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ORIGINAL ARTICLE

Longitudinal changes in corneal curvature and its relationship to axial length in the Correction of Myopia Evaluation Trial (COMET) cohort

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KEYWORDS
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AL/CR ratio;
Axial length;
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Abstract
Purpose: To describe longitudinal changes in corneal curvature (CC) and axial length (AL) over 14 years, and to explore the relationship between AL and CC, and the axial length/corneal radius (AL/CR) ratio.
Methods: In total 469, 6 to <12-year-old, children were enrolled in COMET. Measurements of refractive error, CC (D), CR (mm), and ocular component dimensions including AL were gathered annually. Linear mixed models were used to evaluate longitudinal changes adjusting for covariates (gender, ethnicity, lens type, baseline age and baseline refraction). The Pearson correlation coefficient between AL and CC was computed at each visit.
Results: There was a slight but significant ($p < 0.0001$) flattening in CC over 14 years. At all visits females had significantly steeper CC than males (overall difference = 0.53 D, $p < 0.0001$). Caucasians had the steepest CC, and Hispanics the flattest ($p = 0.001$). The correlation between AL and CC was −0.70 ($p < 0.0001$) at baseline (mean age = 9.3 years) and decreased to −0.53 ($p < 0.0001$) at the 14-year visit (mean age = 24.1 years). The average AL/CR ratio was 3.15 at baseline and increased to 3.31 at the 14-year visit. The correlation between the magnitude of myopia and AL/CR ratio was significantly higher ($p < 0.0001$) at each visit than the correlation between myopia and AL alone.
Conclusions: Differences in average corneal curvature by age, gender, and ethnicity observed in early childhood remain consistent as myopia progresses and stabilizes. This study also demonstrates increases in the AL/CR ratio as myopia progresses and then stabilizes, supporting observations from previous cross-sectional data.

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PALABRAS CLAVE
Estudio sobre miopía COMET;
Ratio LA/RC;
Longitud axial;
Curvatura de la córnea;
Radio de la córnea

Cambios longitudinales en la curvatura de la córnea y su relación con la longitud axial en el estudio COMET (Correction of Myopia Evaluation Trial)

Resumen
Objetivo: Describir los cambios longitudinales en la curvatura de la córnea (CC) y la longitud axial (LA) durante un periodo de catorce años, y explorar la relación entre dichos valores y el ratio longitud axial/radio de la córnea (LA/RC).
Métodos: Se incluyó en el estudio COMET a cuatrocientos sesenta y nueve niños, de edades comprendidas entre 6 y <12 años. Se realizaron anualmente las mediciones del error refractivo, CC (D), RC (mm), y las dimensiones de los componentes oculares. Se utilizaron modelos lineales mixtos para evaluar los cambios longitudinales, ajustando las covariables (sexo, etnia, tipo de lente, edad inicial y refracción inicial). Se calculó el coeficiente de correlación de Pearson entre LA y CC en cada visita.
Resultados: Se observó un aplanamiento ligero, aunque significativo (p<0,0001) de la CC a lo largo de los 14 años. En todas las visitas, las mujeres reflejaron una CC considerablemente más curva que los varones (diferencia general = 0,53 D, p<0,0001). La raza caucásica reflejó una CC más cerrada, y la hispana reflejó un aplanamiento superior (p=0,001). La correlación entre LA y CC fue de -0,70 (p<0,0001) en la visita inicial (edad media = 9,3 años), descendiendo a -0,53 (p<0,0001) transcurridos catorce años (edad media= 24,1 años). El ratio medio LA/RC fue de 3,15 en la visita inicial, incrementándose a 3,31 transcurridos catorce años. En cada visita, la correlación entre la magnitud de la miopía y el ratio LA/RC fue considerablemente superior (p <0,0001) que la correlación entre miopía y LA, únicamente.
Conclusiones: Las diferencias en la curvatura media de la córnea por edad, sexo y etnia, observadas en la infancia, son consistentes a medida que la miopía va progresando y estabilizándose. Este estudio demuestra también los incrementos en el ratio LA/RC a medida que la miopía progresa y se estabiliza, lo que respalda las observaciones de los datos transversales previos.

Introduction

The results of both human and laboratory animal studies show that emmetropization is actively regulated by visual feedback,[1] and change in the amount of axial growth appears to be the most influential factor.[2,3] However, despite the consensus that AL is the main factor that determines the degree of refractive error, it is not yet clear how the other ocular components such as corneal curvature affect myopia progression and stabilization.[3]

Researchers[3–6] suggest that there may be a range of axial lengths over which the cornea can exert an emmetropizing effect to prevent myopia. However, as axial length continues to increase, the cornea may be incapable of further flattening. Instead, with increasing axial length the cornea may actually steepen, perhaps because of mechanical stretching of the globe.[3] In a large, retrospective chart review of 15,488 adult patients, Hoffmann and Hütz[6] found a strong statistical correlation between axial length and mean corneal radius, but this correlation was not present with extremely short or long eyes. A number of cross-sectional studies have investigated the correlation between corneal power and myopia in juvenile and young adult myopia, with most studies finding no relationship between axial length and corneal curvature in any category of myopia.[7–10] However, Goss and Erickson[11] found a lack of a correlation in juvenile myopia, but a significant correlation in young adult myopia.

Previous studies have explored the relationship between corneal curvature, gender, and ethnicity. Twelker et al.[12] presented cross-sectional, ocular component data for the entire Collaborative Longitudinal Evaluation of Ethnicity and Refractive Error (CLEERE) Study cohort by age, gender, and ethnicity. They found that corneal curvature varied significantly by gender with females showing a greater mean corneal curvature in both meridians when compared with males. In the horizontal meridian the ethnic differences in corneal power were marked, with Native Americans and Hispanics having both a statistically significant and clinically meaningful (≥0.50 D) flatter horizontal meridian than Whites.[12] Statistically significant differences between ethnic groups were observed in the vertical meridian, although these differences were not large enough to be clinically significant. In a population-based study of 11–15 year old Australian children, Ip et al.[13] found the mean corneal curvature was steeper in children of European Caucasian ethnicity and South Asian ethnicity than in children of other ethnic groups, although differences were not clinically meaningful. They did not report differences separately for horizontal and vertical meridians.

Researchers have also investigated the AL/CR ratio as a method of exploring the role of the cornea in the development of refractive error.[14,15] Based on an analysis of data from 194 adult eyes, Grosvenor and Scott[16] suggested that the emmetropic eye would be expected to have an AL/CR ratio close to 3/1 (24.0/8.0). Studies of non-myopic eyes