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Correlation between Central Corneal Thickness and Degree of Myopia among Malaysian Patients Undergoing Laser Keratorefractive Surgery

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Authors' contributions

This work was carried out in collaboration between all the investigators. Author SCR designed the study, collected the literature search, prepared the data collection proforma and wrote the manuscript. Author MMS performed the surgeries and managed the patients. Author AMD collected the data and analyzed the results. All the authors read and approved the final manuscript.

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ABSTRACT

Purpose: To determine the central corneal thickness in myopic adult patients scheduled for laser corneal refractive surgery and to explore its correlation with degree of refractive error.
Materials and Methods: The case records of 130 myopic patients who underwent laser corneal refractive surgery in a military hospital over a period of two years were reviewed to determine the central corneal thickness. All patients had 6/6 vision with best correction, and did not have any other anterior segment or fundus diseases in both eyes. The central corneal thickness was measured with Visante Carl Zeiss anterior segment optical coherence tomography instrument.
Results: Out of 130 patients, males were more (73, 56.2%); mean age of patients was 33.8 years (range 18-60 years) and majority were Malays (110, 84.6%). The spherical power of myopia ranged from – 0.5 to – 10.00 D, and the cylindrical power ranged from – 0.25 to – 3.25 D. The

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mean central corneal thickness of both eyes was 528.2 µm (range 331- 615 µm); in the mild degree of myopia (- 0.50 to - 2.00 D) 527.9 µm, moderate degree (- 2.25 to -5.00 D) 529.4 µm, and high degree (-5.25 to -11.00 D) 523.9 µm.

Conclusion: The anterior segment optical coherence tomography provides noncontact, rapid, pachymetry mapping of the corneal thickness. In Malaysian patients, the mean central corneal thickness of both eyes in myopia was 528.1 µm (range 331- 615 µm). There was no correlation between the mean central corneal thickness and degree of myopia, different genders, age groups, ethnic groups and two eyes.

Keywords: Myopia; central corneal thickness; degree of myopia; gender; age group; ethnic group.

1. INTRODUCTION

Central corneal thickness (CCT) is important to decide whether or not to perform corneal refractive surgery and the type of procedure to be performed in patients wearing myopic glasses so that postoperatively they can see the objects clearly without spectacles. To prevent corneal ectasia which results in visually debilitating refractive instability after laser assisted in situ keratomileusis (LASIK), it is recommended that at least 250 µm of residual corneal stromal tissue should be left after laser ablation of cornea [1].

The literature search (PubMed, Science Direct, Google search) of recent publications revealed many reports on CCT in patients scheduled for, or undergone laser corneal refractive surgery from different countries in the world [2-13]. However, there was no study reported on this subject from Malaysia. The published studies showed contradictory reports on the correlation of CCT with degree of myopia in the literature. Therefore, we conducted a retrospective study of case records of patients scheduled for laser corneal refractive surgery to determine the central corneal thickness and its correlation with degree of myopia, different genders, age groups, ethnic groups and two eyes.

2. MATERIALS AND METHODS

The case records of patients who underwent laser corneal refractive surgery in Hospital Angkatan Tentera Tuanku Mizan (Military Hospital), Kuala Lumpur, from January 2015 to December 2016 were reviewed. Age, gender, race, refractive power of eyes, central corneal thickness and type of operation done were noted from the records. All the patients who had 6/6 vision with best correction in both eyes were included in this study. Preoperative evaluation included visual acuity, refraction, slit lamp examination of anterior segment, applanation tonometry and fundus examination with +90 D lens in all the patients. They did not have any other anterior segment or fundus diseases in both eyes except myopia.

Refraction of both eyes was evaluated with manual streak retinoscopy and subjective correction with glasses. The spherical equivalent of refractive error was calculated by adding half the number of cylindrical power to the spherical error and adjusted to the nearest 0.25 D grades for right eye and left eye (total 260 eyes). The central corneal thickness was measured with Visante Carl Zeiss anterior segment optical coherence tomography instrument (Fig. 1), which uses low coherent interferometry with a 1310 µm wavelength light source and a scanning speed of 512 A-scans in 250 ms, resulting in high speed without loss of signal:noise ratio. All participants were asked to fixate on the optical target in the system and the center of measurement was aligned with the corneal apex. A pachymetry scan protocol was chosen for assessment. The system automatically processes 8 line scans and presents a map of the pachymetry values. The average reading displayed in the center represents the central 2 mm corneal thickness and was used for analysis in this study. Both refraction and pachymetry tests were performed during the same session by a qualified, trained and experienced optometrist working in the eye department of the hospital.

The military hospital, Kuala Lumpur is the teaching hospital for the Faculty of Medicine and Defence Health, National Defence University of Malaysia. This study was carried out in accordance with the tenets of the Declaration of Helsinki; The data from the patient records were entered into SPSS version 18 software and analyzed using student 't' test, ANOVA test and correlation coefficient test for the significance of variables. The P value of <0.05 was considered as significant.

Fig. 1. showing Visante Carl Zeiss anterior segment optical coherent tomography instrument

3. RESULTS

Out of 130 patients, 57 were Femtosecond LASIK operation and 73 small incision lenticule extraction (SMILE) operation. Males were more (56.2%) than females; the mean age of patients was 33.8 years (range 18-60 years) and 78.4% were below 40 years age. Majority (84.6%) were Malays. The spherical power of myopia ranged from -0.50 to -10.00 D, and the cylindrical power ranged from -0.25 to -3.25 D. The spherical equivalent of the refractive power was calculated by adding half the number of cylinder power to the spherical error and adjusted to the nearest 0.25 grades of right eye and left eye. The mean spherical equivalent refractive power in the right eye was - 4.25 D (range -0.50 to -10.75 D), and in the left eye it was - 4 D (range -1.00 to -11.00 D). The spherical equivalent of myopia of both eyes was added and the degree of myopia was classified as mild (-0.25 to -2.00 D), moderate (- 2.25 to -5.00 D) and high (-5.25 to -11.00 D), There was no significant association between the mean CCT and degree of myopia, different genders, age groups, ethnic groups, and two eyes (Table 1). The mean central corneal thickness of both eyes in myopia was 528.1 µm (range 331- 615 µm).

4. DISCUSSION

The laser keratorefractive surgery has become quite popular in Asian countries. Two types of refractive procedures ((LASIK or SMILE) are being performed in myopic patients. In LASIK operation, a corneal flap was made from the periphery (using micro blade or Femtosecond laser) with a hinge on its nasal side; and the flap was reflected onto the limbus. Then the corneal stroma was abladed with Excimer or Femtosecond laser, and the corneal flap was reposited back on to the stroma at the end of operation.

In SMILE operation, small lenticule was made in the cornea with anterior and posterior intra stromal incisions in the periphery and a small incision in the upper part inside the limbus using femtosecond laser. Then, the corneal lenticule was separated anteriorly and posteriorly and removed manually from the cornea. The amount of thickness of the corneal flap or thickness of coneal lenticule to be removed is determined by the CCT of the eyes in these patients.

Table 1. Correlation between central corneal thickness (CCT) and demographic variables, degree of refractive error in 130 myopic patients

Parameter	Number (percentage)	Mean CCT	P value (statistical test)
Gender			
Male	73 (56.15%)	533.2 µm	0.57 (t test)
Female	57 (43.84%)	520.7 µm	
Age			
18 – 20 years	3 (2.30%)	521.2 µm	
21 – 30 years	44 (33.84%)	525.4 µm	0.70 (t test)
31 – 40 years	55 (42.30%)	531.3 µm	Correlation coefficient
41 – 50 years	26 (20.00%)	526.5 µm	r = 0.03
51 – 60 years	2 (1.53%)	505.2 µm	
Race			
Malay	110 (84.61%)	528.1 µm	
Chinese	13 (10.00%)	524.8 µm	0.93 (ANOVA)
Indian	7 (5.38%)	527.0 µm	
Eye tested (n = 260 eyes)			
Right	130 (50.00%)	528.3 µm	0.87 (t test)
Left	130 (50.00%)	527.9 µm	
Spherical equivalent degree of refractive error (n = 260 eyes)			
Mild myopia - 0.50 to - 2.00 D	46 (17.69%)	527.9 µm	0.55 (ANOVA)
Moderate myopia - 2.25 to -5.00 D	147 (56.54%)	529.4 µm	
High myopia -5.25 to -11.00 D	67 (25.77%)	523.9 µm	

In our study, the mean CCT in myopia patients who underwent laser corneal refractive surgery was 528.1 µm (range 331- 615 µm). The CCT in Malaysian patients is higher than patients of similar group from India and Yemen, while it was lower than the patients of similar group from other countries in the world (Table 2). This variation of CCT values could probably be due to differences in the study population and use of different types of pachymeters. In our study, the CCT was measured with anterior segment optical coherence tomography instrument while in other studies the CCT was measured with different types of pachymeters.

Depending on the availability, the CCT can be measured with pachymeters such as ultrasound pachometer, sonomed micropach, noncontact specular specular microsope, orbscan, anterior segment optical coherence tomography [11]. The CCT values vary with different instruments.

Ho et al. [14] compared corneal pachymetry assessment using Orbscan II (Bausch & Lomb), Visante (Carl Zeiss Meditec), Pentacam (Oculus, Inc.), and ultrasound pachymetry (Sonomed, 200P) instruments in 53 patients (103 eyes), six months after LASIK surgery for myopia. They concluded that Pentacam and Visante measurements of corneal thickness were significantly less than those obtained using Orbscan and Ultrasound pachymetry, When undertaking LASIK procedure, CCT is an important consideration to prevent the cornea from becoming too thin after the operation, resulting in corneal ectasia. Corneal ectasia is a sight-threatening complication of excimer laser refractive surgery characterized by progressive steepening and thinning of the cornea. Although its prevalence is theoretically low, estimated between 0.04% and 0.6% [15], SMILE is thought to reduce the probability of iatrogenic ectasia compared to LASIK (only four cases in the literature) [16].

The published reports from different countries showed contradictory findings about the correlation of CCT with degree of myopia among patients who were scheduled for/underwent corneal refractive surgery (Table 2). Mimouni et al. [2] in their study of 30245 patients who underwent myopic laser refractive surgery reported that there was a direct correlation between the degree of myopia and CCT (r=0.94, p <0.001). Contrary to this report, Bamashmus et al. [5] in their study of 2304 subjects from a refractive surgery unit reported that the CCT decreased statistically as the power of myopia increased (p=0.026). However, in our study, there was no correlation between the mean CCT

and degree of myopia (ANOVA p=0.55), which is similar to the most of the studies published earlier in similar group of patients [3,6-10,12]. This may perhaps be explained by the differences in the study population and measurement of CCT with different types of instruments. In our study, there was no statistical significant difference between the mean CCT and different genders (males and females, p=0.57), different age groups (p=0.70, r=0.03), different races (Malays, Chinese, and Indians, p=0.93), right eye and left eye (p=0.87), Table 1.

Wang et al. [3] reported that males had significantly thicker CCT (8.8 µm higher) than females (p<0.001), while Chen et al. [6] found that CCT was significantly less (2 µm) in females than in males (p=0.012). The observation of Koucheki et al. [8], no significant difference between CCT and two genders (p>0.05), was similar to our study.

Mimouni et al. [2] and Prasad et al. [7] reported no significant association between CCT and age of patients, which was similar finding in our study. Contrary to our finding of no difference between CCT and two eyes, Wang et al. [3] reported that CCT in the left eye was slightly thicker (2 µm) than the right eye and the difference was statistically significant (p<0.001). In Malaysia, three ethnic populations (Malays, Chinese and Indians) are present, while in all the published studies only one ethnic population is present. Therefore, it is not appropriate to compare our findings regarding race and CCT with other studies.

Table 2. Showing demography data, mean central corneal thickness and instrument used, in myopia patients before corneal refractive surgery

Author (year)	Country	No. of patients	Age in years	Mean CCT µm (range)	Instrument used, correlation with degree of myopia
Mimouni et al. [2] (2018)	Israel	30245	Older than 18	533.5 ± 35.5 (404 - 794)	USP, Significant direct correlation
Wang et al. [3] (2017)	China	1190	18- 44	539.2 ± 37.8	SM No correlation
Zhao et al. [4] (2015)	China	158	18 - 52	531.6 ± 24.3	NCSM Not available
Bamashmus et al. [5]	Yemen	2304	18-50	521.7 ± 31.62 (432- 643)	USP, Significant negative correlation
Chen et al. [6] (2014)	Taiwan	528	21- 64	560 ± 35	OS No correlation
Prasad et al. [7] (2011)	USA	5158	17- 83	544 ± 34 (415- 695)	USP No correlation
Koucheki et al. [8] (2010)	Iran	340	18- 55	549.5 ± 33.6 (467- 672)	USP No correlation
Al-Mezaine et al. [9] (2009)	Saudi Arabia	491	18- 56	543.8 ± 35.4	USP No correlation
Ahmad & Memon [10] (2008)	Pakistan	154	14- 50	535.68 ± 33.84 (418- 623)	USP No correlation
Li et al. [11] (2006)	USA	21	Older than 21	546.9 ± 29.4 (477- 599)	High-speed OCT Not available
Fam et al. [12] (2006)	Singapore	714	15- 59	534.5 ± 38.1 (305- 684)	OS No correlation
Kunert et al. [13] (2003)	India	615	18 and above	518.23 ± 31.03 (428- 607)	OS Not available
PRESENT STUDY	Malaysia	130	18- 60	528.1 (331- 615)	ASOCT No correlation

USP= ultrasound pachometer, SM= sonomed micropach 200P+, NCSM= noncontact specular microsope, OS= orbscan, OCT = optical coherence tomography, ASOCT= anterior segment optical coherence tomography

5. CONCLUSION

The anterior segment optical coherence tomography provides noncontact, rapid, pachymetry mapping of the corneal thickness. The mean CCT of both eyes in myopia was 528.1 µm (range 331µm to 615 µm) in Malaysian patients undergoing laser corneal refractive surgery. There was no correlation between the mean CCT and degree of myopia, different genders, age groups, ethnic groups, and two eyes of the patient.

6. LIMITATIONS

The short comings of the present study was small number of patients and so its results could only be applicable to similar keratorefractive surgery patients. Due to retrospective nature of the study, axial length was not available for analysis of its relationship with CCT, because it was not measured routinely in the preoperative evaluation of patients undergoing corneal refractive surgery. We have not used an emmetropic patients for comparison of CCT in myopia. However, our data were compared with the findings of similar patients who were scheduled for or underwent laser corneal refractive surgery from the published literature.

CONSENT AND ETHICAL APPROVAL

Informed consent was obtained from all the patients who participated in the study. This study was approved by research and ethics committee of National Defence University of Malaysia.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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