
| LK | Lamellar Keratoplasty. |
| NADPH | Nicotinamide adenine Dinucleotide Phosphate. |
| OVD | Ophthalmic Viscoelastic Device. |
| PAS | Periodic Acid Shift. |
| PBK | Pseudophakic Bullous Keratopathy. |
| Pk | Penetrating Keratoplasty. |
| PMD | Pellucid Marginal Degeneration. |
| PPLK | Progressive Post Laser Keratoectasia. |
| PPMD | Posterior Polymorphous Destrophy. |
| PPV | Pars Plana Vitrectomy. |
| UV | Ultra Violet. |

# Introduction

The history of lamellar keratoplasty (LK) spans over 100 years, and the advantages of lamellar surgery have long been known. The surgery was usually used for tectonic purposes; however, new techniques have expanded the applications of LK in optical rehabilitation. Instrumentation such as viscoelastics, diamond knives, ultrasonic pachymetry, artificial anterior chambers, advanced microkeratomes, and the excimer laser have enhanced our ability to work more safely in the tedious microsurgical environment of the lamellar procedure *(Terry;2000)* .

Microsurgical techniques have vastly improved the technique of lamellar keratoplasty, as they have also substantially improved the results with penetrating keratoplasty.

Lamellar keratoplasty involves replacement of the damaged or diseased part of the cornea or even the stroma (middle layer of the cornea), Bowman's membrane (second layer of the cornea)or the endothelium with donor material. Most of the other layers of the cornea can be preserved. The donor corneal disc becomes repopulated with host cells, and the recipient epithelium usually covers the anterior corneal surface. This procedure is technically more difficult than penetrating keratoplasty .Anterior Lamellar keratoplasty has the advantage of being primarily extraocular, making it a procedure that preserves the endothelium. The risk of endothelial rejection is abolished or eliminated. The risks of wound leaks or flat anterior chambers associated with an intraocular procedure may be eliminated *(Synder;2005).*

Lamellar keratoplasty is an exciting new form of surgery that provides selective lamellar transplantation. This surgery allows restoration of the normal corneal topography, with very little change from the preoperative corneal curvature. This in turn provides more accurate IOL calculations for combined cataract and transplantation procedures, as well as avoiding the surprises of high astigmatism and high refractive errors that are so common after standard PK surgery *(Busin et al;2005).* DLEK can even be performed suturless through a lamellar wound as small as a modern cataract surgery wound *(Melles;2002).*

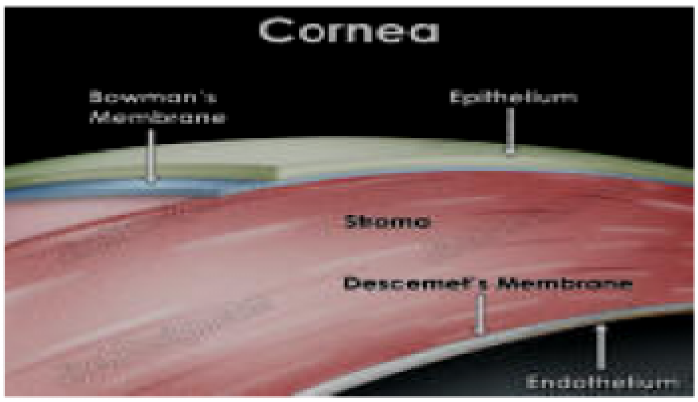
Whereas the surgical techniques of LK are still in accelerated development, it appears that LK is moving forward quickly to become the preferred, if not the ideal method of corneal transplantation for the treatment of endothelial dysfunction.

The disadvantages of LK are the technical challenge of the procedure, the risk of perforation, and the need for special designed blades for dissection. Another source of frustration for surgeons is the haze that may form in the interface between the host and donor corneas *(Leccisotti;2007).*

# Anatomy

The cornea is the most densely innervated tissue in the body. The sensory supply is via the first division of the trigeminal nerve. There is a subepithelial and a stromal plexus of nerves *(Kanski, 2003).*

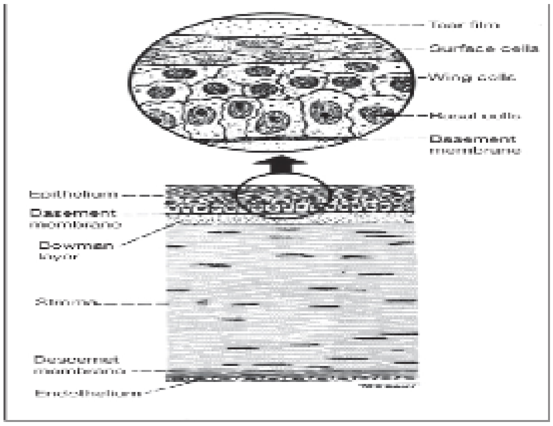
The average corneal diameter is 11.5 millimeter (mm) (vertical) and 12mm (horizontal). It is made up of 5 distinct layers, fig. (1) *(Snell and lemb ;1998).* Starting from the outer layer and moving inward, they are:




(Fig.1 A): Cornea cross-section, corneal layers, epithelium, Bowman's, stroma, Descemet's, endothelium
*(Gipson and Nancy; 1995).*

## 1-The epithelium

The epithelium is stratified squamous and non-keratinized, and consists of a single layer of basal columnar cells attached by hemidesmosomes to the underlying basement membrane, 2 to 3 rows of wing cells and two layers of squamous epithelial cells *(Snell and lemb, 1998).* The surface area of the outermost cells is increased by microplicae and microvilli that facilitate the attachment of mucin and the tear film. After a lifespan of a few days the superficial cells are shed into the tear film *(Kanski, 2003).*




(Fig.1 B) layers of the cornea *(Kanski, 2007)*.

The epithelial stem cells are principally located at the superior and inferior limbus, possibly in the palisades of Vogt, and are indispensable for the maintenance of healthy corneal epithelium. They also act as a junctional barrier, preventing conjunctival tissue from growing onto the cornea *(kanski, 2007).*

## 2-The Bowman's layer

The Bowman's layer is the acellular superficial layer of the stroma *(Roberts, 2000)*.

## 3-The substantia Propria

The substantia propria makes up 90% of corneal thickness. It is principally composed of regularly orientated layers of collagen fibrils whose spacing is maintained by proteoglycan ground substance {chondroitin sulphate (CS) and keratin(KS)} with interspersed modified fibroblasts (keratocytes) *(Kanski, 2007)*.

## 4-The Descemet's membrane

The Descmet's membrane; is composed of a fine latticework of collagen fibrils. It is periodic acid schiff (PAS) positive glassy basement membrane of the endothelial cells and does regenerate after injury. It forms at the periphery the line of Schwalbe, referred to clinically when assessing the anterior chamber by gonioscopy. It consists of an anterior banded zone that is deposited in-utero and a posterior non-banded zone laid down throughout life by the endothelium *(Kanski, 2003).*

## 5-The endothelium

The endothelium consists of a single layer of hexagonal cells that cannot regenerate. It plays a vital role in maintaining corneal deturgescence *(Kanski, 2007)*.

The corneal structural and reparative properties are essential to its function as a resilient, yet transparent, barrier to intraocular injury. Because the cornea is also the scaffold for the major refractive surface of the eye, any mechanical or biological response to injury will also influence optical performance. Consequently, the same mechanisms responsible for preserving ocular integrity can undermine the goals of achieving predictable and stable visual outcomes after keratorefractive surgery *(Roberts, 2000).*

# Biochemistry

The cornea is not only designed for light transmission but is the main light refracting element in the eye. Its cellular and extracellular components are of the same chemical basic composition as other cells and tissues in the body that normally scatter light extensively, thus rendering them opaque. Light scattering in opaque tissues is due to the large disparity in refractive index (RI) between matrix components such as collagen, glycosaminglycans (GAGs) and cells. The cornea's ability to transmit light is a function of how the cells and matrix components are organized within the tissue to reduce this refractive index disparity *(Forrester et al, 2003).*

## Corneal transparency

### 1-The epithelium

All the thick stratified squamous epithelium presents the first refracting interface to transmitted light. Most of the light absorbing properties take place in this layer, mainly for short wave-length light. However the majority of light of visible spectrum is transmitted through the epithelium *(David, 2004).*

The cells are typical keratin expressing epithelial cells, containing integrin receptors for basement membrane components such as fibronectin & laminin. Corneal epithelial cells express a particular combination of keratin 3 and keratin 12. Keratin 12 may be important for corneal epithelial junctions *(Berman, 1991).* Hemidesmosomes affect the adhesion between the basal epithelium and the basement membrane. They bound to the corneal stroma through a band of anchoring fibrils, which pass through the lamina densa in a woven network. These fibers are composed of type VII collagen. In addition type XVI collagen supports firm adhesions in theses basal cells *(David, 2004).*

The epithelium presents an effective barrier against fluid transport, which is achieved by extensive close contacts and junctional complexes between the basal cells. Spot desmosomes are numerous and studies have revealed that there are differences in the content of desmosomal proteins depending on the site *(Forrester et al, 2003).*

## 2-The stroma

### A-collagen

Several different types of collagen are present in the cornea. In addition to the normal basement membrane, type IV & VII are in contact with the epithelial and endothelial layers, the two specialized corneal regions. Bowman's layer is a condensation of type I and IV with high proportion of type III collagen in a matrix containing proportions of chondoitin sulphate (CS) & dermatan sulphate (DS), while Descmet's membrane contains high levels of novel collagens (types IV , VIII, IX & XII) organized in lattice arrangement. This provides elasticity and deformability to the cornea while maintaining high levels of light transmission *(Kenney et al, 2005).*

The regular arrangement of the stromal type I collagen (which accounts 50 – 55 % of stromal collagen) fibrils is considered to be an important factor in corneal transparency. Transparency was initially attributed to destructive interference in which light is scattered by neighboring fibrils in predictable and opposing directions, which tends to cancel each other out except along the primary visual axis. However, this concept cannot be applied to