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Corneal elevation in a large number of myopic Chinese patients

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ABSTRACT

Purpose: To establish a normative database for corneal elevation in Chinese myopic patients who underwent refractive surgery, and analyze the association of corneal elevation with sex, age, and ocular parameters.
Methods: A total of 3000 eyes in 1500 patients were evaluated with the Pentacam. Anterior and posterior elevations were measured at the apex and thinnest point. Normative thresholds were defined according to the Tukey method. Univariate and multivariate analyses were performed to assess the association of corneal elevation with sex, age, and ocular parameters.
Results: Normal upper limits for corneal elevation in adult Chinese were 4.95 μm, 5.25 μm, 6.2 μm, and 11.0 μm at the anterior apex, anterior thinnest point, posterior apex, and posterior thinnest point, respectively. Thinner corneal pachymetry at the apex and greater anterior corneal astigmatism tended to show greater anterior corneal elevation values. Younger age, greater anterior corneal astigmatism, lower anterior and posterior keratometry, and shallower anterior chamber depth resulted in greater posterior corneal elevation values.
Conclusions: Locally derived thresholds may offer higher sensitivity and specificity when screening eyes for myopic refractive surgery, and keratoconic and post-orthokeratology eyes. Anterior and posterior corneal elevation at the apex and thinnest point were associated significantly with anterior corneal astigmatism, showing a positive correlation.

1. Introduction

Corneal elevation has emerged as a major determinant in the pre-operative evaluation of potentially refractive surgical patients. Effective screening requires an applicable normative database. The previously published normative databases for corneal elevation values by the Pentacam are based on a sample of 100 eyes from a North American and South American refractive surgical population [1,2]. Moreover, Feng et al.'s study [3] indicated that China, Egypt and India have locally derived thresholds of corneal elevation and/or pachymetry that differ from previously published North and South American normal values. Gilani et al. [4] evaluated 341 eyes with the Pentacam to determine normal values of corneal elevation in a North American population. Locally derived thresholds could minimize potential false positive and negative results during screening. The goal of this study was to establish a Chinese normative database for corneal elevation in myopic refractive surgery candidates, based on a large population. Multiple reports have evaluated the association of corneal thickness with age, sex, and ocular parameters, including refractive state, mean keratometry (Km), anterior chamber depth (ACD), and axial length (AL) [5–8]. To date, the association of corneal elevation with sex, age, and ocular parameters in Chinese patients has not been reported. Thus, this study aimed to analyze the association of corneal elevation with sex, age, refractive state, ocular AL, corneal pachymetry, corneal astigmatism, Km and ACD.

2. Materials and methods

This study was conducted at the Eye Hospital of Wenzhou Medical University. The research protocol adhered to the tenets of the Declaration of Helsinki, and was approved by the Office of Research Ethics, Eye Hospital of Wenzhou Medical University. It was a retrospective review of data from 3000 normal myopic eyes of 1500 Chinese adults who presented for refractive surgery

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evaluation. Inclusion criteria were: best spectacle-corrected visual acuity of revise 20/25, no ocular disease, and no prior refractive surgery. Soft and rigid contact lens wearers were requested to stop contact lens use for at least two and four weeks, respectively. The refractive state of each eye was acquired by manifest subjective refraction. The ocular AL was measured by A-scan ultrasonography.

A rotating Scheimpflug system, Pentacam high resolution (Oculus GmbH, Wetzlar, Germany) was used in this study. The patient was instructed to open both eyes and continue to fixate on a 475 nm blue light source in the camera center during scanning. Automatic release mode was used to reduce operator-dependent variables. The rotating camera captured 25 slit images of the anterior segment in less than 2 s. Each slit image consisted of 1,380 true elevation points. Only scans with instrument-generated quality factor revise 95% were selected for further analysis. Three maps for each eye were acquired, with an acceptable map having at least 9.0 mm of corneal coverage with no extrapolated data in the central 8.0 mm diameter zone. Corneal pachymetry at the apex and thinnest point, anterior and posterior corneal astigmatism, anterior and posterior corneal Km, ACD at the corneal apex, as well as anterior and posterior corneal elevation at the apex and thinnest point were recorded. Three measurements of all ocular parameters were averaged for each eye.

Corneal elevation data can be shown either in absolute or relative terms. Belin et al. [9] proposed the relative elevation data to be used in clinic. The latter represent the differences between actual elevation data (absolute) and the reference shape. The best fit sphere (BFS) is the most useful reference shape fitted 8.0 mm diameter zone centered on the apex [1,2,9]. There was no evidence of extrapolated data in this 8.0 mm zone and no extrapolated data were used for BFS assessment. Fig. 1 shows anterior and posterior corneal relative elevation maps of the right eye for a patient by the Pentacam.

3. Statistical analyses

Statistical tests were performed using the SPSS software (version 17.0, SPSS Inc., Chicago, Illinois, USA). First, the Kolmogorov–Smirnov test showed that anterior and posterior corneal elevation data were not normally distributed. Thus, elevation data were handled accordingly by reporting medians and quartiles. To construct normative thresholds, the upper limit of normal was defined as 1.5 the interquartile range (IQR) above the third quartile (Q3) or Q3 + 1.5 × IQR, according to the Tukey method [10]. In the second step, the associations of corneal elevation with sex, age, refractive state, ocular AL, corneal pachymetry, corneal astigmatism, Km and ACD were assessed in a univariate manner by using spearman rank correlation. Then, a multiple regression analysis was performed with corneal elevation as a dependent parameter and all other variables associated significantly with corneal elevation in the univariate analysis, as independent parameters. In multiple regression analysis, the residuals should be normally distributed. Spearman rank correlation analysis showed that elevation data were highly correlated between paired right and left eyes. Thus, only one eye was randomly selected from each patient for statistical analysis. All p-values were two-sided, and considered statistically significant when <0.05.

4. Results

The randomization of 3000 paired eyes in 1500 patients yielded a balanced proportion of right and left eyes. 1500 eyes were evaluated to determine normal values for anterior and posterior elevation. Patients were 18–48 years old, including 861 men and 639 women. All 1500 eyes had myopia with spherical equivalent refractive error (SE) between −0.50 D and −13.38 D. The median, IQR, and upper limit of normal myopic corneal elevation values are shown in Table 1. In general, elevation data trended toward a wider distribution, as shown by the increasing IQR, when moving from

Table 1
Median, IQR, and upper limit of normal myopic corneal elevation values (μm).

Location	Median	Q1–Q3	IQR	Upper limit
Anterior apex	2.0	1.7, 3.0	1.3	4.95
Anterior thinnest	2.3	1.5, 3.0	1.5	5.25
Posterior apex	0.0	−1.3, 1.7	3.0	6.2
Posterior thinnest	3.0	1.0, 5.0	4.0	11.0

Q1 = the first quartile; Q3 = the third quartile; IQR = Interquartile range (Q3-Q1); Upper Limit = upper limit of normal defined as Q3 + 1.5 × IQR according to the Tukey method.

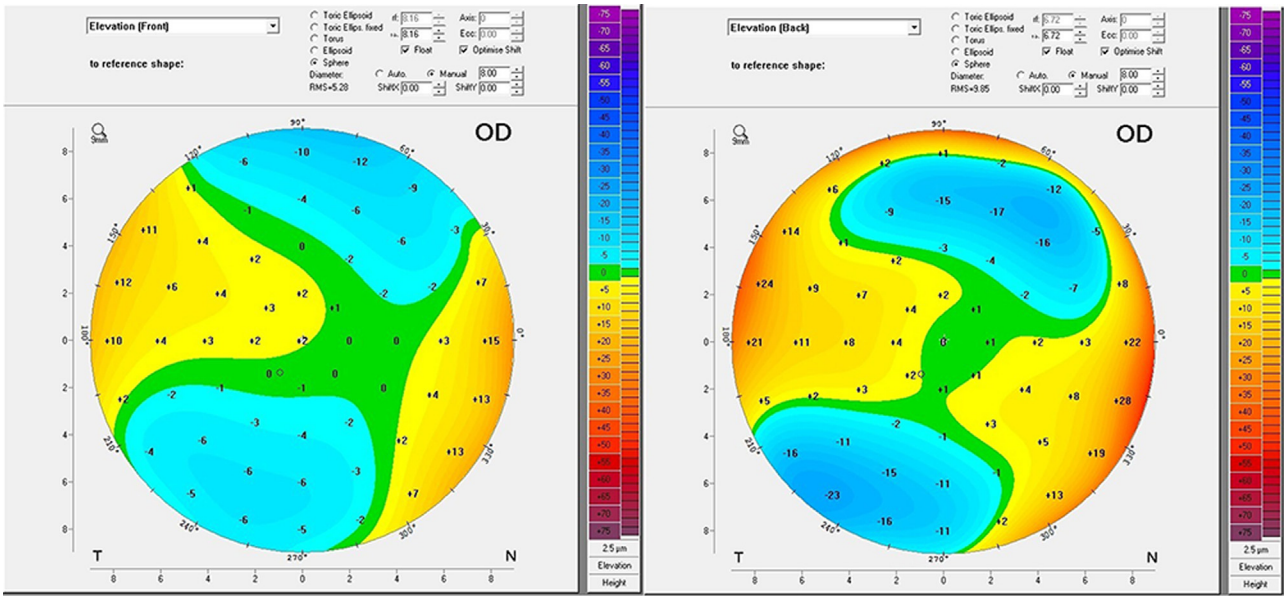

Fig. 1. Anterior and posterior corneal relative elevation maps of the right eye for a patient by the Pentacam. (A) Anterior elevation map. (B) Posterior elevation map. A white dot marks the apex point; a black ring indicates the thinnest point.

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