The influence of corneal astigmatism on retinal nerve fiber layer thickness and optic nerve head parameter measurements by optical coherence tomography

Thesis

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Presented By

Sara Mohamed Mohamed Saied Ahmed

M.B.B.Ch.

Supervised By

Prof. Dr. Negm Eldein Helal Abd Allah

Professor of Ophthalmology
Faculty of Medicine - Ain Shams University

Prof. Dr. Lamia Salah Elewa

Professor of Ophthalmology
Faculty of Medicine - Ain Shams University

Dr. Ahmed Mohamed Al Bayomy

Lecturer of Ophthalmology
Faculty of Medicine Ain Shams University

Faculty of Medicine
Ain Shams University
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بسم الله الرحمن الرحيم

قالوا

سبحانك لا علم لنا
إلا ما علمتنا إنك أنت
العليم الحكيم

صدق الله العظيم

سورة البقرة الآية: ٣٢

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List of Contents

List of Tables

Table No.	Title	Page No.

List of Figures

List of Figures Cont...

Fig. No.	Title	Page No.

List of Graphs

List of Abbreviations

Abb.	Full term
ATR	Against-the-rule
AUC	Area under curve
BCVA	Best corrected visual acuity
CA	Corneal astigmatism
CCIs	Clear corneal incisions
CSLO	Confocal scanning laser ophthalmoscope
DM	Descemet's membrane
ECD	Endothelial cell density
IOP	Intraocular pressure
IQR	Inter-quartile range
MICS	Micro-incision cataract surgery
NPV	Negative predictive value
NSE	Neuron- specific enolase
OCT	Optical coherence tomography
ONH	Optic nerve head
PPV	Positive predictive value
PRL	Photoreceptor layer
RNFL	Retinal nerve fiber layer
ROC	Receiver operating characteristic curve
SIA	Surgically induced astigmatism
UCVA	Uncorrected visual acuity
WTR	With-the-rule

Introduction

Astigmatism is a worldwide common ocular disorder. Total astigmatism is mainly driven by corneal astigmatism (CA), which occurs due to an irregular shape of the cornea. In eyes with astigmatism, retinal images can be distorted. Langenbucher et al. reported that the retinal image was distorted to an ellipse, and the image size could vary according to the axis of astigmatism assessed with computer-based methodology in astigmatic eyes ***(Langenbucher et al., 2007).***

Optical coherence tomography (OCT) can provide imaging of ocular structures by a noninvasive method, it is widely used in clinical and scientific ophthalmology to obtain high-resolution cross-sections of the retina images. The thickness of the retinal nerve fiber layer (RNFL) and optic nerve head (ONH) parameters can be measured by OCT. Evaluation of these parameters is essential, since the thickness of the RNFL may be effected in various diseases.

Many studies have reported the effect of refractive error changes on RNFL thickness measured by OCT ***(Leung et al., 2006; Salchow et al., 2011),*** while little is known about the effect of cylindrical refractive error (astigmatism) on RNFL and ONH parameters measured by OCT. The purpose of this study was to evaluate the influence of corneal astigmatism on the peripapillary RNFL thickness and ONH parameters obtained by Cirrus HD spectral-domain OCT ***(Kang et al., 2010).***

The optical coherence tomographer is a modern imaging device designed to measure the RNFL and ONH parameters in a noncontact and noninvasive manner. RNFL measurements have been reliable and reproducible, and newer versions of optical coherence tomographers based on spectral domain technology that provide higher resolution and faster scanning speeds have been developed ***(Paunescu et al., 2004).*** Reproducibility of nerve fiber thickness, macular thickness, and optic nerve head measurements using Stratus OCT. It has been reported that many factors, including refractive error, axial length, myopic optic disc tilt, eccentric scan location, and head tilt during the examination can affect the OCT measurements ***(Kang et al., 2010).***

Effect of myopia on the thickness of the retinal nerve fiber layer measured by Cirrus HD optical coherence tomography.

Lee et al. reported that refractive error changes induced by wearing soft contact lenses of eight diopters without astigmatic power could affect RNFL thickness measured by a Cirrus HD OCT ***(Paunescu et al., 2004; Savini et al., 2007; Hwang et al., 2012).***

They considered the RNFL thickness was underestimated in eyes with increasing negative refractive error, while it was overestimated with increasing positive refractive error. Therefore, we hypothesize that, not only spherical refractive error, but also cylindrical refractive error can affect OCT measurements.

Studies showed that CA influenced spectral-domain OCT measurements of both RNFL thickness and ONH parameters ***(Lee et al., 2011).***

AIM OF THE WORK

To evaluate the influence of corneal astigmatism (CA) on retinal nerve fiber layer (RNFL) thickness and optic nerve head (ONH) parameters measured with optical coherence tomography (OCT) in high astigmatic patients.

Chapter 1

ANATOMY OF CORNEAL ENDOTHELIUM

Cornea

It is the anterior part of outer fibrous coat of the eye. Anteriorly, the cornea is elliptical and diameter horizontally is 11.7 mm, and vertically is 10.6 mm. Posteriorly, the cornea is circular with a diameter of 11.7 mm. The radius of curvature of the convex anterior surface is 7.7 mm and of the concave posterior surface is 6.9 mm. Regarding thickness, the central corneal thickness is 0.5 µm, while the peripheral portion is 0.7 µm thick ***(Snell and Lemp, 1998).***

The endothelial layer lines the posterior corneal surface and forms the anterior surface of the anterior aqueous chamber. It maintains normal corneal thickness and transparency by its active pump ***(Snell and Lemp, 1998)***.

Origin of endothelial cell layer:

Endothelial cells are neuroectodermal in origin ***(Snell and Lemp, 1998).***

Microanatomy and cell morphology of the endothelium:

The corneal endothelium consists of monolayer of hexagonal cells with a characteristic honey comb appearance.

Each cell measures about 4-6 μm in length, about 20 μm in width and cell area of 250 μm and has a large central nucleus about 7 μm in diameter ***(Kaufman, 1999).***

The posterior cell surface is covered by microvilli about 0.5 to 0.6 μm in length which project into the anterior chamber (Figure. 1). Oligocilia are also present on some cells especially in the corneal periphery projecting from the cell's centriole pair in the posterior cytoplasm and are about 2 to 7 μm in length.

It was thought that this association is responsible for the inability of the adult endothelial cells to divide after birth ***(Kaufman, 1999).***

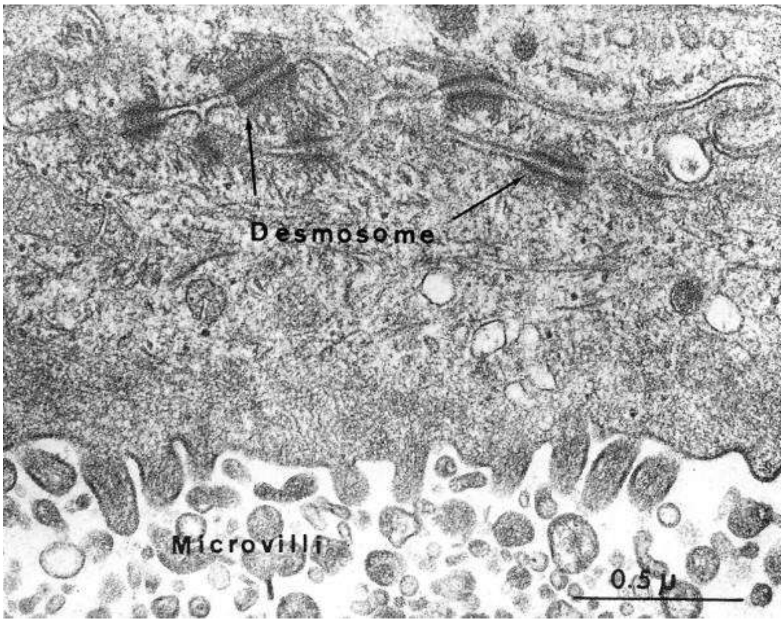

Figure (1): Microvilli projecting from the apical surface of the corneal endothelium ***(Crawford et al., 2003).***