COMPARATIVE STUDY BETWEEN THE CORNEAL VOLUME IN MILD AND SEVERE KERATOCONIC EYES USING PENTACAM TOMOGRAPHY

Thesis

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Amal Salah Mohammed

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ACD	Anterior Chamber Depth
BAD	Belin ambrosio display
BFS	Best- Fit Sphere
CCT	Central Corneal Thickness
CT	Computed tomography
CV	Corneal Volume
CXL	Cornea cross-linking
DALK	Deep anterior lamellar keratoplasty
DM	Descemet's Membrane
FSL	Femtosecond laser
ICRS	Intrastromal corneal ring segments
INTACS	Intrastromal corneal ring segments
IOP	Intra Ocular Pressure
MMPs	Metalloproteinases
P IOLs	Phakic intraocular lenses
PDL	Pre-Descemet's Layer
PDL	Pre-Descemet's layer
PK	Penetrating Keratoplasty
RGP	Rigid Gas Permeable
TBM	Trabecular Meshwork
TGF-β	Transforming growth factor beta
TP	Thinnest Point
UV-A	Ultraviolet A

ABSTRACT

Background: Keratoconus is the most common corneal ectasia. It usually appears in the second decade of the life and affects both genders and all ethnicities. Tomographic-based data have added significantly more information to the screening of corneal ectasia. In addition to anterior corneal analysis, tomography also provides information about the posterior cornea and the pachymetric distribution, which can increase our ability to identify early and subtle corneal changes.

Aim of the Work: The main aim is to determine how the corneal volume measurement changes in different diameters of corneal tissue, in the central 3 mm and 5 mm in mild and severe cases of keratoconus; in an attempt to quantify the loss of corneal tissue in keratoconus.

Patients and methods: This cross-sectional study included 20 eyes of keratoconic patients, from 15 to 36 years old. They were divided into 2 groups, each group included 10 eyes: Group A: mild keratoconic cases with steepest keratometry reading lower than 45 D. Group B: severe cases with steepest keratometry greater than 52 D, All cases were diagnosed as keratoconus using pentacam parameters.

Results: Corneal volume at 3 and 5 mm diameter was significantly lower in the severe keratoconic cases than in mild cases ($P<0.01$).

Conclusion: based on the data in our study, we think the effect of keratoconus is not limited to corneal thickness. Rather, it affects all anterior segment parameters of the eye and results in significant alternations with the progression of the disease. There is a clear reduction of corneal volume in early keratoconus, and such reduction increases significantly with the severity of the disease. Measurement of corneal volume could prove to be a useful tool to monitor the progression of the disease and in other applications, such as assessing the effect of treatments including corneal collagen crosslinking and implatation of Intacs.

Recommendations: Further studies on a larger scale of patients are needed to confirm the results obtained by this work.

Keywords: corneal volume, keratoconus, pentacam tomography.

INTRODUCTION

Keratoconus is a chronic, bilateral, usually asymmetrical, non-inflammatory, ectatic disorder, being characterized by progressive steepening, thinning and apical scarring of the cornea ***(Serdarogullari et al, 2013).***

As the cornea steepens, the amount of astigmatism increases, causing a distortion of the image which reduces visual acuity of affected patients (***Patel and Shah, 2012).***

Keratoconus is a complex condition that involves both external factors, such as allergies and eye rubbing, and genetics factors (***Sugar and Macsai, 2012***) .Severity of the disease has been shown to be associated with family history and ethnic origin ***(Jordan et al, 2011).***

Histological studies have described how, in the advanced stages of keratoconus, the basal cells of the epithelial layer eventually disappear, leaving the epithelium with only one or two layers of superficial flattened cells ***(Hollingsworth et al, 2005).***

In the advanced stages of keratoconus, Bowman's layer may present prominent fracture lines **(*Sawaguchi et al, 1998*)** that are thought to occur in weak areas due to the inability to withstand normal intraocular pressure or physical stress, such as that caused by eye rubbing, leading to breaks ***(Sherwin et al, 2002).*** The

collagen lamellae in the keratoconic stroma slides resulting in loss of their natural arrangement and corneal thinning.

The basic diagnostic examinations for keratoconus include placido disk–based corneal topography, Orbscan I and II slit topography, Pentacam Scheimpflug imaging ***(Fernández, 2014).***

Corneal tomography provides 3-dimensional reconstruction of the cornea, enabling evaluation of the anterior and posterior corneal surfaces and creation of a pachymetric map ***(Pflugfelder et al, 2002).*** Corneal thickness spatial profile, corneal volume (CV) distribution, percentage increase in thickness, and percentage increase in volume were studied, and it was reported that these parameters could serve as indices to diagnose keratoconus and screen refractive candidates ***(Ambrósio et al, 2006).***

Among the numerous morphologic parameters that can be measured by modern examination techniques is the CV, it reflects topographical and pachymetric changes and characterizes corneal morphometric changes with a single value ***(Cervino et al, 2009).***

CV was recently identified as an additional screening factor for keratoconus ***(Emre et al, 2007).*** Significant differences in CV have been reported between normal and moderate keratoconic eyes ***(Ambrosio et al, 2006)*** Suggesting the potential role for CV as a diagnostic factor for corneal ectatic disorders.

AIM OF THE WORK

The main aim is to determine how the corneal volume measurement changes in different diameters of corneal tissue, in the central 3 mm and 5 mm in mild and severe cases of keratoconus using pentacam tomography.

In attempt to quantify the loss of corneal tissue in keratoconus.

CHAPTER (1):
ANATOMY OF THE CORNEA

The cornea is an important component of the ocular refractive system.

It is an avascular, transparent tissue. Corneal curvature and transparency are essential for maintaining the refractive power of the cornea which accounts for about 2/3 of the refractive power of the eye **(*Jain and Azar, 1994*).**

In an average adult, the horizontal diameter of the cornea is 11.5– 12.0 mm and the vertical diameter is about 1.0 mm smaller ***(Reufer et al, 2005).***

The central curvature of the corneal surface is 7.8 mm (44 diopters)

This is slightly larger in the horizontal meridian than in the vertical meridian, and it corresponds to a toricity of 0.5 diopters axis horizontal ***(Ehlers and Hjortdal, 2005).***

Layers of Cornea

The cornea has six layers and the Dua's layer or the pre-Descemet's layer (PDL) which is present between the stroma and Descemet's membrane is a new addition to the traditional classification of corneal layers into five ***(Dua et al, 2013)***

1. Epithelium
2. Bowman's membrane
3. Stroma
4. Dua's layer
5. Descemet's membrane 6. Endothelium **(Figure 1)**

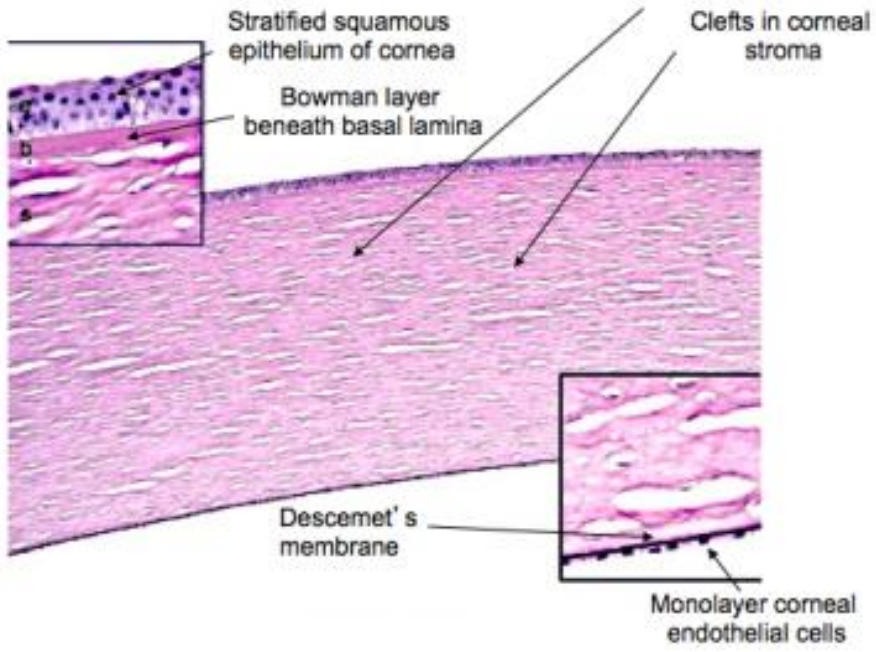

Figure 1 (Layers of the cornea) ***(Wilson, Steven, 1994)***

1. Epithelium

This is the outermost layer of the cornea and is derived from the surface ectoderm. It's a non-keratinized stratified squamous epithelium measuring 50 μm in thickness composed of five to seven layers of cells ***(Krachmer et al, 2005).***

The epithelium plays a crucial role in maintaining a smooth refractive surface along with the tear film. It also provides a mechanical barrier to all external pathogens. The superficial cells are two to three layers, flat, polygonal with numerous microvilli and microplicae on their surface that secrete glycocalyx which play a role in maintaining stability of the tear film ***(Krachmer et al, 2005).***

These cells are well differentiated. The next layer-the wing cell layer, consists of two to three layers. The basal layer is the only layer where the cells have mitotic activity and differentiate into wing and superficial cells. The basal layer is attached by hemidesmosomes to the basal lamina. There are different types of intercellular junctions between the epithelium. The superficial cells have desmosomes and tight junctions (zonula occludens) which are mostly present along the apical surface of the superficial cells providing an effective barrier to penetration of tears. The wing cells and basal cells have desmosomes, gap junctions, and hemidesmosomes the epithelium regenerates every 7–14 days. ***(Krachmer et al, 2005)*** **(Figure 2).**

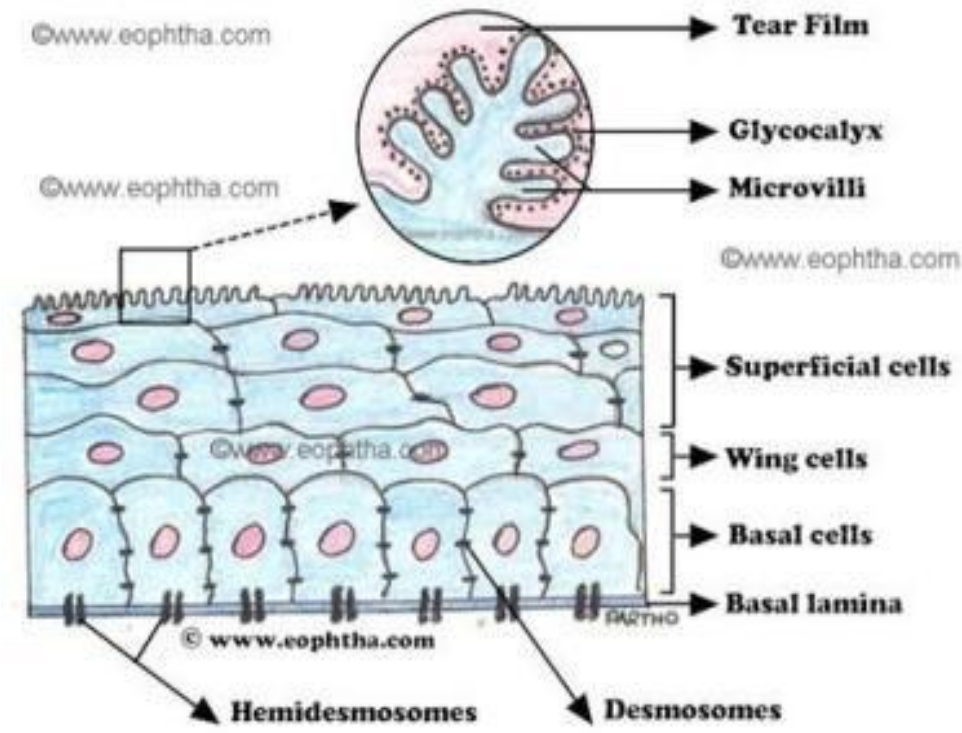

Figure 2. (Corneal epithelium)(Dua *et al, 2000)*

2. Bowman's Layer

This is an acellular, tough membrane measuring 10 μm situated between the epithelium and stroma. It is not a true basement membrane unlike the Descemet's membrane. It is composed of randomly arranged collagen fibers which are continuous with that of the anterior stroma. This layer primarily contains collagen types 1 and 3. The Bowman's layer helps maintain the shape and is also resistant to trauma.

Unlike epithelium, it does not have the property to regenerate once destroyed and can form a fibrous scar following injury. In