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ORIGINAL ARTICLE

Correlation of age, corneal curvature and spherical equivalent with central corneal thickness☆

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KEYWORDS
Central corneal thickness;
Bimodal distribution;
Age;
Keratometry;
Spherical equivalent

Abstract
Objective: To describe the distribution of the central corneal thickness (CCT) measurements on a healthy Hispanic sample population and its correlation with age, mean simulated keratometry (SimK), and mean refractive spherical equivalent (MRSE).
Methods: Retrospective analysis on the records of healthy patients from the Ophthalmology and Visual Sciences Institute, Tecnologico de Monterrey, January 2015 to August 2015. CCT data, age, gender, corneal curvature, and spherical equivalent was obtained. A descriptive analysis and correlation by the Spearman method was performed. The sample was divided by age subgroups: <20 years old, ≥20 and ≤40 years, and >than 40 years old and correlation analysis with CCT values was determined.
Results: A total of 93 (186 eyes) patients were included. Mean age: 32.54 ± 12.04 years. 43% were women. Mean CCT: 545.69 ± 36.88 μm, mean SimK: 43.56 ± 1.90 D and MRSE: −2.54 ± 3.15 D. No correlation was registered between CCT and the variables when analyzed with the Anderson–Darling ($p = 0.006$), Shapiro–Wilk ($p = 0.043$), and Kolmogorov–Smirnov ($p = 0.01$). CCT showed a bimodal distribution with higher density at 540 μm. Age groups <20 and >40 years showed significant difference in CCT ($p = 0.016$), a positive correlation with CCT was observed in the group <20 ($\rho = 0.596$, $p = 0.001$).
Conclusions: The findings regarding the lack of normality, the bimodal distribution (540 μm), and the correlation between age and CCT in younger patients, may lead us to redefine the ''normal'' CCT value in our population in order to be used properly for clinical purposes.
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☆ Partial results of this research have been presented as a poster at ARVO, May 5, 2013, Seattle, WA.

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PALABRAS CLAVE
Grosor corneal central;
Distribución bimodal;
Edad;
Queratometría;
Equivalente esférico

Correlación de edad, curvatura corneal y equivalente esférico con el grosor central corneal

Resumen
Objetivo: Describir la distribución de las mediciones del grosor central corneal (GCC) en una población sana de hispanos y analizar su correlación con la edad, queratometría simulada promedio (SimK) y el equivalente esférico refractivo (EE).
Métodos: Análisis retrospectivo, pacientes sanos del Instituto de Oftalmología y Ciencias Visuales, Tecnológico de Monterrey (enero de 2015 a agosto de 2015). Se obtuvo GCC, edad, género, SimK y EE. Se realizó análisis descriptivo de las variables y se utilizó el método de Spearman para correlaciones. La muestra se dividió en 3 subgrupos (<20 años, ≥20 y ≤40, y > 40 años) para analizar la correlación entre GCC y edad.
Resultados: Se incluyeron un total de 93 pacientes (186 ojos). Edad promedio: 32.54 ± 12.04 años, 43% mujeres. GCC promedio: 545.69 ± 36.88 μm, SimK promedio: 43.56 ± 1.90 D y el EE promedio: -2.54 ± 3.15 D. No había correlación entre GCC y edad, género, SimK o EE con análisis Anderson-Darling (p = 0.006), Shapiro-Wilk (p = 0.043) y Kolmogorov-Smirnov (p = 0.01). GCC mostró distribución bimodal, pico principal en 540 μm. Los subgrupos <20 años y >40 años, mostraron diferencia significativa (p = 0.016) al comparar GCC. Se observó correlación positiva entre grupo <20 años y GCC (ρ = 0.596, p = 0.001).
Conclusiones: La falta de normalidad en la distribución del GCC, la distribución bimodal (540 μm) y la tendencia a observar mayor GCC en jóvenes, llevan a redefinir los valores «normales» de GCC en nuestra población, con la finalidad de ajustar su uso para propósitos clínicos.
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Introduction

Central corneal thickness (CCT) is one of the major parameters for measuring corneal health.[1,2] Its measurement is essential in the assessment, management and follow up of corneal ectatic diseases (i.e. keratoconus, post-LASIK ectasia) and corneal endothelium dysfunction, since the changes in the corneal thickness are directly associated with the severity of the disease.[3–6] CCT measurement is also essential in the management of glaucoma patients, given that applanation tonometry underestimates the intraocular pressure (IOP) in eyes with thin corneas and it overestimates this in thick corneas.[7,8] CCT has also been used as a predictor of graft survival and cell density measurement after penetrating keratoplasty, thicker corneas have shown a tendency to develop graft failure within 5 years post-surgery.[3] Thin corneas, along with low residual stromal bed thickness (<300 μm), deep ablation and abnormal corneal topography, have been considered as preoperative risk factors in corneal refractive surgery for developing corneal ectasia.[9–11] However, there is ongoing debate surrounding the precept that ''thinner'' corneas are indeed ''weaker'' corneas with biomechanical liability, since the influence of CCT over the long-term stability of LASIK procedures has not been demonstrated.[12,13]

Normal CCT values have been established by different research groups.[7] However, a large variability among different ethnic groups has been reported.[14–17] Age,[7,18,19] gender,[20] the transition from lower to higher humidity, UV radiation exposure, hereditability,[21,22] genetics,[23,24] altitude have also been associated with changes and variability in CCT.[25,26] Additionally, the correlation of different ocular parameters with CCT has been studied, including corneal radius and curvature,[27] anterior chamber depth, axial length,[28] the spherical equivalent,[29] visual acuity, and IOP.[30]

All the factors mentioned before and the controversial results regarding the use of CCT as a predictive parameter for different ocular procedures indicate that the ''normality'' concept for CCT needs to be re-evaluated so it can be used appropriately as a clinical parameter. In this study, we aimed to measure the CCT among healthy Hispanic patients, and to determine its correlation with age, gender, curvature, and spherical equivalent.

Materials and methods

A retrospective analysis of pachymetric measurements conducted between February 2012 and November 2012 at the Ophthalmology and Visual Sciences Institute (Tecnologico de Monterrey, School of Medicine, Monterrey, Mexico) was performed. Data from 93 healthy patients were obtained after calculating the optimal sample size using Raosoft® (Raosoft, Inc., Seattle, WA, USA) with a confidence interval (CI) of 90% and an error margin of 5% in a population of 600 patients. Patients with abnormal topography (inferior steepening, irregular pattern, non-orthogonal bowtie), contact lens users or with history of refractive surgery were excluded. The CCT was obtained using ultrasonic pachymetry (AccuPach VI; Accutome, Inc., Malvern, PA, USA). Briefly, the cornea was anesthetized with topical 1%

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