NEW LINES IN

KERATOCONUS MANAGEMENT

Essay

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master degree in ophthalmology

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Abdullah Elgohary

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List of Abbreviations

ADH	**Alcohol DeHydrogenase**
ADH1B	**Alcohol DeHydrogenase (class1) Beta polypeptide**
AST	**Astigmatism**
BCVA	**Best Corrected Visual Acuity**
BL	**Bowman's Layer**
BSCVA	**Best Spectacle Corrected Visual Acuity**
C3-C	**Corneal Collagen Cross-linking with vit C**
CAB	**Cellulose Acetyl Butyrate**
CCLs	**Corneal Contact Lenses**
CL	**Contact Lenses**
CR3	**Corneal Collagen Cross-linking with Riboflavin**
CXL	**Collagen Cross Linking**
D	**Diopter**
DALK	**Deep Anterior Lamellar Keratoplasty**
DLK	**Deep Lamellar Keratoplasty**
DM	**Descemet's Membrane**
Fig	**Figure**
GP	**Gas Permeable**
GPC	**Giant Papillary Conjunctivitis**
HSV	**Herpes Simplex Virus**
ICR	**Intrastormal Corneal Ring**
ICRS	**IntraCorneal Ring Segments**
IL	**InterLeukin**
IOL	**IntraOcular Lens**
IOP	**IntraOcular Pressure**
I–S	**Inferior–Superior**
K	**Keratometery reading**
KC	**KeratoConus**
LASIK	**LASer In-situ Kertomileusis**
LKP	**Lamellar KeratoPlasty**
MMP	**Matrix MetalloProteinase**
NGF	**Nerve Growth Factor**
OCT	**Optical Coherence Tomography**
PAS	**Periodic Acid-Schiff**
PIOLs	**Phakic IntraOcular Lenses**
PKP	**Penetrating KeratoPlasty**
PMMA	**PolyMethylMethAcrylate**

PRK	**PhotoRefractive Keratectomy**
PTK	**PhotoTherapeutic Keratectomy**
RGP	**Rigid Gas Permeable**
SAI	**Surface Asymmetry Index**
ScCLs	**Scleral Contact Lens**
SRAX	**Skewed Radial AXis**
SRI	**Surface Regularity Index**
TIMP	**Tissue Inhibitor of MetalloProteinase**
TNF	**Tumour Necrosis Factor**
TPIOLs	**Toric Phakic Intraocular Lenses**
TrkANGFR	**NGF-Receptor TrkA**
UBM	**Ultrasound BioMicroscopy**
UCVA	**UnCorrected Visual Acuity**
UV	**Ultra Violet**
UVA	**Ultra Violet A**
UZS	**Urrets-Zavalia Syndrome**
VCG	**Vacuum Centering Guide**

LIST OF FIGURES

Introduction

Keratoconus is a noninflammatory, progressive, bilateral thinning disease of the cornea. It is characterized by the development of a corresponding protrusion with an apex often located centrally or in an inferior eccentric position. Despite extensive investigation, the etiology and underlying mechanism of stromal thinning in keratoconus is not understood **. (Colin & Velou, 2003)**

Keratoconus being a disease of the youngs causes significant loss of productivity and has a disproportionate impact on the quality of life and the psychosocial condition. Any procedure that can improve the quality of life in a given disease deserves a close look **. (Agrawal, 2009)**

The treatment of keratoconus depends on the severity of the disease **(Colin & Velou, 2003).**

In the disease's early stages conservative approaches, aimed at maintaining visual acuity, such as spectacles and different types of contact lenses placed to straighten corneal aberrations. **(Tomkins & Garzozi, 2008)**

Rigid contact lenses are the principal optical means for managing visual impairment produced by keratoconus **(Mcmahon et al., 2004).** Contact lens difficulties are the most common indication for the decision to have a graft **(Colin & Velou, 2003).**

In advanced cases with severe corneal irregular astigmatism and stromal ***opacities*** penetrating keratoplasty (PKP) may be required to restore visual function**.** When the cornea is ***transparent***, other surgical options can be considered. **(Colin & Velou, 2003)**

Studies have shown that in deep lamellar keratoplasty, endothelial rejection reaction is rare with cell counts being maintained for a longer period. This confers obvious advantages over penetrating keratoplasty in the treatment of keratoconus. **(Patel, 2003)**

Intacs implantation was a safe and efficacious treatment for keratoconus with significant and sustained improvements in objective visual outcomes. (**Colin & Malet, 2007)**

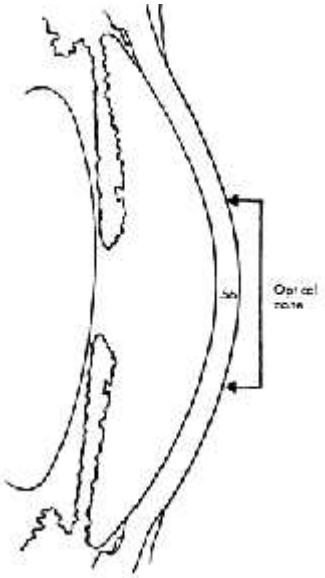
Corneal collagen cross-linking(CXL) is a new approach that directly targets the corneal stromal imbalances. This method provide an easily accessible tools to stop the progression, and even correct visual deterioration due to corneal ectasia. **(Tomkins & Garzozi, 2008)**

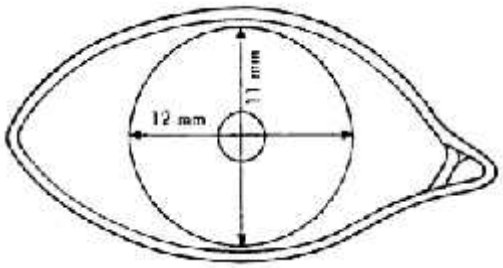
Other surgical options are multiple and varied, and include, Thermokeratoplasty, Toric phakic intraocular lenses, or Epikeratophakia**. (David et al., 2007)**

Some surgeons advocate the use of radial keratotomy for the correction of selective patients with mild to moderate keratoconus **(Utine et al., 2006).** An association between the development and acceleration of corneal ectasia in keratoconic eyes and LASIK has been clearly established and overt and forme fruste keratoconus are an absolute contraindication to LASIK surgery **(Rabinowitz, 2006)**.

Anatomy

The cornea is a transparent avascular tissue that is exposed to the external environment. The anterior corneal surface is covered by the tear film, and the posterior surface is bathed directly by aqueous humor (Fig1). The avascular cornea forms, together with the sclera, the outer shell of the eye-ball. The highly vascularized limbus constitutes the transition zone between the cornea and sclera, and contains a reservoir of pluripotential stem cells**. (Nishida, 2005)**





(1) **(2)**

Fig 1:**The cornea is thiner centrally (0.56 mm) and measures approximately (1.0 mm) in the periphery** ***Fig2:*****Anterior dimensions of the cornea(Stein et al., 2001)**

The shape of the anterior corneal surface is convex and aspheric. The anterior surface is transversely oval, the adult human cornea measures 11 to 12 mm horizontally and 9 to 11 mm vertically (Fig2), it is approximately 0.5 mm thick at the center, and its thickness increases gradually toward the periphery, where it is about 0.7 mm thick. The curvature of the corneal surface is not constant, being greatest at the center(optical zone)(Fig 1) and smallest at the periphery.The radius of curvature is between 7.5 and 8.0 mm at the central 3 mm optical zone of the cornea where the surface is almost spherical**.(Nishida, 2005)**

Vision depends on the cornea and lens as refractive components, the refractive power of the cornea is 40 to 44 diopters and constitutes about two thirds of the total refractive power of the eye**. (Nishida, 2005)**

The cornea is a highly specialised structure which possesses the following vital functions:

- Clear refractive interface,
- Tensile strength,
- Protection of the intraocular contents from the external environment. **(Weng Sehu & Lee, 2005)**

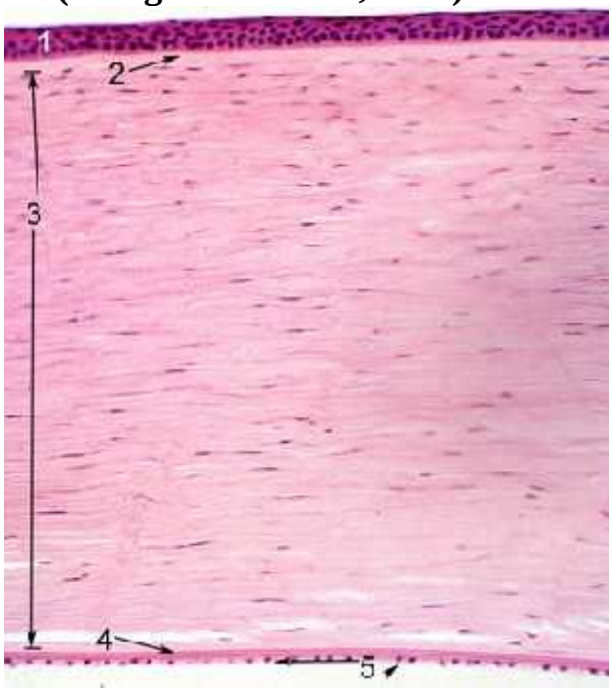


Fig 3:A full thickness histology section of the cornea demonstrates the relative thinness of the epithelium and endothelium in relation to the stroma. (Weng Sehu & Lee, 2005)

Histologically the cornea consists of five layers (Fig3):

***1- Epithelium*:**

Consisting of five or six layers. These layers are divided into:

(a) Basal cell layer: cuboidal cells where cell division occurs.

(b) Wing cells: the second layer is wing shaped to fit over the rounded anterior surface of the basal cells.

(c) Superficial cells: the next three layers become increasingly flattened as they progress towards the surface due to mitotic activity in the basal cell layer. The most superficial cells detach from the surface as a normal process of "wear-and-tear". The cells of the epithelium are attached by desmosomes and the basal layer is attached to Bowman's layer by an anchoring complex. **(Weng Sehu & Lee, 2005)**

2- Bowman's layer

A thin homogeneous layer which serves as a base for the epithelial anchoring system. Once destroyed, this layer is never replaced. Its absence indicates previous trauma or ulceration. **(Weng Sehu & Lee, 2005)**

3- Stroma **:**

the stroma forms about 90% of the corneal thickness(Fig3), it is about 500µm in thickness, and made up of interlacing layers of collagen fibrils embedded within a matrix of proteoglycans (fig4). **(Radner et al., 1998)**. Composed mainly of type 1 collagen fibrils with types III, V, and VI also found. **(Tomkins & Garzozi, 2008)**

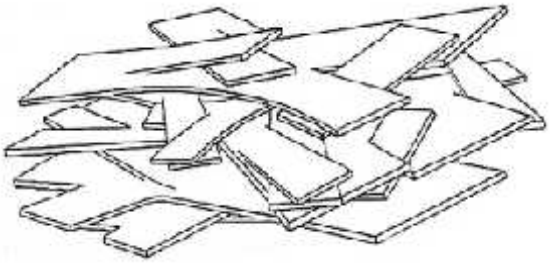


Fig 4: Diagram of The interlacing of collagen lamellae in the corneal stroma.(Anderson et al., 2004)

Fibrous collagen is responsible for the mechanical strength of both the cornea and sclera, protecting the inner components of the eye from physical injury and maintaining the ocular contour**. (Weng Sehu & Lee, 2005)**

The keratocytes are spindle cells with long branching interconnecting processes. These cells lie between lamellae which contain bundles of uniformly spaced collagen fibrils. The interfibrillar spacing is such that any light scattering is cancelled by interference with light rays from adjacent fibrils and is the basis for one of the theories to explain corneal transparency(Fig5). The orientation of the fibrils varies by 60 degrees between lamellae and this provides structural strength. **(Weng Sehu & Lee, 2005)**

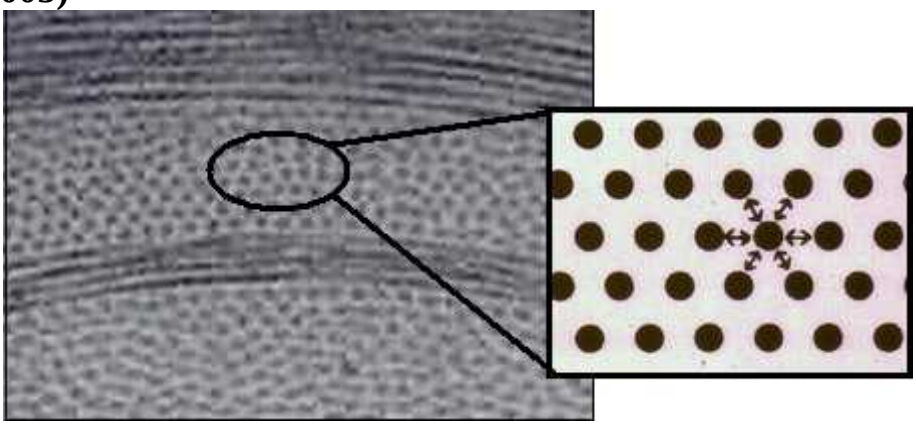


Fig 5: Transmission electron microscopy of the human corneal stroma show lamellar structure of collagen fibers. The magnified View shows collagen fibrils lattice pattern arrangement. (Modified from (Nishida, 2005) & (Stein et al., 2001))

4 Descemet's membrane:

A thin elastic membrane possessing high tensile strength and containing proteoglycans and glycoproteins in addition to collagen. The membrane stains intensely pink with the Periodic acid-Schiff **(**PAS) stain.

At the ultrastructural level, two zones can be identified, an anterior banded zone which is formed in fetal life and a posterior non-banded zone which increases in thickness throughout adult life(Fig6). **(Weng Sehu & Lee, 2005)**

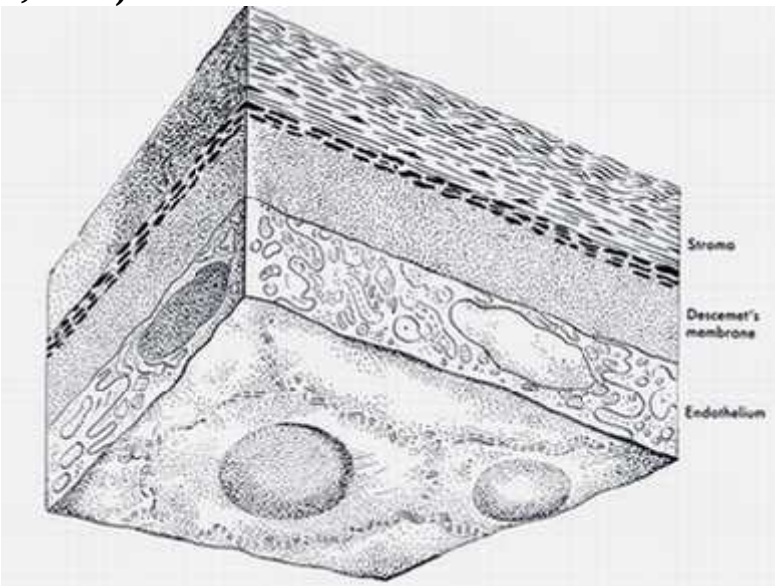


Fig 6:Diagram of Details of the inner portion of the cornea, including stroma, Descemets membran, and endothelium. (Stein et al., 2001)

5 Endothelium:

Corneal endothelium is a neural crest-derived cellular monolayer, that utilizes an ATP dependent pump to maintain physiologic stromal hydration necessary for corneal clarity. Corneal endothelial cells in humans do not normally proliferate in vivo. Corneal endothelial cells are normally lost throughout life at an estimated rate of 0.6% per year, although higher rates of cell loss occur in the settings of trauma (both surgical and nonsurgical). Corneal endothelial cell loss is compensated for through flattening and enlargement of remaining cells without cell division in order to maintain a continuous monolayer**. (Suh et al., 2008)**

Examination of the posterior surface by scanning electron microscopy reveals that the endothelial cells are arranged in a uniform hexagonal pattern(fig7). **(Weng Sehu & Lee, 2005)**

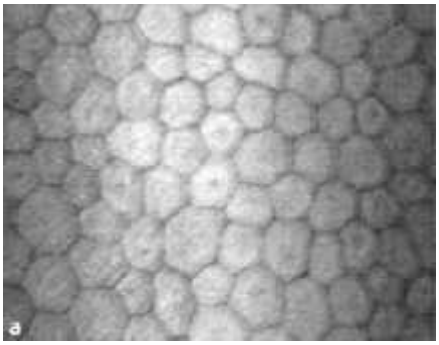


Fig 7: In vivo confocal microscopy image of normal corneal endothelial cells. Note ordered, hexagonal array of cells.(Suh et al., 2008)