

Corneal Apex Location in Relation to Refractive Error

by Mark Bradley

Abstract: 17 subjects (34 eyes) were participants in the study of location of corneal apex in low to moderate hyperopic and low to moderate myopic eyes. There were 9 myopic patients with refractive errors ranging from -0.50 to -6.00 ds with <2.00 D of astigmatism. There were 8 hyperopic eyes with refractive errors ranging from $+0.50$ to $+2.00$ ds with <2.00 D of astigmatism. The EyeSys Corneal Analysis System was the corneal topographer used as the means of measuring and analyzing data. Results showed hyperopic eyes to have corneal apex average location to be $.188$ mm inferior and $.088$ mm nasally. For myopic eyes the average corneal apex location was found to be $.317$ mm inferior and $.067$ mm nasally. The composite average location in all 34 eyes showed corneal apex location to be $.252$ mm inferior and $.078$ mm nasally.

INTRODUCTION

Corneal apex location in relation to the visual axis is important for contact lens fitting. A knowledge of differences between apex location in hyperopic and myopic eyes would be helpful to the practitioner, especially in the fitting of rigid gas permeable lenses. Very little (if any) literature exists relating apex location to refractive error. Perhaps even more important in RGP fitting is the rate of flattening of the peripheral cornea. This is, for various reasons, beyond the scope of this study. Having an idea of the general trends of average apex location in low to moderate hyperopes and myopes is the main thrust of this project.

METHODS

The EyeSys Corneal Analysis System is a corneal topographic analyzer that projects a series of white and black concentric rings on the cornea, acquires a video image of the rings, and then converts that image into approximately 6,000 curvature values. These 6,000 values describe the refractive power of the cornea in a 10mm diameter and are displayed as a 14 color

curvature or dioptric map. This allowed for very precise and accurate measurement of corneal apex location.

Seventeen subjects sat for the study for a total of 34 corneas to be analyzed. There were 9 myopic patients with refractive errors ranging from $-.50$ to -6.00 DS with <2.00 D corneal cylinder. There were 8 hyperopic patients with refractive errors ranging from $+.50$ to $+2.00$ DS with <2.00 D corneal cylinder. Right eyes were calculated separately from left eyes, as well as together. Color printouts were made of each cornea and individually analyzed. The mean distance in mm from the line of sight was calculated for each eye, in all four quadrants, Superior, Inferior, Nasal, and Temporal.

RESULTS

The results for the hyperopic eyes can be seen in Fig. 1. Right eyes mean corneal apex location was $.125$ mm inferior and $.125$ mm nasal. Left eyes mean corneal apex location was $.25$ mm inferior and $.05$ mm nasal. Average location in both right and left eyes together was $.188$ mm inferior and $.088$ mm nasal. The results for myopic eyes can be seen in Fig. 2. Right eyes mean corneal apex location was $.238$ mm inferior and $.188$ mm nasal. Left eyes mean corneal apex location was $.475$ mm inferior and $.05$ mm temporal. Average location in both right and left eyes together was $.317$ mm inferior and $.067$ mm nasal. Results for all eyes (both hyperopic and myopic) showed the average corneal apex location to be $.252$ mm inferior and $.078$ mm nasal. Overall the average corneal apex

location was within .5mm of the visual axis for all eyes in the study. This is in accordance with the findings of Tomlinson and Schwartz.

DISCUSSION

The method used to find the location of the corneal apex in this study is very accurate. The EyeSys Corneal Analysis system is a highly technical device and is composed of an illuminating Placidos target, high resolution solid state camera, a proprietary digital image processing electronics board, an IBM compatible computer, and a color graphics printer. Inconsistencies due to various personnel taking data was eliminated in this study since only one person recorded all data. However, errors or inconsistencies in the subjects' personal variance of head/chin placement as well as fixation of line of sight is to be considered.

Myopic eyes showed a tendency to be more varied in the placement of corneal apex with 11 being inferior, 6 being superior, 1 being temporal, and 1 being nasal. Hyperopic eyes showed less variance of apex location with 10 being inferior, and 6 being superior, with no direct nasal or temporal displacement from the line of sight. From this limited experiment it can be concluded that hyperopic eyes respect the vertical axis more than do myopic eyes and show less variance. Eighty-seven percent of hyperopic eyes showed no horizontal displacement. Sixty-one percent of myopic eyes showed no horizontal displacement. Furthermore, it can be

concluded that 74% of eyes ranging in power from -6.00 to +2.00DS with <2.00D cylinder have no horizontal displacement from the vertical axis of the line of sight. Consideration must be given to the fact that such a small sample size (34 eyes) could lead to less than perfect results. A larger sample size would be required to more accurately describe the statistically true location of corneal apex location in the average low to moderate hyperopic or myopic eye.

Fig.1 (all values in mm)

Low to Moderate Hyperopic Eyes

OS	OD
INF .4	INF .4
S/N .6/.4	S/N .8/1.0
INF .4	INF .4
INF .3	INF .4
INF 1.0	INF .9
SUP .2	SUP .2
SUP .7	SUP .7
INF .5	INF .6

Fig.2 (all values in mm)

Low to Moderate Myopic Eyes

OS	OD
I/N 1.0/.6	I/N .8/.5
INF 1.5	SUP 1.0
INF .2	SUP 1.0
SUP 1.2	I/N 1.4/.3
INF .2	SUP .5
INF 1.0	INF .2
TMP 1.0	NSL .5
SUP .1	INF .5
INF 1.2	I/N 1.5/.3

REFERENCES

1. Tomlinson, A., and Schwartz, C., The Position of the Corneal Apex in the Normal Eye, American Journal of Optometry and Physiological Optics, Vol. 56 No. 4 p.236-240, 1979.