DIURNAL VARIATIONS IN CORNEAL TOPOGRAPHY

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Abstract: Anterior corneal curvature was measured using the EyeSys corneal analysis system at three different times of day in nine human participants. The participants' corneas showed significant diurnal variations regarding anterior surface curvature. The trend was for the curvature to be flattest in the morning and to become steeper in the afternoon.

INTRODUCTION

The purpose of this experimentation was to investigate the natural diurnal changes of the anterior corneal curvature. Although the study failed to prove that all corneas steepened during the day, it did produce a trend toward such a steepening.

METHODS

The data was acquired utilizing the EyeSys corneal analysis system. This corneal curvature analyzer projects a series of black and white rings onto the cornea, acquires a television image of these rings, and then converts that image into approximately 6,000 curvature values. These 6,000 curvature values describe the refractive power of the anterior surface of the cornea in a 10mm diameter and are displayed as a dioptic power map. The system is composed of an illuminating Placido's disc, a high resolution solid state camera, a proprietary digital image processing electronics board, an IBM-compatible computer, and a color graphics printer. The patient fixates on the Placido center in the camera unit known as the photokeratoscope. When the operator achieves proper focus, he depresses the acquisition switch, the electronics processing board captures and digitizes the screen image in 1/30th of a second. This elaborate technology all but eliminates human error, which has been a concern with earlier studies that utilized traditional keratometry to obtain data.

RESULTS

Three measurements of anterior corneal curvature were obtained in one day from nine participants (18 eyes). The data was further broken down to study changes in the steep meridain and the flat meridian of each individual cornea (36 meridians).

As shown by Figure 1, 24 of the 36 meridians showed an average increase of 0.20125 diopters, 9 meridians showed an average decrease of 0.1144 diopters, and 3 meridians showed no change at all.

Figure 1

Patient	Eye	Flat △K	Steep △K
1	OD	-0.05	-0.22
1	OS	0.00	+0.17
2	OD	0.00	+0.10
2	OS	+0.21	+0.16
3	OD	+0.29	+0.12
3	OS	+0.24	-0.18
4	OD	+0.06	+0.06
4	OS	-0.17	-0.06
5	OD	+0.28	+0.28
5	OS	+0.06	+0.17
6	OD	0.00	-0.04
6	OS	+0.21	+0.27
7	OD	+0.11	+0.12
7	OS	+0.74	+0.72
8	OD	+0.12	+0.06
8	OS	-0.08	+0.06
9	OD	+0.05	-0.17
9	OS	-0.06	+0.17

DISCUSSION

Studies previously conducted on this topic also reported a trend toward an increase in corneal curvature throughout the day. The flattest readings were obtained in the morning and the steepest in the afternoon, similar to the trend displayed in this study.

Various theories as to the cause of this phenomenon have been offered by other researchers. These causes include relative hypotonicity of the tear film during prolonged closure of the eyelids compared to when the eye is open, decreased oxygen availiability during lid closure leading to corneal edema, and lid tension altering corneal topography during prolonged lid closure.

Because corneal thickness and topography are controlled by a balance between the passive movement of water into the stroma and the active transport of water out of the cornea by metabolic action, the above possible explanations are logical. But in a study by Yoshizo Kikkawa (1973) on rabbit corneas, it was demonstrated that a diurnal variation in corneal topography was related to metabolic activity and heightened states of consciousness more than time of day or lid closure. This was done by suturing the eyelids of rabbits shut and opening them only momentarily to obtain topographical data. This study showed that while corneal edema did occur with prolonged closure of the eye the cornea still showed dirunal variations similar to those when the lids were allowed to open and close normally. Furthermore, the trend was for curvatures to increase during heightened activity and decrease during restful or drowsy behavior, regardless of prolonged lid closure.

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