الملخص العربي

قرنية العين تتميز بخصائص ميكانيكية التي تعطيها جودة التباطؤ. تباطؤ القرنية هو مؤشر مهم من خصائص النشاط الحيوي للقرنية. كان الهدف من دراستنا إظهار تأثير مرض السكري على الميكانيكا الحيوية للقرنية.

لقد تم استخدام جهاز محلل استجابة العين الذي يمكنه قياس تباطؤ القرنية و عامل مقاومة القرنية و معاوض قرنية ضغط العين وضغط جولدمان للعين للكشف عن تغيرات تحدث في معالم القرنية مع المرضى الذين يعانون من السكري من النوع ٢حيث ارتفاع السكر في الدم لدى مرضى السكري يغير بنية القرنية عن طريق عرقلة ترطيب القرنية و تغيير التوازن في ظهارة و سدى و بطانة القرنية.

لقد أجرينا دراستنا على مرضى السكري و أشخاص طبيعين للكشف عن العلاقة بين مرض السكري والميكانيكا الحيوية للقرنية. وقد أجريت الدراسة على ٨٠ عين من ٤٤ مريضا وتم تقسيم هؤلاء المرضى إلى مجموعتين. المجموعة (أ) تشارك ب٤٠ عين من ٢٠ شخص طبيعى والمجموعة (ب) تشارك ب٤٠ عين من ٢٢من مرضى السكري.

أفادت دراستنا أن مرض السكري يؤدي الي زيادة في الميكانيكا الحيوية للقرنية حيث أن تباطؤ القرنية و عامل مقاومة القرنية كانوا مرتفعين مع المرضى من المجموعة (ب) (مرضى السكري).

تفسيرنا لتلك النتائج أنها بسبب ارتفاع السكر في الدم حيث أن الجلوكوز يتراكم في بروتينات الكولاجين مما يمكن أن يكون بمثابة عامل ربط للكولاجين مما يؤدي إلى زيادة سمك القرنية .

أيضا على الأرجح المرضى الذين يعانون من ارتفاع السكر في الدم (ارتفاع نسبة الهيموجلوبين السكري) أظهروا زيادة في تثبيط القرنيةز هذه الزيادة تنعكس علي الزيادة في تباطؤ القرنية.

وفي الوقت نفسه دراستنا أفادت ارتباط كلا من تباطؤ القرنية و عامل مقاومة القرنية مع مدة داء السكري ونسبة الهيموجلوبين السكري في كلا مجموعتين الدراسة لإظهار تأثير مرض السكري على الميكانيكا الحيوية للقرنية.

كشفت نتائجنا ضعف علاقة خطية إيجابية بين تباطؤ القرنية ومتوسط مدة مرض السكري في مجموعة مرضى السكري وعدم وجود ارتباط بين تباطؤ القرنية ومستوى متوسط نسبة الهيموجلوبين السكري في مرضى المجموعة الطبيعية. ولكن كان هناك علاقة خطية إيجابية ضعيفة بين تباطؤ القرنية ومستوى متوسط نسبة الهيموجلوبين السكري في مرضى السكري .

و بالنسبة الي عامل مقاومة القرنية كانت هناك علاقة خطية إيجابية ضعيفة بينها وبين متوسط مدة مرض السكري في مجموعة مرضى السكري، وكان هناك علاقة خطية سلبية ضعيفة للغاية بينها وبين متوسط

مستوى نسبة الهيموجلوبين السكري في مرضى المجموعة الطبيعية. ومع ذلك كانت العلاقة خطية إيجابية متوسطة بينها وبين نسبة نسبة الهيموجلوبين السكري في مجموعة مرضى السكري.

Evaluation of the effect of Diabetes Mellitus on Corneal Biomechanics

Thesis

Submitted for partial fulfillment of M.Sc. Degree in Ophthalmology

By

Rowda Ragab Mousa Mohammed Mousa

M.B.B.Ch

Under supervision of

Prof. Dr. Karim Adly Raafat

Professor of Ophthalmology

Faculty of Medicine - Cairo University

Prof. Dr. Mohamed Abdel Monem Hassaballa

Professor of Ophthalmology

Faculty of Medicine - Cairo University

Dr. Riham Samy Hanafy Mahmoud Allam

Lecturer of Ophthalmology

Faculty of Medicine

Cairo University

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من الطبيبة:

روضة رجب موسي محمد موسي

بكالوريوس الطب والجراحة

تحت اشراف:

الاستاذ الدكتور/كريم عدلي رأفت

أستاذ طب وجراحة العيون

الطب - جامعة القاهرة كلية

الاستاذ الدكتور/محمد عبد المنعم حسب الله

أستاذ طب وجراحة العيون

الطب - جامعة القاهرة كلية

الدكتورة/ ريهام سامي حنفى محمود علام

مدرس طب وجراحة العيون

الطب - جامعة القاهرة كلية

كلية الطب

جامعة القاهرة

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List of abbreviations

- **AGEs**…… …….Advanced glycation end products
- **Akt signaling**……Protein Kinase B
- **ALL**…….....Anterior Limiting lamina
- **BCVA** …… Best corrected visual acuity
- **CCM**……. Corneal confocal microscopy
- **CCT** ……. Central corneal thickness
- **CH**…….. Corneal hysteresis
- **CML**…… N^{ε}-(carboxymethyl) lysine
- **CRF**……..…Corneal resistance factor
- **DC**……...…Diopter cylinder
- **DS**…….…… Diopter sphere
- **ECD**……Endothelial cell density
- **EGF receptor**……...…Epidermal growth factor
- **FBG**……Fasting blood glucose
- **HBA1c**…….Glycated hemoglobin
- **HCD**…….....Horizontal corneal diameter

- **IOP**……... Intraocular pressure
- **IOPcc**……. Corneal compensated IOP
- **IOPg**……. Goldman- correlated IOP
- **K**……... Constant
- **LASIK**……..Laser Assisted Insitu Keratomileusis
- **LC**…… Lamina cribrosa
- **LCD**……Lamina cribrosa displacement
- **MMPs**……Matrix metalloproteinases
- **OCE**…… Optical coherence elastography
- **ONH**……...…Optic nerve head
- **ORA**……. Ocular response analyzer
- **P1**……..…...…Inward applanation pressure
- **P2**……Outward applanation pressure
- **PG**…….. Proteoglycans
- **PI3K**…… phosphatidylinositide 3-kinases
- **ppSc** ……... Peripapillary sclera
- ***r***……..Pearson product-moment correlation **coefficient**
- **RAGE**……..... AGE receptors
- **RBG**…….……Random blood glucose
- **SCE** ……scleral canal expansion
- **SD**……..……Standard deviation

- **TEM**……Transmission electron microscopy
- **UCVA**……..Uncorrected visual acuity

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AIM OF THE WORK

To compare the biomechanical properties of the cornea in patients having diabetes mellitus and age matched normal individuals as regards to corneal hysteresis (CH), corneal resistance factor (CRF), Corneal compensated IOP (IOPcc) and Goldman-correlated IOP (IOPg).

ANATOMY OF THE CORNEA

The cornea is the major refractive surface of the eye, the anterior surface of the cornea provides approximately 45 diopters of power. It also serves as a strong barrier protecting the inner structures of the eye against trauma and infection (***Armitage, 1999).***

GROSS ANATOMY

The cornea is a clear transparent tissue that joins the opaque sclera at the limbus and is bounded anteriorly by the tear film and posteriorly by the aqueous humour. When it is viewed from the outside, it has a certain diameter, most commonly now assessed by measures of the horizontal corneal diameter (HCD). This is also known as the visible iris diameter or white to white diameter since it is essentially the transition from the visible edge of the iris to the white sclera surrounding the cornea. Human cornea might be considered as round when viewed from the outside. It is slightly oval so that the vertical diameter measures are slightly smaller (***Jonuscheit & Doughty, 2009).***

Its outer aspect is slightly elliptical with a horizontal axis of 11.7 mm and a vertical axis of 10.6 mm while from the inner aspect it is circular with a diameter of 11.7 mm. The radius of curvature of the anterior surface of the central cornea is 7.8 mm and that of the posterior surface is 6.5 mm, while the peripheral cornea is more flattened ***(Bron et al., 1997).***

Measures of the anterior and posterior curvatures are readily obtained by modern instrumentation using a special scheimpflug photography (pentacam) system ***(Ho et al., 2008).***

The difference in curvature between the anterior and the posterior surfaces results from the central corneal thickness being relatively thinner than the periphery. Maurice reported that the central corneal thickness value is 0.52 mm and the peripheral corneal thickness is 0.65 mm when measured with an optical pachemeter ***(Maurice et al., 1984).***

There is no gender difference in the corneal thickness, but other corneal dimensions are slightly less in females ***(Armitage, 1999).***

Microscopic anatomy

Previously, the human cornea, which is approximately 550 microns thick, was thought to be comprised of five layers **(figure 1)** from front to back, the corneal epithelium, Bowman's layer, the corneal stroma, Descemet's membrane, and the corneal endothelium ***(Bron et al., 1997).***

Based on clinical experience with corneal transplants, Dua described a layer that exists between the corneal stroma and Descemet's membrane ***(Dua et al., 2013).***

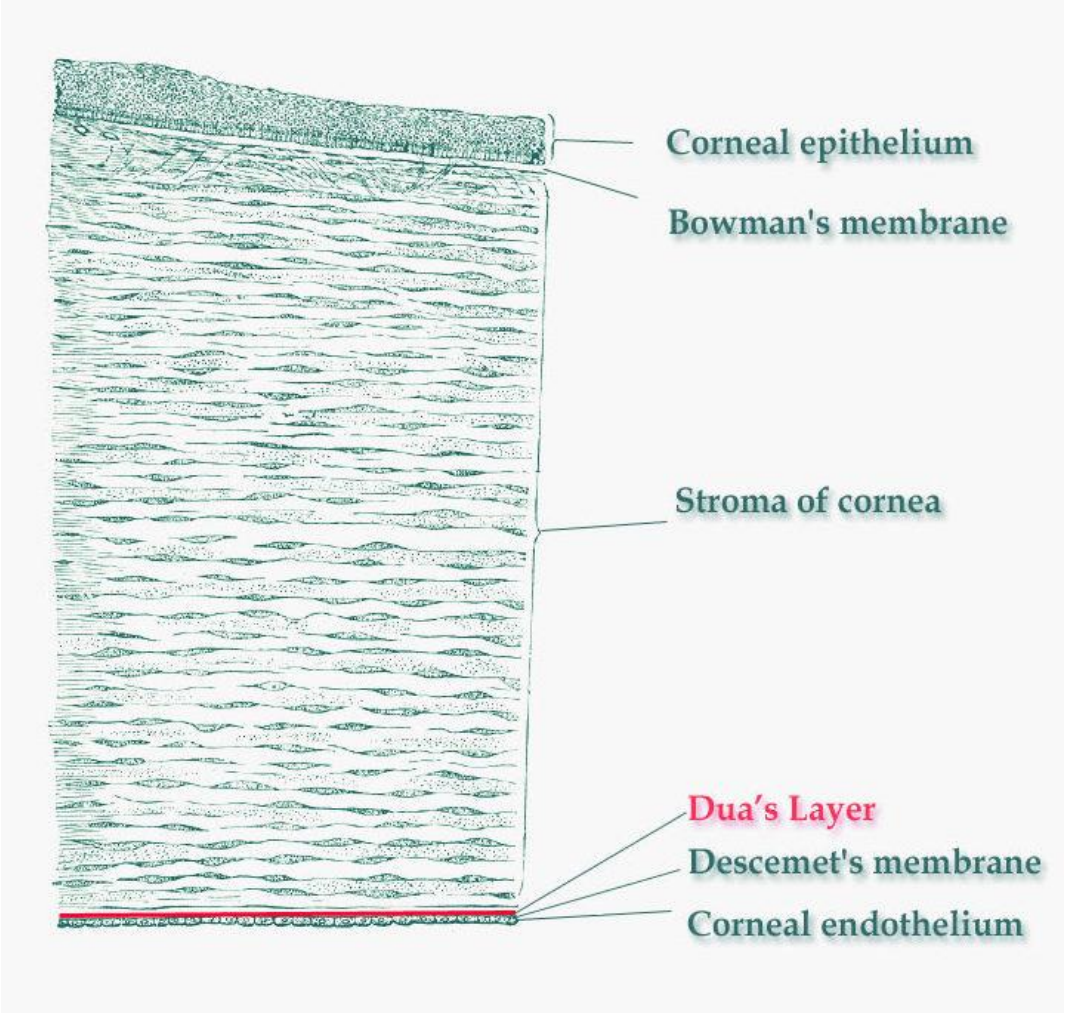

Figure (1): Histological view of the corneal layers ***(Dua et al. 2013).***

Epithelium:

It accounts for 10% of the corneal thickness. It is of non-keratinized stratified squamous epithelial layer and becomes continuous with the epithelium of bulbar conjunctiva at the limbus. It consists of 5-7 layers of cells. The deepest (basal) layer is made up of columnar cells of about 18 um in height and 10 um in diameter with a flat basal surface and a rounded apical surface. Moving anteriorly, cells become more flattened to form 2-3 layers of wing or umbrella cells, while those in the outermost layer are highly flattened squamous cells that are only 4 um thick and up to 45 um across. The basement membrane zone "basal lamina" is a complex interface between the basal cells and the underlying bowman's layer ***(Armitage, 1999).***

The basal cells are connected to one another by desmosomes and to the underlying basal lamina by hemidesmosomes. Both the wing and basal cells possess numerous fibrils called anchoring filaments which pass through the desmosomal structures to be inserted into the underlying basal lamina ***(Khoudadoust et al., 1968).***

The superficial cells are attached to each other by tight junctions'zonulaoccludens in addition to the desmosomal connections ***(Tonjum, 1974).***

Langerhan's cells are antigen presenting cells that carry both class 1 and 2 major histocompatibility antigens which are confined to the peripheral 1/3 of the epithelium, but corneal diseases, trauma or chemical stimulators can result in substantial recruitment of it into the central region (***Armitage, 1999).***

The cornea has a rich supply of sensory nerve fibers, with their main origin being the ophthalmic division of the trigeminal nerve. The corneal sensory nerve extending from the basal to more anterior layers ***(Muller el al., 1996).***

Recent studies on post-mortem human corneas indicate that central nerve fibers form a network that extends uniformly in all directions across the epithelium with estimated densities of some 600/mm^2 in more anterior layers ***(Marfurt et al., 2010).***