# CORNEAL CURVATURE AS IT RELATES TO CORNEAL THICKNESS

By

Ashley Marie Muhlada
&
Brad Daniel Masuga

This paper is submitted in partial fulfillment of the
requirements for the degree of

Doctor of Optometry

Ferris State University
Michigan College of Optometry

March, 2007

# CORNEAL CURVATURE AS IT RELATES TO CORNEAL THICKNESS

By

Ashley Marie Muhlada
&
Brad Daniel Masuga

Has been approved

May, 2007

Ferris State University
Doctor of Optometry Paper
Library Approval and Release

CORNEAL CURVATURE AS IT RELATES TO CORNEAL THICKNESS

I, Brad Masuga, and Ashley Munlada, hereby release this paper as described above to Ferris State University with the understanding that it will be accessible to the general public. This release is required under the provisions of the Federal Privacy Act.

## ABSTRACT

*Purpose*: To better understand the anatomical relationship between corneal thickness and corneal curvature. To potentially allow keratometry measurements to provide further insight of a patient's corneal thickness when pachymetry is unavailable.

*Methods*: Subjects: 39 20-30 year old males and females (78 eyes) with no prior history of corneal surgery, pathology, or trauma that would alter shape and/or thickness of the cornea.

Procedure: Senior students performed keratometry using a manual keratometer followed by central corneal pachymetry using the DGH 5100 E Combination A-Scan/Pachymeter on each volunteer. Keratometry readings in the two principle meridians were averaged and used for analysis. Five pachymetry readings were taken for each eye and the average was used for analysis.

Analysis: A Pearson Product-Moment Correlation also know as the Pearson Correlation Coefficient was used to analyze the data.

*Results*: Based on the correlation coefficients and p values, no statistically significant correlation was found between average keratometry and pachymetry readings.

*Conclusions*: Practitioners are not able to infer corneal thickness based on average keratometry readings. In order to obtain accurate readings, both corneal thickness and curvature must be measured separately or by the use of other instrumentation.

TABLE OF CONTENTS

## LIST OF TABLES

Table Page

## Introduction:

Keratometry and Pachymetry and two commonly performed tests in primary care optometry. Keratometry can be very valuable in evaluating corneal curvature for new contact lens patients and in the diagnosis of various corneal thinning disorders. Pachymetry is commonly performed on glaucoma patients to increase accuracy of intraocular pressure readings and is also used to screen all potential LASIK candidates. Although these two tests seem to be unrelated, there may be a common link. Keratoconus (KC) is a bilateral corneal ectasia causing progressive thinning of the cornea resulting in an outward bulge inferiorly. The correlation between corneal curvature and corneal thickness in this disease state suggests there may be correlation of these two variables in the general public. It was therefore hypothesized that a inverse relationship exists between corneal thickness and corneal curvature in the average patient with no prior history of corneal pathology.

This study attempts to relate central corneal pachymetry measurements to average corneal keratometry readings. It is hypothesized that thinner corneas will have subsequent increased curvature due to the internal pressure of the aqueous humor. In performing this study, we hope to gain a better understanding of the anatomical relationship between the two variables and insight into the mechanism of KC.

## Methods:

39 students 20-30 years old were used as subjects in the evaluation of corneal thickness and curvature. Only patients with no prior history of corneal surgery, pathology, or trauma that would alter shape and/or thickness of the cornea were allowed to participate in this study. Two senior students performed keratometry using a manual keratometer followed by central corneal pachymetry using the DGH 5100 E Combination A-Scan/Pachymeter on each volunteer. Keratometry was performed by one student and pachymetry by another to eliminate variability between examiners. Keratometry measurements were taken in primary gaze in the two principle meridians with the average of the two being used for analysis.

Pachymetry was then performed on each volunteer. A drop of 0.5% Proparacaine was instilled into each eye prior to performing the readings. The pachymeter probe was gently applied to the surface of the central cornea several times for approximately one second to obtain a reading. Five readings were taken for each eye and the average was used for analysis.

Our analysis attempted to find a correlation between two variables: corneal thickness and corneal curvature. A Pearson Product-Moment Correlation also known as the Pearson Correlation Coefficient was used for the analysis.

## Results:

Results of the keratometry and pachymetry measurements can be found in **Table 1**. Average keratometry readings were 44.60 diopters with a standard deviation of 1.13 diopters. Average pachymetry readings were 546.5 microns with a standard deviation of 32.8 microns. Data analysis (**Table 2**) using the Pearson Product-Moment Correlation revealed a correlation value of 0.055. However, the significance (p value) was found to be 0.631 revealing no statistically significant correlation between the average keratometry and pachymetry readings.

**Table 1**

**Descriptive Statistics**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| Average K | 44.6039 | 1.13242 | 78 |
| Average Pachymeter | 546.51 | 32.790 | 78 |

**Table 2**

**Correlations**

| | | Average K | Pachymeter |
|---|---|---|---|
| Average K | Pearson Correlation | 1 | .055 |
| | Sig. (2-tailed) | | .631 |
| | N | 78 | 78 |
| Average Pachymeter | Pearson Correlation | .055 | 1 |
| | Sig. (2-tailed) | .631 | |
| | N | 78 | 78 |

## Discussion

Corneal curvature and corneal pachymetry are two tests commonly performed in primary care optometry. Both tests can be very useful in the diagnoses and management of certain corneal disorders such as keratoconus. Although the etiology of keratoconus is not well understood, researches have come up with many theories as to the underlying cause. Some claim that it is an enzyme abnormality in the corneal epithelium that causes a degradation of the corneal stroma. Others suggest an abnormality in the corneal collagen and its cross linking.(1) While the cause of keratoconus remains uncertain, studies show that all cases involve both corneal thinning and inferior steepening.

This study attempts to find a correlation between the corneal thinning and steepening that occurs with keratoconus. Results show, however, that corneal thickness and corneal curvature are not related in any statistically significant way. This finding suggests that it is not just the thinning of the cornea that creates the outward bulging in

keratoconic patients. It is likely that an alternate or additional factor is affecting the cornea causing the severe steepening.

One possible hypothesis for the outward bulge found in keratoconic patients is that of increased intraocular pressure causing steepening of the thinned cornea inferiorly. However, according to the Reykjavik Eye Study, which sampled 1,045 subjects and measured central corneal thickness, corneal curvature, and IOP, there is no significant correlation between corneal curvature and IOP(2).

A second hypothesis lies in the distribution of corneal layers. Research has found that keratoconus affects all layers of the cornea. Epithelial cells become elongated and begin to forma whorl-like pattern. There is a decrease in the collagen lamella making up the stroma leading to subsequent loss of the fibular arrangement of the stroma. Descemet's membrane often develops striae and endothelial cell loss is also present (3,4). These findings suggest that thinning is only part of the problem; there is also an apparent redistribution of the corneal layers that may ultimately lead to the severe corneal steepening. This may explain why individuals with thinner corneas do not exhibit the bulge and increased corneal curvature found in keratoconic patients (3).

Although many studies have been performed regarding the pathogenesis of keratoconus, the cause remains unclear. It is evident that more must be done to fully understand what is contributing to this common corneal disorder.

## References


1) Yanoff M. and Duker J. Ophthalmology: Second edition. Copyright 2004, Mosby Inc

2) Eysteinsson T, et al. Central Corneal Thickness, Radius of the Corneal Curvature and Intraocular Pressure in Normal Subjects Using Non-Contact Techniques: Reykjavik Eye Study. Acta Ophthalmol. Scand. 2002: 80: 11-15

3) Hayes S, et al. A study of corneal thickness, shape and collagen organization in keratoconus using videokeratography and X-ray scattering techniques Exp Eye Res. Dec 15 PMID: 17178118

4) Weissman B, et al. Keratoconus. Jan 2007. Available from: www.emedicine.com/oph/topic104.htm