Corneal Asphericity and Apical Curvature in Children: A Cross-sectional and Longitudinal Evaluation


PURPOSE. The contour of the human cornea is closely modeled by a conic section, which is fully described by asphericity (Ω) and apical radius of curvature (rο). The relationship between corneal shape and other ocular dimensions in children, including anterior and vitreous chamber depths, axial length, and spherical equivalent refractive error, was investigated.

METHODS. Corneal asphericity and rο were calculated by using corneal topography data on 643 children (72 myopes, 370 emmetropes, and 201 hyperopes), ages 6 to 15 years, who participated in the Orinda Longitudinal Study of Myopia (OLSM) during 1991. Measurements from a younger subset of these children, including 8 myopes, 92 emmetropes, and 75 hyperopes, ages 6 to 9 years in 1991, were compared to 1996 data for longitudinal analysis.

RESULTS. Mean ± SD Q of the 1991 study sample was −0.346 ± 0.101, representing a prolate corneal shape. Almost all (99.7%) of the corneas examined were prolate. Corneal asphericity was less prolate among myopes than in emmetropes and hyperopes (P = 0.010). Less prolate corneas were related to deeper anterior chamber depths among emmetropes (r = 0.324, P < 0.0001) and hyperopes (r = 0.275, P < 0.0001), but not among myopes (r = 0.230, P = 0.0515). Flatter values of rο were related to longer vitreous chamber depth (r = 0.607, P < 0.0001) and axial length (r = 0.606, P < 0.0001) in all refractive error groups. Initial corneal shape was unrelated to change in refractive error over a 5-year period.

CONCLUSIONS. Most corneas examined in this study were prolate in contour. Deeper anterior chamber depths were related to less prolate corneas among emmetropes and hyperopes, which is probably the result of mechanical influences on the peripheral cornea as the anterior chamber elongates during ocular growth. Longitudinal results suggest initial corneal shape is of little or no value in predicting refractive error progression. (Invest Ophthalmol Vis Sci. 2005;46:1899-1906) DOI:10.1167/ iovs.04-0558

In recent years, anterior corneal surface shape has been the focus of numerous studies. Many investigators have sought to define corneal shape and its relationship to other ocular dimensions. Others have used corneal topography as a tool in the study of refractive surgery procedures and aberration analysis. Advances in corneal mapping technology in the form of computer-aided corneal topographers, or videokeratoscopes, have allowed for more accurate and complete descriptions of the corneal shape, providing researchers greater insight into the shape and optical performance of the human cornea. The corneal topographer offers clinicians and researchers alike a myriad of graphical and numerical representations of the corneal shape.

Corneal asphericity is one of the many descriptors of corneal shape used by today’s corneal topographers. This unitless expression of corneal shape is calculated by proprietary algorithms using the array of curvature data measured by corneal topographers. Corneal asphericity refers to the rate of curvature change along the corneal surface from apex to periphery.1-3 Most human corneas flatten from apex to periphery (i.e., the central cornea is relatively steeper than the peripheral).1,3-6 Corneal asphericity has been shown to be nearly rotationally symmetric, exhibiting little meridional variation, in subjects with less than 2.0 D of refractive astigmatism, and remains constant during diurnal fluctuations in corneal thickness.3,7 Knowledge of corneal asphericity is vital to understanding the overall shape of the anterior corneal surface. The contour of the cornea is commonly represented with a conic section, the shape of which is fully described by corneal asphericity (Ω) and apical radius of curvature (rο). Apical radius represents the curvature at the corneal apex, which is the point of maximum curvature on the corneal surface when maximum curvature is found at a single point. Apical radius also determines the size of the conic section model.3 In general, this position does not coincide with the center point on a corneal map, which represents the point at which the optic axis of the videokeratoscope is directed.10 Corneal asphericity describes the rate of curvature change of the conicoid representation, from apex to periphery, and may be used to categorize the corneal contour as a member of the conic family.

- Ω > 0, oblate ellipsoid with major axis parallel to the x-y plane
- Ω = 0, sphere
- −1 < Ω < 0, prolate ellipsoid with the major axis in the z direction
- Ω = −1, paraboloid with the axis along the z axis
- Ω < −1, hyperboloid.

The typical shape of the human cornea is that of a prolate ellipsoid, flattening from corneal apex to periphery, though a small percentage of normal adult corneas are oblate, steepening from corneal apex to periphery (Fig. 1).5

In several studies, corneal shape, including corneal asphericity, has been characterized within adult populations.5,7,11-13 In other studies, the relationship between corneal shape and other ocular components has been examined, including anterior chamber depth, vitreous chamber depth, and axial length.14-17 Most studies analyzing corneal shape have been limited to adult subjects.

Carney et al.14 examined 113 adult eyes using the topographic modeling system. A correlation was found between Ω and several ocular dimensions, including spherical equivalent...
refractive error, vitreous chamber depth, and axial length. The degree of peripheral corneal flattening was found to decrease with increasing myopia, vitreous chamber depth, and axial length. To our knowledge, Carney et al.\textsuperscript{14} are the only researchers to report a relationship between corneal asphericity and refractive error.

Few studies have been conducted to evaluate corneal asphericity in children.\textsuperscript{18–20} Carkeet et al.\textsuperscript{20} found no difference in corneal asphericity between refractive error groups in Singaporean children. In two other studies, corneal shape and other ocular dimensions were measured in myopic children over time, and corneal shape was evaluated with respect to ocular growth and refractive error progression. Parsinen\textsuperscript{18} reported no change in vertical or horizontal shape factors among 145 myopic children over a 3-year period. Horner et al.\textsuperscript{19} found a significant reduction in the rate of peripheral corneal flattening in eyes with greater myopic progression. Furthermore, they reported that myopic children with more-prolate initial Q underwent significantly greater myopic progression, suggesting Q may be of value in predicting refractive error progression. It is well established that refractive error progression is primarily due to changes in the axial length of the eye.\textsuperscript{21,22} However, refractive astigmatism is primarily the result of corneal toricity. Few studies have been undertaken to investigate refractive astigmatism and corneal shape in children of ages similar to those reported in the present study. Friedman et al.\textsuperscript{23} reported that corneal toricity in children 6 to 14 years, with various refractive errors, was <1.50 D in ~96% of the subjects and remained relatively stable over time. In other studies of childhood astigmatism, infants have been grouped with toddlers and school-aged children with young adults. Longitudinal studies of infants and toddlers show larger amounts of astigmatism, which tend to undergo significant reduction and stabilization by approximately 4 years of age.\textsuperscript{24–27}

The purpose of the cross-sectional portion of this study was to characterize the shape of the anterior corneal surface in children with respect to refractive error and other ocular dimensions. Through longitudinal evaluation, we investigated the relationship between changes in these ocular dimensions over a 5-year period and attempted to evaluate the diagnostic value of corneal shape in predicting the progression of refractive error.

**Methods**

Measurements used in the present study were collected from the right eyes of children participating in the Orinda Longitudinal Study of Myopia (OLSM). Using a cohort study design and performing biometry on numerous ocular components of the children enrolled in these cohorts, investigators in the OLSM sought to characterize refractive error development and normal eye growth among school-aged children.\textsuperscript{28} Cross-sectional data for the present study came from OLSM measurements taken in 643 children, ages 6 to 15 years, in 1991 (Table 1). Data collected from a younger subset (n = 175) of these same children, ages 6 to 9 years in 1991, were compared with data from the same children in 1996 for the purpose of longitudinal analysis (Table 2). Along with videokeratoscope data, other ocular dimensions measured during the OLSM include anterior chamber depth, vitreous chamber depth, axial length, and spherical equivalent refractive error. Axial dimensions were recorded as the average of five A-scan ultrasound readings.\textsuperscript{29} Refractive error was calculated as the average of 10 cycloplegic autorefractor readings (Canon R-1). 25 minutes after 2 drops of 1% tropicamide was administered.\textsuperscript{30}

Four videokeratoscopic measurements were taken on the right eye of each subject, by using the topographical modeling system (TMS-1). These images were reprocessed with the TMS-1 for this study, and each corneal map was visibly screened for quality.\textsuperscript{30} Subjects with at least two maps of adequate quality in both 1991 and 1996 were included in the study. Data generated by the TMS-1 for up to 6400 corneal positions in 256 semimercidians, within a 4-mm radius of the corneal map center point, were stored in a series of binary files. Among these files, ‘.DIO’ and ‘.RAD’ files contained data for dioptric power and perpendicular distance from the corneal apex, respectively, for each corneal position measured. Power data were edited by a ‘scrubbing’ technique to omit anomalous data values. This editing function deleted data points with an inter--ring variation of greater than ≥0.75 D, as described by Zadnik et al.\textsuperscript{31} Dioptric power was then converted to the radius of curvature using the assumed corneal refractive index of 1.3375 and the equation \( r = 0.3375/P \), where \( r \) is radius and \( P \) is dioptric power.

Bennett\textsuperscript{32} derived an equation for a conic section, which can be written

\[
r_a^2 = r_o^2 + (-Q)y^2,
\]

where \( r_a, Q, r_o, \) and \( y \) refer to the apical radius of curvature, corneal asphericity, the axial radius of curvature, and perpendicular distance from the corneal apex, respectively. Both \( r_a \) and \( y \) are provided by the TMS-1 in the .DIO (\( r_a = 0.3375\)/DIO) and .RAD files, respectively. Assuming the TMS-1 measures axial radius of curvature, we graphed data for each corneal position as axial radius of curvature squared, \( r_a^2 \), versus perpendicular distance from the corneal apex squared (\( y^2 \)). When the best-fitting line is plotted to this graph by the method of least squares, the square root of the y-intercept equals apical radius of curvature (\( r_a \)), and the negative slope equals corneal asphericity (\( Q \)).\textsuperscript{32}

When data obtained from the TMS-1 are used, this graphical method has been found to be very accurate when measuring aspheric surfaces near \( Q = -0.2 \) as demonstrated on calibrated conicoid surfaces.\textsuperscript{33} A demonstration of the graphical method for one topography reading of a subject included in the study can be found in Figure 2. Corneal asphericity and \( r_a \) obtained using the graphical method can be consid-

**Table 1.** Age and Ocular Dimension Characteristics of Subjects with OLSM from 1991 Who Were Included in the Cross-sectional Analysis

<table>
<thead>
<tr>
<th>Age (y)</th>
<th>9.92 ± 2.42 (6–15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>643</td>
</tr>
<tr>
<td>Spherical equivalent refractive error (D)</td>
<td>+0.31 ± 1.12 (−5.95–4.23)</td>
</tr>
<tr>
<td>Refractive astigmatism (D)</td>
<td>−0.58 ± 0.31 (−1.47–0.02)</td>
</tr>
<tr>
<td>Anterior chamber depth (mm)</td>
<td>3.69 ± 0.23 (2.98–4.56)</td>
</tr>
<tr>
<td>Vitreous chamber depth (mm)</td>
<td>15.94 ± 0.82 (13.86–19.23)</td>
</tr>
<tr>
<td>Axial length (mm)</td>
<td>23.07 ± 0.85 (20.80–26.38)</td>
</tr>
</tbody>
</table>
Table 2. Age and Ocular Dimensions of Subjects with OLSM in 1991 and 1996 Who Were Included in the Longitudinal Analysis.

<table>
<thead>
<tr>
<th>Mean ± SD (Range)</th>
<th>Mean ± SD (Range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>1996</td>
</tr>
<tr>
<td>Age (y)</td>
<td>7.54 ± 1.00 (6 to 9)</td>
</tr>
<tr>
<td>n</td>
<td>175</td>
</tr>
<tr>
<td>Spherical equivalent refractive error (D)</td>
<td>+0.62 ± 0.95</td>
</tr>
<tr>
<td></td>
<td>(−5.95 to +4.23)</td>
</tr>
<tr>
<td>Refractive astigmatism (D)</td>
<td>−0.52 ± 0.28</td>
</tr>
<tr>
<td></td>
<td>(−1.45 to −0.02)</td>
</tr>
<tr>
<td>Anterior chamber depth (mm)</td>
<td>5.64 ± 0.21</td>
</tr>
<tr>
<td></td>
<td>(3.04 to 4.20)</td>
</tr>
<tr>
<td>Vitreous chamber depth (mm)</td>
<td>15.68 ± 0.73</td>
</tr>
<tr>
<td></td>
<td>(13.97 to 17.92)</td>
</tr>
<tr>
<td>Axial length (mm)</td>
<td>22.80 ± 0.71</td>
</tr>
<tr>
<td></td>
<td>(20.87 to 24.94)</td>
</tr>
</tbody>
</table>

RESULTS

Cross-sectional results from OLSM during 1991 represent analysis from 643 children of various refractive errors. Spherical equivalent refractive error in this population was inversely related to anterior chamber depth (ρ = −0.315, P < 0.0001), vitreous chamber depth (ρ = −0.496, P < 0.0001), and axial length (ρ = −0.542, P < 0.0001). The mean ± SD Q for the cross-sectional study population was −0.346 ± 0.101, representing a prolate corneal shape. Of the 643 corneas examined only two were oblate in contour (Fig. 3). Corneal asphericity was directly related to anterior chamber diameter among emmetropes (ρ = 0.324, P < 0.0001) and hyperopes (ρ = 0.275, P < 0.0001; Fig. 4). Thus, corneas of emmetropic and hyperopic eyes with deeper anterior chambers were less prolate. The relationship between Q and anterior chamber depth among myopes fell just short of significance (ρ = 0.230, P = 0.0515), perhaps as the result of a smaller sample size (n = 72). No other ocular dimension was related to Q.

Cross-sectional analysis of the 1991 corneal topography data resulted in mean (±SD) rρ of 7.55 ± 0.24 mm. Apical radius of curvature was found to be directly related to anterior chamber depth (ρ = 0.206, P = 0.0034) among hyperopes only (Fig. 5). Apical radius of curvature was directly related to axial length among myopes (ρ = 0.708, P < 0.0001), emmetropes (ρ = 0.740, P < 0.0001), and hyperopes (ρ = 0.732, P < 0.0001; Fig. 6). Not surprisingly, apical radius of curvature was also directly related to vitreous chamber depth among myopes (ρ = 0.689, P < 0.0001), emmetropes (ρ = 0.714, P < 0.0001), and hyperopes (ρ = 0.717, P < 0.0001). These results indicate that longer eyes were related to flatter rρ values. Apical radius of curvature was not related to spherical equivalent refractive error or Q.
Subjects were categorized according to their refractive error (Table 3). The corneas of myopes were significantly less prolate than those of emmetropes and hyperopes \( (P = 0.010) \). However, refractive error groups did not differ significantly in \( r_o \) \( (P = 0.144) \).

Over the 5-year period included in this study, the mean positive change in \( Q \) and \( r_o \) indicates that corneas of all refractive error groups became less prolate and underwent apical flattening (Table 4). Refractive error groups did not differ in change in \( Q \) \( (P = 0.627) \), \( r_o \) \( (P = 0.139) \), or anterior chamber depth \( (P = 0.305) \). Change in spherical equivalent refractive error \( (P = 0.003) \), vitreous chamber depth \( (P < 0.0001) \), and axial length \( (P < 0.0001) \) each differed significantly between refractive error groups.

The median change in spherical equivalent refractive error of the 175 children included in the longitudinal portion of this study was \(-3.72\) D in myopes, \(-0.48\) D in emmetropes, and \(-0.48\) D in hyperopes (Table 4). It should be noted that the large interquartile range in change in spherical equivalent refractive error among myopes may be attributable to the small sample size \( (n = 8) \). Over this 5-year period, change in spherical equivalent refractive error among all subjects was inversely related to increase in vitreous chamber depth \( (r = -0.680, P < 0.0001) \) and axial length \( (r = -0.704, P < 0.0001) \). Change in spherical equivalent refractive error was not related to change in anterior chamber depth \( (r = -0.078, P = 0.305) \).

No relationship was found between change in \( Q \) and change in any other ocular dimensions for any refractive error group. Initial \( Q \) was directly related to change in anterior chamber depth among myopes \( (r = 0.832, P < 0.010; \text{Fig. 7}) \). Thus, corneas that were initially less prolate tended to belong to eyes that underwent greater increases in anterior chamber depth among myopes. Initial \( Q \) was not related to change in any other ocular dimension.

Change in \( r_o \) was not significantly related to change in any other ocular dimension. Furthermore, initial \( r_o \) was not related to change in any ocular dimension.

In each refractive error group the mean ratio of change in corneal asphericity over change in apical radius \( (\Delta Q/\Delta r_o) \) was determined (Table 4). This ratio was used to determine whether refractive error groups differed in the relative change in these corneal shape dimensions during ocular growth. Analysis of variance indicated no difference in this ratio between refractive error groups \( (P = 0.270) \).

**FIGURE 3.** Distribution histogram for \( Q \) among subjects included in the cross-sectional analysis.

**FIGURE 4.** Relationship between anterior chamber depth (ACD) and \( Q \) among myopes \( (r = 0.230, P = 0.0515) \), emmetropes \( (r = 0.324, P < 0.0001) \), and hyperopes \( (r = 0.275, P < 0.0001) \) included in the cross-sectional analysis.

**DISCUSSION**

The percentage of prolate corneas, 99.7%, observed in the 1991 OLSM subjects is somewhat higher than that reported by other studies, but is within the range of 80%\(^{12,19}\) to 100%\(^{13}\) reported by most studies. Budak et al.\(^{16}\) reported an unusually high number of oblate corneas among their subjects, with only 60.3% of corneas demonstrating a prolate contour. Budak et al.\(^{16}\) also reported a mean \( Q \) of \(-0.03 \pm 0.23\), which is significantly less prolate than the majority of studies reporting average \( Q \). The present study found myopic corneas were significantly less prolate than those of hyperopes and emmetropes \( (P = 0.010) \), which seems consistent with the tendency for less prolate corneas with increasing amounts of myopia, as noted by previous studies.\(^{14,19}\) One exception to this trend is a recent study by Llorente et al.,\(^{38}\) who found less prolate corneas in hyperopes than in myopes.

The present study found a mean positive change in \( Q \) over a 5-year period, indicating a relative decrease in the rate of...
peripheral corneal flattening that occurred during this period of ocular growth. The positive change in $Q$ was seen in all three refractive error groups (Table 4). These findings are in agreement in their direction, but are higher in magnitude than the mean positive change in $Q$ of 0.014 noted by Horner et al.\textsuperscript{19} for myopic children over a 5-year period. The change in $Q$ observed by Horner et al.\textsuperscript{19} was related to a 1.46-D increase in myopia. We found a mean positive change in $Q$ of 0.086 and an increase in myopia of 3.72 among myopic children ($n=11005$), but the two were unrelated. Parssinen\textsuperscript{18} did not find a significant change in corneal asphericity among myopic children over a 3-year period.

As expected, spherical equivalent refractive error was inversely related to axial length and vitreous chamber depth among all refractive error categories. Initial values of $Q$ were less prolate among myopes. Carney et al.\textsuperscript{14} are the only investigators to have found a significant relationship between $Q$ and refractive error. Consistent with our results, they found that higher degrees of myopia were associated with less peripheral corneal flattening that occurred during this period of ocular growth. The correlation reported by Carney et al.\textsuperscript{14} for this relationship was weak ($R^2 = 0.076$). Considering the various mechanisms that may be involved with changes in $Q$ and refractive error, it is understandable that this correlation would be low, if it truly does exist. However, we found no difference in change in $Q$ as a function of refractive error group.

Corneal asphericity correlated weakly with anterior chamber depth among emmetropes and hyperopes, such that eyes with deeper anterior chambers were less prolate. One explanation for the correlation between $Q$ and anterior chamber depth may be that if axial elongation tends to exceed the rate of equatorial growth at the limbus, the peripheral cornea is less able to flatten to maintain its attachment at the limbus. Restriction of equatorial relative to axial expansion in myopia may restrict $Q$ to less prolate values as the cornea flattens and the anterior chamber depth increases.

Correlation analysis demonstrated that $r_o$ was related to axial length and vitreous chamber depth, such that longer eyes tended to have flatter $r_o$ values. However, this relationship...
seems counterintuitive when considering that myopia is commonly associated with both steeper central corneas and longer axial lengths. Scott and Grosvenor have noted that longer eyes, regardless of refractive error, are associated with flatter central corneas when considering myopic eyes alone. Van Alphen has accounted for this observation by speculating on two unique factors at play during "normal" growth (occurring during emmetropic growth), referred to as the size factor, and myopic growth, referred to as factor R. In normal growth, harmonious axial elongation of the eye and flattening of the cornea result in emmetropization. The factor R that van Alphen refers to results in an axial elongation that is not accompanied by significant flattening of the ocular poles, including the central cornea. This growth results in the development of myopia. Axial elongation of the eye in the case of myopia may be accompanied by corneal steepening. The inability of the cornea to flatten during ocular growth may be the result of the inability of equatorial growth to maintain pace with axial growth in the development of myopia. This paradoxical relationship may account for both the lack of relationship between and spherical equivalent refractive error and the finding that no significant difference in existed between refractive error groups during this study.

The mean of subjects included in the longitudinal portion of this study at baseline was 0.360 ± 0.094. This value of is more negative, representing a more prolate cornea, than those reported by most studies involving adults. However, by the end of a 5-year period the mean of subjects in the present study was 0.258 ± 0.088, representing a less prolate cornea, and more comparable to the average values reported by adult studies. However, it should be pointed out that it is difficult to compare across studies that have used various methods and instrumentation to achieve this value.

Over a 5-year period, change in spherical equivalent refractive error was strongly associated with increase in vitreous chamber depth and axial length, as expected. However, change in refractive error was not related to change in. Horner et al. reported that increases in myopia correlated with corneas becoming more oblate in contour. They also reported a correlation between initial and increase in myopia over time. Such a correlation between initial and myopia progression suggests a potential predictive value for in estimating future change in refractive error. In the present study, we did not find this relationship. Again, the study by Horner et al. included only myopic subjects, whereas the present study included relatively few myopic children. Thus, it is possible that a relationship between initial and change in refractive error among myopes was not found here due to an inadequate sample of myopic children.

However, initial was related to change in anterior chamber depth among myopes. Corneas with less prolate contour underwent greater increase in anterior chamber depth over a 5-year period. Although this relationship was strong among myopes, it was not found among other refractive error groups. As demonstrated previously, the relationship between anterior chamber depth and peripheral corneal curvature is important. Deeper anterior chambers may require less flattening of the peripheral cornea to maintain its junction at the limbus. One of the limitations of this study is the small sample size of myopes included in the longitudinal portion (n = 8). Furthermore, the lack of any differences in between refractive error groups and the lack of correlation between initial and refractive change may well be due to low statistical power from the small sample size of myopes. Although we have found some differences in myopes with respect to and anterior chamber depth, more definitive answers regarding and refractive change would require a larger sample.

Nearly all of the corneas examined in this study were prolate in contour. Corneal asphericity was not related to spherical equivalent refractive error. Nor was initial predictive of change in refractive error. Deeper anterior chamber depths were related to less prolate corneas among emmetropes and hyperopes. These relationships are probably the result of mechanical influences on the peripheral cornea present during ocular growth. Flatter values were related to longer eyes among all refractive error groups, which is in agreement with previous studies. During this 5-year period, became less prolate and flattened among all refractive error groups. The

### Table 3. Spherical Equivalent Refractive Error and Corneal Shape in Groups Included in the Cross-sectional Analysis

<table>
<thead>
<tr>
<th>Refractive error category parameters (D)</th>
<th>Myopes</th>
<th>Emmetropes</th>
<th>Hyperopes</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>72</td>
<td>370</td>
<td>201</td>
</tr>
<tr>
<td>Spherical equivalent refractive error (D)</td>
<td>−1.47 (1.44)</td>
<td>+0.36 (0.43)</td>
<td>+1.01 (0.39)</td>
</tr>
<tr>
<td>Q</td>
<td>−0.32 ± 0.10</td>
<td>−0.35 ± 0.10</td>
<td>−0.36 ± 0.10</td>
</tr>
<tr>
<td>( r_o ) (mm)</td>
<td>7.53 ± 0.27</td>
<td>7.54 ± 0.24</td>
<td>7.57 ± 0.23</td>
</tr>
</tbody>
</table>

Spherical equivalent refractive error is expressed as the median (interquartile range). Corneal shape data are expressed as the mean ± SD.

### Table 4. Change in Spherical Equivalent Refractive Error and Corneal Data for the Study Group Over a 5-Year Period

<table>
<thead>
<tr>
<th>Refractive error category parameters (D)</th>
<th>Myopes</th>
<th>Emmetropes</th>
<th>Hyperopes</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>8</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>( \Delta Q )</td>
<td>−3.72 (3.33)</td>
<td>−0.49 (0.60)</td>
<td>−0.48 (0.49)</td>
</tr>
<tr>
<td>( \Delta r_o ) median (1st and 3rd quartiles)</td>
<td>0.156 ± 0.057</td>
<td>0.166 ± 0.039</td>
<td>0.178 ± 0.047</td>
</tr>
</tbody>
</table>

Spherical equivalent refractive error is expressed as the median (interquartile range). Corneal parameters are expressed as the mean ± SD.
present study suggests that corneal shape is of little or no value in predicting future refractive error progression in children.

The present study is relatively unique in that it is among only three longitudinal studies known to is in which the relationship between corneal shape and other ocular dimensions in children has been investigated. The relatively large data set used in this study gives it the advantage of statistical power, though the paucity of myopes included in the longitudinal portions is a weakness that can be rectified in future research.

Acknowledgments

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References


34. Roberts C. Analysis of the inherent error of the TMS-1 Topographical Modeling System in mapping a radially aspheric surface. Cornea. 1995;14:258–265.


