·Investigation·

Difference in normal corneal thickness and curvature between Mongolian and Han nationalities

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Abstract

• AIM: To investigate the differences in central corneal thickness (CCT) and curvature in myopic patients with different genders between Mongolian and Han nationalities in the Inner Mongolia region.

• METHODS: Patients with myopia, among whom 122 cases (244 eyes) were Mongolian and 150 cases (300 eyes) were Han, were selected. Pentacam was used to measure the corneal curvature, whereas CCT was determined by Pentacam, Orbscan and ultrasound pachymetry.

• RESULTS: Comparisons of the curvature of men and women in Mongolia showed a significant difference ($P<0.05$) by comparing of the CCT values measured by three methods in Han and Mongolian in Inner Mongolia, we can draw a conclusion that the CCT values measured by Pentacam are less than the values by Orbscan and ultrasound pachymetry, and there are statistically significant difference in CCT measurement among the instruments except between the Orbscan and ultrasound pachymetry. The CCT values of Mongolians are more than Han people, and the analysis exhibited statistical significance. The CCT values measured by Orbscan in Mongolia of women are more than men, the difference showed statistical significance.

• CONCLUSION: Corneal curvature in Mongolian females was significantly higher than that in males. However, no significant difference was observed among Han males and females. The CCT values of Mongolian females were higher than those of males. The normal CCT values measured by Pentacam in Mongolian myopic patients were smaller than those obtained by Orbscan or ultrasound. The normal CCT values of Mongolian patients with myopia were higher than those reported for domestic people.

• KEYWORDS: pentacam; orbscan; mongolian nationality; Han nationality; gender; central corneal thickness

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INTRODUCTION

Laser *in situ* keratomileusis (LASIK) has recently become the most popular refractive surgical procedure in which corneal curvature and central corneal thickness (CCT) serve an important function[1]. Accurate measurement of corneal curvature and CCT is important in decreasing the incidence of postoperative iatrogenic keratoconus [2]. Such measurement provides guidance and serves a preventive function in decreasing the occurrence of curvature negative pressure suction ring selection during surgery and in preventing the formation of free flap. More types of instruments are available for CCT measurement, and these instruments possess different governing principles. Pentacam anterior segment panoramic instrument is a newly developed three-dimensional anterior segment analysis system that can accurately scan the front and rear surfaces of the cornea and the other anterior segment of the system, particularly CCT.

Clinical observation revealed that the cornea curvature of most Mongolian women is higher than men. No domestic studies have been conducted on the regularity of Mongolian keratometry values. This study mainly aims to observe the differences in corneal curvature among men and women of Mongolian and Han nationality. Results were analysed to obtain a common principle that can guide the selection of negative pressure suction ring during clinical surgery to avoid the occurrence of free flap, improve surgical safety, screen preoperative pre-clinical keratoconus, and prevent postoperative iatrogenic keratoconus. This study investigates the normal cornea curvature and CCT values of myopia patients born and raised in Mongolia and determines whether these factors differed between male and female Han and Mongolian patients. Findings provide a reference for the selection of negative pressure suction ring in clinical surgery and reservation of corneal thickness values in different ethnic patients with different genders to ensure the safety of myopia laser surgery. The domestic CCT reference values was also provided for different nationalities with gender-related myopia.

Table 1 Comparisons of the clinical data of the Mongolian and Han patients *n* (%)

Group	Gender		Age		Spherical (D)		Cylinder (D)	
	M	F	Scope	$\bar{x} \pm s$	Median	Range	Median	Range
Mongolian	65 (53)	57 (47)	18-40	24±3	-5.125	-7.25	-0.75	-2.0
Han	83 (55)	67 (45)	18-42	25±4	-5.25	-7.25	-0.75	-2.0

SUBJECTS AND METHODS

Subjests We selected patients (272 myopia cases, 544 eyes) who were born and raised in Mongolia and who accepted myopic LASIK surgery from June 2012 to October 2013 in the Affiliated Hospital Eye Centre of Mongolia Medical University. Among these cases, 122 cases (244 eyes) are Mongolian (within three generations), which included 65 male cases (130 eyes) and 57 female cases (114 eyes). Meanwhile, 150 cases are Han (300 eyes), including 83 male cases (166 eyes) and 67 female cases (134 eyes). The average age was 18 to 40 (22±5) years old. Preoperative spherical equivalent degree was -1.25 D to -8.50 D with mean of (-4 ±-2) D. Patients with contraindications in surgery, such as organic diseases and systemic autoimmune diseases, were excluded. Moreover, patients who wore soft corneal and rigid contact lenses stopped wearing these devices for more than two weeks and a month, respectively. This study was conducted in accordance with the Declaration of Helsinki. This study was conducted with approval from the Ethics Committee of Mongolia Medical College. Written informed consent was obtained from all participants.

Methods In the inspection using Pentacam (OCULUS, Weltzlar, Germany) anterior segment panoramic instrument, patients were asked to place the mandibular jaw on a pad, and the forehead was fixed with a forehead belt. The patients were then instructed to open their eyes wide and watch the centre of the blue circle. The examiner adjusted the joystick and focus by tipping the screen, after which the blue light flashed for 5s. An image of each eye was captured three times to obtain the measurement results and determine the average. This experiment was performed in the mesopic condition. Moreover, in the inspection using Orbscan II (ORBTEK, Salt Lake city, USA) slit scanning topography/corneal thickness measurement system, the patients were in a sitting position. The collar and forehead were placed against a check bracket, and the head locate was adjusted and fixed by the examiner. The patients were asked to watch the red flashing lights inside the machine. The examiner focused the cornea on the centre of the video monitor, pressed the button to switch the machine on to start recording. Once the corneal tape was consistent with the machine, the patients were asked to blink before capturing the photos within 2s. For the ultrasound measurements, 0.4% Oxybuprocaine [Benoxil (R), Santen] eye drops were administered in the conjunctival sac of the patients (Santen Pharmaceutical Co., Ltd., Tokyo, Japan) as surface anaesthesia. The patients were asked to watch the central red dot, and a probe was used for the direct measurement of the central cornea by using an ultrasonic pachymeter (OPTIKON 2000, Roma, Italy). This process was performed three times, and the average was calculated. Each examination was performed by a skilled technician using the instrument.

Table 2 Comparisons of the mean cornea curvature of the Mongolian and Han males and females $\bar{x} \pm s$

Group	Mongolian	Han
M	42.93±1.44[a]	43.28±0.99
F	43.56±1.30	43.60±1.25

[a]P<0.05, the difference was statistically significant.

Statistical Analysis SPSS 13.0 statistical software was used for data processing. Results of the cornea curvature and CCT values measured by three different instruments were analysed by ANOVA analysis, with P<0.05 considered as statistically significant.

RESULTS

Clinical Data Gender, age, spherical equivalent and cylinder equivalent had no significant difference between the Mongolian and Han patients (P> 0.05, Table 1).

Cornea Curvature The differences in corneal curvature between Mongolian men and women was statistically significant (P=0.005). Moreover, the corneal curvature between Han men and women had no significant difference (P=0.102). The corneal curvature comparison between Mongolian and Han men(P=0.144) exhibited no statistically significant difference, similar to that between Mongolian and Han women (P=0.925, Table 2).

Central Corneal Thickness Comparisons of the CCT values among the three instruments are as follows: 1) comparisons among Mongolian men by Pentacam, Orbscan and ultrasonic pachymeter instrument exhibited a statistical significance (P=0.000), but no statistically significant difference was observed between measurements of the Orbscan and ultrasonic pachymeter instrument (P=0.550); 2) comparison among Mongolian women by the three instruments exhibit a statistically significant difference (P= 0.000), whereas no statistically significant difference between measurements by the Orbscan and ultrasonic pachymeter instrument (P=0.888); 3) comparisons among Han males by using the three instruments exhibited a statistically significant difference (P=0.023), similar to the difference between measurements by the Pentacam and ultrasonic pachymeter instrument (P=0.040). Meanwhile, no statistically significant difference was found between measurements by Orbscan and ultrasonic pachymeter instrument(P=0.524). Comparisons among Han males by the three instruments exhibited statistical significance(P=0.000).

Table 3 Comparisons of the average CCT values measured by the three instruments ($\bar{x} \pm s$, μm)

Group	Mongolian		Han	
	M	F	M	F
Pentacam	536.33±24.27	552.50±29.92	554.48±35.03	546.27±29.88
Orbscan	545.33±24.10	562.27±31.08	570.28±37.12[a]	561.20±34.49[a]
Ultrasonic pachymeter instrument	548.93±23.94	565.00±30.83	569.72±36.06[a]	557.41±29.48[a]

[a]P<0.05, the difference was statistically significant *vs* Pentacam. The CCT values of Han men and women measured by Pentacam measurements were lower than that by Orbscan and ultrasonic thickness measurements.

Pentacam measurements were significantly different from those by the ultrasonic pachymeter instrument (P=0.040), whereas measurements by Orbscan and ultrasonic pachymeter instrument exhibited no statistically significant difference (P=0.327, Table 3).

CCT values measured by using a relatively simple instrument among different genders and ethnicities were compared. The CCT values of Mongolian men measured by Orbscan were smaller than that of Mongolian women, and the difference was statistically significant (P =0.013). A pair-wise comparison of CCT values among different genders and nationalities exhibited no statistically significant difference (P>0.05, Table 4).

Table 4 CCT value comparison of different genders and nationalities P

Group	Pentacam	Orbscan	Ultrasonic pachymeter instrument
(Mongolian) M-F	0.149	0.013[a]	0.151
(Han) M-F	0.076	0.497	0.100
(M) Mongolian-Han	0.083	0.066	0.132
(F) Mongolian-Han	0.291	0.554	0.191

[a]P<0.05, difference was statistically significant. CCT values of Mongolian female measured by Orbscan measurements were higher than those of the Mongolian male.

DISCUSSION

In addition to glasses, corneal refractive surgery has recently become the mainstream method to correct myopia. The safety of such surgery has thus become the focus of attention. Preoperative keratometry and corneal thickness were inspected to ensure the success of corneal refractive surgery. These factors are important for preoperative keratoconus exclusion, as well as for the prevention of free flap formation during surgery and post-operative iatrogenic posterior corneal bulge [3,4]. The instruments to measure corneal curvature and CCT are more and more advanced, and the accuracy and repeatability of the outcome measures are better, which provides support to the safety of surgeries. We had not discovered researches about the regularity of the Mongolian corneal curvature values reported when we wrote the paper, and the comparison of corneal curvature and CCT between Hans and Mongolians which measured by Pentacam, Orbscan and ultrasound pachymeter is rare.

The corneal curvatures of most Mongolian women were higher than those of men. Domestic research is lacking on the regularity of Mongolian keratometry values. The corneal curvature values in this study were measured by Pentacam with the primary objective of observing the differences in corneal curvature among Mongolian and Han men and women. Results were analysed to establish a common principle that contributes to the choice of the negative pressure suction ring in clinical surgery to avoid free flap formation and improve surgical safety.

The primary instruments used to measure corneal thickness are traditional ultrasonic pachymeter, Orbscan corneal topography system, Pentacam anterior segment panoramic instrument and other instruments with different principles, but CCT values measured by ultrasound pachymetry remain the gold standard for measurement [5-7]. The ultrasonic pachymeter emits ultrasonic waves through an ultrasonic probe in the acoustic wave oscillator to calculate corneal thickness [8]. Anaesthetic drops were administered before measurement. Data were measured through direct contact with the front corneal surface, and results were thinner compared with those of the latter two instruments [9]. This result may contain some biases because of the subjective judgment for the central corneal location of the tester. The thinnest point of the cornea was difficult to locate. Thus, the operation requires highly skilled operators.

The Orbscan corneal topography system uses the slit optical scanning principle combined with Placido disk reflection imaging to perform non-contact tomography scanning of the cornea using 20 crack light bands from the left and right eyes with an angle of 45°. The three-dimensional information on 9600 points from the anterior and posterior corneal surfaces was obtained within 1 to 2s. The information was then analysed using the computer system to determine the corneal front and back surface shapes, curvature, thickness and other data[10,11].

Pentacam anterior segment panoramic instrument is based on the Scheimpflug optical principle. According to this principle, when the subjected and extension lines of the film plane intersect at some point, the image of the whole subject is clearly recorded. Thus, non-contact tomography scanning with 0° to 180° rotation can be performed on the cornea and other anterior segments within 2s. Fractured images are obtained 50 times, and the real height of 25 000 points is ultimately realized[12,13].

The panoramic anterior segment analyser is the most recently introduced measurement system for anterior segment structures. In this system, the measured cornea data have high accuracy and repeatability, particularly in terms of corneal surface measurement[14].

Some studies [15] showed that the Pentacam anterior segment system was similar to the ultrasonic pachymeter in terms of CCT measurement. O'Donnell and Maldonado-Codina [16] found that the corneal thickness data measured by Pentacam were slightly lower than those measured by the ultrasonic corneal thickness gauge (ranging from 6 μm to 10 μm); these results are similar to those of this study. Ciolino *et al* [17] reported no significant difference between the two measurements. Al-Mezaine *et al* [18] believed that the thickness measured by Pentacam was higher than that measured by the ultrasonic pachymeter. However, most studies suggested good correlation and consistency between the measurements of the two instruments.

In this work, the CCT values of Mongolian myopia patients measured by Pentacam, Orbscan and ultrasonic pachymeter were different from those in the study by Shao *et al* [19]. In addition to the significant differences in the CCT of Mongolian men and women based on Orbscan measurement instrument, the differences in CCT among different nationalities and genders, as measured by the other two instruments, were not statistically significant. The CCT values measured by the three instruments were higher than those reported for domestic people with myopia; these values were (526.3±38.4) μm for men and (522.6±37.8) μm for women, with possible regional differences[20].

All selected myopic patients were from Mongolia, indicating that the CCT values of myopic patients from Mongolia were higher than that for patients from other provinces. This finding may be attributed to the small and biased sample size. The sample size should be further expanded for comprehensive clinical observation. These aspects should be further studied.

Moreover, all normal CCT values measured by Pentacam were approximately 10 to 20 μm thinner than those measured by Orbscan and ultrasonic pachymeter. For patients that will undergo LASIK surgery, Pentacam is more reliable for the reservation of surgical corneal thickness values. This research focused on the normal CCT. Therefore, a further study should be conducted to assess the accuracy and consistency of the CCT values among Mongolian and Han patients of different genders under conditions such as cornea expansion and corneal refractive surgery.

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