Corneal Characteristics in Myopic Patients

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Objectives: *To evaluate the characteristics of the cornea in myopic patients.*
Material and Method: *A retrospective study of 420 eyes in 210 patients who visited the Excimer Laser Surgery Clinic at Siriraj Hospital, Mahidol University from January 1999 to June 2002 was conducted. All cases that were eligible for myopic refractive surgery were included in the present study. A preoperative ocular examination was done in a fashionable method, including manifest refraction and Orbscan Topography to evaluate corneal thickness, corneal curvature and corneal diameter. Statistical analysis was performed to identify the characteristics of the cornea in the patients.*
Results: *The mean age of the patients was 31.66 $\pm$ 7.77 years. (ranging from 16-51). The mean manifest refraction (spherical equivalent) was -4.9 $\pm$ 2.29 diopters (ranging from -0.50 to -13.75). The mean corneal diameter (white to white) was 11.60 mm $\pm$ 0.37 mm (ranging from 10.8-12.9). The thinnest point of the cornea varied from 409 to 597 microns (mean = 522.55) and located mostly in the infero-temporal quadrant of the eye (23.69% in the right and 32.05% in the left). The mean curvature of the corneal was 44.6 $\pm$ 13.8 diopters (ranging from 39.05-47.65). The mean corneal astigmatism was 1.34 $\pm$ 0.71 diopters and 93.96% were with the rule astigmatism. Positive angle kappa was found in 408 eyes (97%) but all cases were within a 0.5 mm horizontal and 0.3 mm vertical radius from the pupillary axis.*
Conclusion: *Characteristics of the cornea in Thai myopic patients were demonstrated in the present study. Most of the cornea showed with the rule astigmatism with positive angle kappa and the thinnest point located at the infero-temporal quadrant.*

Keywords: *Cornea, Myopia, Thickness, Curvature*

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Refractive surgery is becoming popular worldwide. Most of the surgery is performed at the corneal plane, known as kerato-refractive surgery. Therefore, surgeons who perform the surgery should have extensive knowledge about the cornea and anterior segment of the eye. In the circumstance of rare complications, suitable management will be carried out instantly based on this basic knowledge[1,2]. One of the basic understanding is the characteristic of the normal cornea. Surgeons should know the normal finding of the cornea in order to identify the abnormal finding. Any finding that is out of the normal range requires caution.

The normal characteristics of the cornea vary from one to another; depending mostly on the race of the population. We investigated the characteristics of the myopic cornea in a subgroup of the Thai population who sought refractive surgery in order to identify the normal pattern.

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Material and Method

A retrospective study of the patients who visited the Excimer Laser Surgery Clinic at the Department of Ophthalmology, Siriraj Hospital, Mahidol University from January 1999 to June 2002 was conducted. All cases that were eligible for the excimer laser surgery were reviewed for inclusion in the study. Inclusion criteria for the study were as follows

- Age of 16 years old or more.
- Myopia with at least-0.25 sphere and -0.25 cylinder.
- Best corrected visual acuity (BCVA) of 20/32 or better.

- No abnormalities of the eye including severe dry eyes, keratoconus, ocular surface disease and irregular astigmatism.

A complete pre-operative ocular examination was performed in all cases including slit-lamp biomicroscopy and manifest refraction. The Orbscan Topography (Bausch & Lomb, USA) was used to evaluate the corneal diameter, corneal curvature, corneal thickness and angle kappa.

Statistical analysis was performed to identify the characteristics of the cornea in the patients.

Results

There were 420 eyes in 210 patients eligible for the present study. 127 cases (60%) were female and 83 cases (40%) were male. The mean age of the patients was 31.66 $\pm$ 7.77 years. (ranging from 16 to 51). The mean manifest refraction (spherical equivalent) was -4.9 $\pm$ 2.29 diopters (ranging from -13.75 to -0.50).

The findings of the cornea in all 420 eyes are shown in Fig. 1 and Table 1.

- The presence of angle kappa was demonstrated. 97% (408 eyes) had positive angle kappa (pseudoexodeviation) but all cases were within 0.5 mm horizontal displacement and 0.3 mm vertical displacement from the pupillary axis. (Fig. 2).

- There was no statistically significant difference between the findings of the right and left eye.

Discussion

Laser in situ keratomileusis (LASIK) is the most popular refractive procedure in Thailand, comprising almost 90% of all refractive procedures. Others consist of photorefractive keratectomy (PRK), laser epithelial keratomileusis (LASEK), phakic intraocular lens implantation and other incisional refractive procedures such as radial keratotomy (RK) or astigmatic keratotomy (AK) which are rarely performed[3]. Most of the surgeries mentioned above were performed at the corneal plane. Therefore, pre-operative evaluation of the cornea in refractive surgery is very critical. Misinterpretation of the corneal finding can sometimes lead to serious complications[4,5]. One of the key points in corneal evaluation is to know the normal finding of the cornea. There is no previous report which characterizes the cornea in the Thai myopic population.

Characteristics of the cornea can be divided into several aspects such as the geometrical and optical properties of the cornea. The geometrical property is the basic property and demonstrates the gross anatomy of the cornea[6]. In contrast, optical property is an intrinsic property and demonstrates how light should be refracted through the corneal surface[7]. These properties are very important to a refractive surgeon. In order to achieve a good outcome, both properties have to be within normal limits.

Diameter and thickness are among the most important geometrical properties of the cornea. The present study didn't reveal any difference between myopic cornea and the general population that has been described in text books and previous literature[6-8]. From this data, the average correction of near sightedness at the corneal plane can be calculated up to -8.00 to -9.00 diopters at 6 mm zone by using Munnerlyn's equation depending on the type of correction (equivalent to 95 to 110 microns of tissue available)[9].

Curvature (which determines the amount of corneal astigmatism) and angle kappa are also very important for the optical property of the cornea. Astigmatism (both corneal and internal) in the present study is also similarly found as in previous reports[7,10,11]. Angle kappa is the angle between the visual axis and the anatomic pupillary axis of the eye. It can be measured by the Hirschberg test which roughly looks at the location of the corneal light reflex. It is slightly 0.5 mm nasal to the center of the cornea due to temporal displacement of the fovea to the pupillary axis. This is termed positive angle kappa. If the reflex is located in a

Table 1. Showed the summary of characteristics of the cornea. Note that there is a statistically significant difference between corneal astigmatism and refractive astigmatism

	Mean $\pm$ SD	Range	Note
Corneal diameter (horizontal white to white)	11.60$\pm$0.37 mm	10.8 to 12.9	
The thinnest point of the cornea	522.55$\pm$26.6 microns	409 to 597 microns	
Corneal curvature (averaged of steepest and flattest axis)	44.60$\pm$13.8 diopters	39.05 to 47.65 diopters	93.96% with the rule astigmatism
Corneal astigmatism	1.34$\pm$0.71 diopters	0.5 to 5.0 diopters	$p < 0.05$
Refractive astigmatism	0.76$\pm$0.79 diopters	0.75 to 4.5 diopters	

	No. of eyes	%		No. of eyes	%
Center	7	1.66	Supero-Nasal	43	10.23
Inferior	23	5.47	Supero-Temporal	100	23.80
Superior	15	3.57	Infero-Nasal	65	15.47
Nasal	20	4.76	Infero-Temporal	117	27.85
Temporal	30	7.14			

Fig. 1 Demonstrated the location and percentage of the thinnest point of the cornea in the right eye (OD) and left eye (OS). Note that the infero-temporal quadrant is the most common location

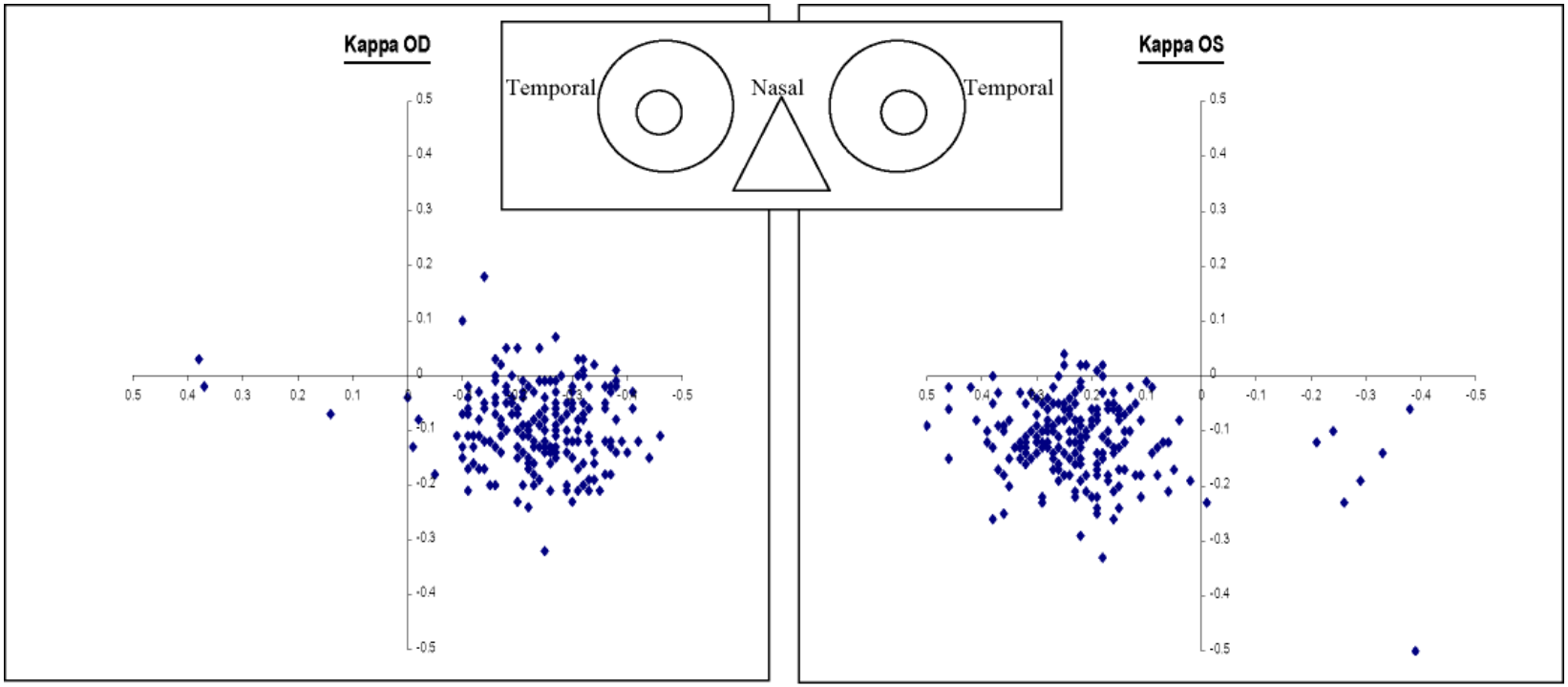

Fig. 2 Demonstrated the location of the angle kappa in the right eye (OD) and left eye (OS). Note that the most common location is within 0.5 mm nasally and 0.3 mm inferiorly

position other than 0.5 mm nasally, the Hirschberg test is positive[12-14]. With the modern technology of Orbscan Topography, the location of the corneal light reflex can be measured to the exact location in x-y axis. The accuracy and precision of the Orbscan Topography measurement has been demonstrated in several aspects[15-17].

The present study found that most of the Thai myopic population had nasal displacement of the reflex within 0.5 mm as previously indicated[12]. Interestingly, it also (for the first time) identified vertical displacement of the reflex that 99% was within 0.3 mm inferior displacement (Fig. 2). So, the negative Hirschberg test should be reclassified at 0.5 mm nasal and 0.3 mm inferior displacement of the corneal light reflex. The location of the corneal light reflex is very critical for the centration of the refractive treatment. It is the point where visual axis goes through, in other words, the point where the patient really looks through[18]. Centration of the refractive treatment should be aligned on this corneal light reflex.

With the growth of refractive surgery, large volumes of patients will undergo one or another type of procedure in a year. Screening of the patients is one of the keys to success. By understanding this normal characteristic of the cornea, a refractive surgeon might be able to perform pre-operative screening more easily and faster.

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การวิเคราะห์ลักษณะเฉพาะของกระจกตาในกลุ่มคนที่มีสายตาสั้น

สบง ศรีวรรณบูรณ์, สุขศรี โชติกวณิชย์

วัตถุประสงค์: *เพื่อหาลักษณะเฉพาะของกระจกตาในกลุ่มผู้ที่มีระดับสายตาสั้น*

วัสดุและวิธีการ: *การศึกษานี้ทำในผู้ที่มารับการตรวจเพื่อทำผ่าตัดแก้ไขสายตาผิดปรกติจำนวน 420 ตา ที่ภาควิชาจักษุวิทยา คณะแพทยศิริราชพยาบาล โดยทำการตรวจและบันทึกข้อมูลเกี่ยวกับ อายุ, ค่าสายตาผิดปรกติ, เส้นผ่าศูนย์กลาง ของกระจกตา, ความหนาและค่าความเอียงของกระจกตาที่ตรวจวัดด้วยเครื่อง Orbscan Corneal Topography แล้วนำผลที่ได้มาวิเคราะห์หาลักษณะเฉพาะของกระจกตาในกลุ่มนี้*

ผลการศึกษา: *ผู้ที่มารับการตรวจ 210 ราย มีอายุเฉลี่ย 31.66 + 7.77 ปี (16 ถึง 51 ปี) มีค่าสายตาสั้นเฉลี่ย (Spherical Equivalent) -4.90 + 2.29 diopters (-0.5 ถึง -13.75), มีค่าเส้นผ่าศูนย์กลางของกระจกตาเฉลี่ย 11.60 + 0.37 มิลลิเมตร (10.8 ถึง 12.9) และมีค่าความหนาของกระจกตาในตำแหน่งที่บางที่สุดเฉลี่ย 522 ไมครอน (409 ถึง 597) และตำแหน่งที่พบบ่อยจะอยู่ทางด้าน infero-temporal ของกระจกตา (พบ 23.69% ในตาขวา และ 32.05% ในตาซ้าย) ค่าความโค้งเฉลี่ยของกระจกตาเท่ากับ 44.6 + 13.8 diopters (39.05 ถึง 47.65) โดยมีค่าความเอียงที่กระจกตาเฉลี่ย 1.34 diopter ซึ่งในกลุ่มนี้จะเป็นความเอียงชนิด with the rule 93.96 % นอกจากนี้ยังพบค่า positive angle kappa ได้ 97% ซึ่งทุกรายจะอยู่ในรัศมี + 0.5 มิลลิเมตรในแนวนอน และ + 0.3 มิลลิเมตรในแนวตั้ง จากกึ่งกลางรูม่านตา*

สรุป: *การศึกษานี้พบว่าลักษณะเฉพาะของกระจกตาในกลุ่มผู้ที่มีระดับสายตาสั้นมักมีค่าความเอียงชนิด with the rule และมี positive angle kappa โดยตำแหน่งที่บางที่สุดของกระจกตาที่พบจะอยู่ทางด้าน infero-temporal*