CORNEAL BIOMECHANICS

Essay
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By
Yousra Shawky Abd El-Rahman

M.B.,B.Ch.
Benha Faculty of Medicine

Supervised by
Prof. Dr. / Mamdouh Hamdy EL-Kafrawy

Professor of Ophthalmology
Dean of Faculty of Medicine
Ain Shams University

Ass. Prof. Dr. / Tamer Mohamed EL-Raggal

Assistant professor of Ophthalmology
Faculty of medicine-Ain Shams University

Faculty of Medicine
Ain-Shams University
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Yousra Shawky Abd El-Rahman

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الطبيبة/ يسرا شوقى عبد الرحمن مصطفى

بكالوريوس الطب والجراحة

جامعة بنها

تحت إشراف

أ.د/ ممدوح حمدى الكفراوى

أستاذ طب وجراحة العيون

عميد كلية الطب

جامعة عين شمس

أ.م / تامر محمد الرجال

أستاذ مساعد طب وجراحة العيون

كلية الطب جامعة عين شمس

كلية الطب

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واْ سُبْحَانَكَ لاَ عِلْمَ لَنَا إِلاَّ مَا
مْتَنَا إِنَّكَ أَنتَ الْعَلِيمُ الْحَكِيمُ

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سورة البقرة
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AL	:	Axial length
APON	:	Acquired pit of the optic nerve
ATP	:	Adenosine triphosphate
ATPase	:	Adenosine triphosphatase
CCT	:	Central corneal thickness
CH	:	Corneal Hysteresis
CPACG	:	Chronic primary angle closure glaucoma
CRF	:	Corneal resistance factor
CXL	:	Collagen cross-linking
D	:	Diopter
ECM	:	Extracellular matrix
FCD	:	Fuchs' corneal dystrophy
FFKC	:	Forme fruste keratoconus
GAGs	:	Glycosaminoglycans
GAT	:	Goldmann Applanation Tonometer
GS	:	Glaucoma suspect
HGF	:	Hepatocyte growth factor
IL-1	:	Interleukin-1
IOL	:	Intraocular lens
IOP	:	Intraocular pressure
IOPcc	:	Corneal-compensated Intraocular Pressure
IOPg	:	Goldmann-correlated Intraocular Pressure
IR	:	Infrared
KGF	:	Keratinocyte growth factor
LASEK	:	Laser Assisted Sub-Epithelial Keratomileusis

LASIK	:	Laser in situ keratomileusis
LRS	:	Laser refractive surgery
µm	:	Micrometer
mm	:	Millimeter
mmHg	:	Millimeters of mercury
ms	:	Milliseconds
Nm	:	Nanometer
NTG	:	Normal tension glaucoma
OHT	:	Ocular hypertension
OHTS	:	Ocular Hypertension Treatment Study
ORA	:	Ocular response analyzer
P1	:	Peak 1
P2	:	Peak 2
P-value	:	Probability value
PACG	:	Primary angle closure glaucoma
PK	:	Penetrating keratoplasty
POAG	:	Primary open angle glaucoma
PRK	:	Photorefractive keratectomy
PTK	:	Phototherapeutic keratectomy
R^2	:	The coefficient of determination
RSB	:	Residual stromal bed
UV-A	:	Ultraviolet A
VF	:	Visual field

INTRODUCTION

Cornea constitutes the transparent anterior one sixth of the outer coat of the globe. It is a remarkable tissue in that it combines the strength required to fulfill its role of producing a tough container for the inner contents of the eye protecting them from infection and damage, with precise curvature and a high level of transparency to visible wavelengths. This is achieved primarily by the unique structural properties of its main dry constituent, collagen **(Morishige et al., 2006)**.

Mechanics study forces that result in movement or equilibrium. It is the analysis of any dynamic system and strength of materials. Biomechanics is concerned with the medical application of mechanical concepts. It seeks to understand the mechanics of living systems. Organ biomechanics helps us to understand its normal function, predict changes due to alterations. The eye is a structure that moves or changes its shape in response to forces such as the IOP, extra-ocular muscles and surgical intervention and hence can be studied through applied mechanics **(Fung, 1981)**.

The corneal stroma provides important structural integrity of the cornea. It differs from other collagenous structures in its transparency and biomechanical properties. The stromal fibers provide the tensile strength of the cornea and extracellular matrix **(Boote et al., 2003)**.

This network reduces light scatter and contributes to the mechanical strength of the cornea. The peripheral stroma is thicker than the central stroma and the collagen fibrils may change direction to run circumferentially as they approach the limbus **(Newton and Meek, 1998)**.

The storma itself is an inelastic, anisotropic structure that distribute tensile stress unequally throughout its thickness, depending on the corneal hydration **(Dupps and Roberts, 2001)**.

The cornea reacts to stress as a visco-elastic material. The visco-elastic response consists of an immediate deformation followed by a rather slow deformation. The immediate elastic response seems to reflect the immediate elastic properties of the collagen fibers, and the steady state elastic response reflects the properties of the corneal matrix **(Edmund, 1988)**.

Since awareness of corneal biomechanics; studies have renewed to measure such a property. A particularly interesting technique has emerged during the last few years; Ocular Response Analyzer (ORA), that enables a dynamic measure for IOP including two applanation events, respectively. The difference between the inward and outward pressures is termed hysteresis and is measured in millimeters of mercury. It is a measure of: corneal damping capacity, visco-elasticity & energy absorption capability of cornea. ORA also provides measurement of IOP that is less affected by the corneal properties in the term of corneal compensated IOP **(Wells et al, 2008)**.

Corneal hysteresis and Corneal Resistance Factor are new measurements that reflect the viscoelastic properties of the cornea, its biomechanical integrity and rigidity. Their measurement assesses the corneal resistance to deformation **(Luce, 2005)**.

These new parameters may be clinically useful in a number of different areas including: Identification of corneal diseases such as keratoconus and Fuchs' Dystrophy, screening potential keratorefractive surgery candidates, accurate IOP measurement and glaucoma diagnosis and management **(Luce, 2005)**.

Corneal Hysteresis (CH) can be used to identify and classify various corneal pathologies; depending on the biomechanical properties of corneal tissue. Subjects whose corneas exhibit low corneal hysteresis, which can be thought of as having a "soft" cornea, are probable candidates for a variety of ocular diseases and complications **(Gatinel et al, 2007)**.

Keratoconic eyes are known to be more elastic and less rigid than normal eyes. Hysteresis was significantly higher in normal than in keratoconic eyes. It may be a useful measurement in addition to CCT **(Shah et al, 2007)**.

Over the last decade, refractive surgery has emerged as an attractive option to people with vision problems. The allure of being less dependent on their spectacles drives some people to seek refractive surgery and that was the reason for concerning with improving the visual outcomes after this surgery by taking into consideration the biomechanical properties of the cornea