



Collagen Cross-Linking in Management of Keratoconus and Corneal Ectasia Disorders

Essay

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وقل رب زدني علماً

صَلَّى
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✍ **Manar Shawky Mahroos**

List of Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
AGEs	Advanced Glycation End Products
ATP	Adenosine triphosphate
BAK	Benzalkonium chloride
BSCVA	Best spectacle corrected visual Acuity
BSS	Balanced salt solution
C3-R	Corneal collagen cross-linking with riboflavin
CH	Corneal Hysteresis
CL	Contact Lens
CXL	Corneal collagen cross-linking
DALK	Deep Anterior Lamellar Keratoplasty
Dextran-T-500	Technical Dextran with Average molecular weight of 500,000Daltons
EUV	Extreme Ultraviolet
eV	Electronvolt
FACIT	Fibril Associated Collagens with Interrupted Triple Helices
FAD	Flavin adenine dinucleotide
FMN	Flavin adenine mononucleotide
FUV	Far Ultraviolet
G	Glucose
ICNIRP	International commission on Non-Ionizing Radiation protector
ICRS	Intra corneal Ring Segment
ISO	International organization of standardization
IOL	Intra Ocular Lens
J	Joule
K⁺	Potassium
K	Keratometry

List of Abbreviations (Cont.)

KC	Keratoconus
LASIK	laser-assisted in situ keratomileusis
qLED	Light emitting diodes
LK	Lamellar Keratoplasty
mOsmol	Milliosmol
MUV	Middle Ultraviolet
Na⁺	Sodium
Nm	Nanometer
NUV	Near Ultraviolet
ORA	Ocular response analyser
PAS	Periodic acid-Schiff
PGs	Proteoglycans
PMD	Pellucid marginal degeneration
PRK	Photorefractive keratectomy
PKP	Penetrating Keratoplasty
PTK	Phototherapeutic Keratoplast
RGP	Rigid gas permeable
ROS	Reactive oxygen species
TGFβ	Transforming growth factor β
UCVA	Uncorrected visual acuity
μm	Micrometer
UV	Ultraviolet
UVA	Ultraviolet A
UVB	UltravioletB
UVC	Ultraviolet C
VUV	Vacuum Ultraviolet

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Introduction

Collagen has a critical role in maintaining corneal transparency, which is dependent upon its regular and uniform spacing. In addition, collagen fibres are necessary for maintaining the rigid curved shape of the cornea (*Scott and Bosworth, 1990*).

The weakened cornea is one of most challenging conditions for surgeons to recognize prior to performing LASIK or to treat after LASIK to avoid post LASIK collagen ectasia (*Hiatt and Boxer, 2004*).

Other examples of collagen ectasia include, Keratoconus, which is a degenerative disorder of the eye in which structural changes within the cornea cause it to thin and change to a more conical shape (*Arffa, 1997*), pellucid marginal degeneration, is a peripheral corneal thinning disorder at inferior cornea (*Jinabhai A et al, 2011*).*Post LASIK Keratectasia as complications after LASIK, Corneal Ulceration (Randleman et al, 2003)*

To understand how to strengthen the cornea, one must understand how the cornea becomes weakened by keratoectasia and keratoconus. Young patients have a propensity to produce high levels of reactive oxygen species (free radicals) in the cornea (*Buddi et al., 2002*). Superoxide dismutase and other enzymes typically prevent the accumulation of these free radicals. Some

patients are unable to produce these protective enzymes, however; as a result, the free radicals accumulate, causing damage to the structural integrity of the cornea (*Brown et al., 2004*).

Corneal thinning and weakening can ensue, and the cornea may steepen due to the biomechanics of IOP-induced strain on the tissue. In other words keratoconus develops out lining this process illustrates (*Hiatt and Boxer, 2004*).

Corneal collagen cross-linking with riboflavin is a new treatment for keratoconus increases collagen by applying a one-time-only topical dose of riboflavin drops to the cornea and exposing the cornea to a low amount of ultraviolet A (UVA) light (*Wollensak et al., 2003c*).

The activated riboflavin enhances corneal strength and integrity by increasing collagen cross-linking, as proven experimentally by reacting; with inducing chemical covalent bonds bridging amino groups of collagen fibrils type 2 photochemical reactions (*Wollensak et al., 2003b*).

The riboflavin/UVA therapy has been safe so far. There have been no reported complications in the crystalline lens or retina due to the limitation of UVA transmission through the cornea in a 3-year study of patients with actively progressing keratoconus. (*Wollensak et al., 2003a*)

Aim of the Work

- *To spotlight the biomechanical properties of the cornea.*
- *To demonstrate the role of collagen cross linking (as a modality of treatment) in arresting the progression of ectatic corneal conditions.*

Anatomy of the Cornea

Cornea is a transparent (dome shape), covering the anterior one sixth of the eyeball, it is an avascular tissue, with convex outer surface and concave inner surface, along with the precorneal tear film form, the major refracting surface of the eye and serves as a barrier between the environment and inside the eye(*Khurana A.K and KhuranaIndu, 2008*).

Because there are no blood vessels in the cornea, it is normally clear and has a shiny surface. The cornea is extremely sensitive; there are more nerve endings in the cornea than anywhere else in the body(*Khurana A.K and KhuranaIndu, 2008*).

Refractive power of the anterior surface of cornea is about +48D, and that of posterior surface is about -5D, total refractive the net refractive power of cornea is about +43D While the total refractive power of the eye 60diopres (*Khurana A.K and KhuranaIndu, 2008*).

Histology of the cornea:

Microscopically the cornea is composed of 5 layers (**Fig. 1**), from front to back:

1. Epithelium

2. Bowman's membrane (layer)
3. Stroma (substantiapropria)
4. Descemet's Membrane (posterior elastic lamina)
5. Endothelium. (*KhuranaA.KandKhuranaIndu, 2008*)

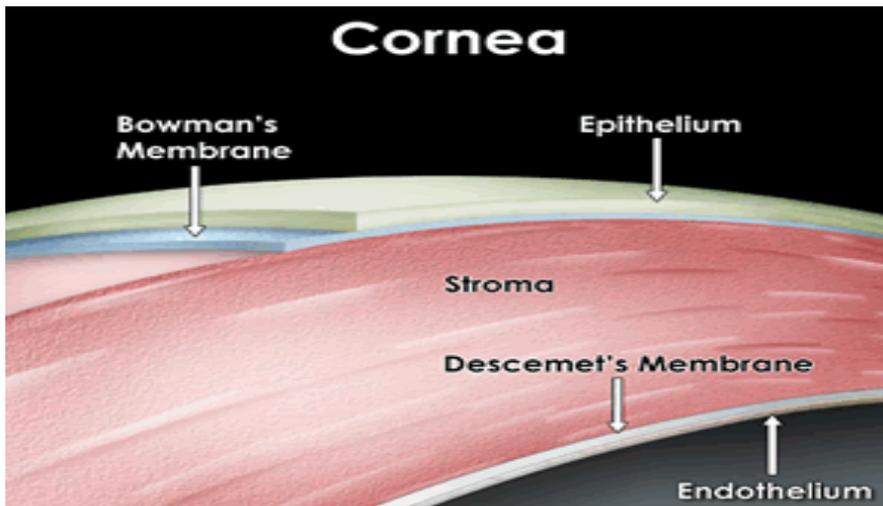


Fig. (1): Layers of the Cornea (*Minear, 2010*).

Transparency of the cornea is achieved by:

1. The regularity and fineness of its collagen fibrils.
2. Active metabolic pump of endothelium which prevents corneal oedema.
3. Absence of the blood vessels except the peripheral 1mm.
4. Non myelination of the corneal nerve fibres.
5. Uniform refractive indices of epithelium, endothelium and Descemet's membrane. (**O'Donnell and Wolffsohn, 2004**).