

The Changes of Anterior Segment in Myopic Eyes —Analysis with Scheimpflug System

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The relationship between the cornea, the anterior chamber depth (ACD) and the anterior chamber angles of these structures which occur in myopia have not been extensively studied. We analyzed each of these parameters in myopic patients using an anterior segment image processing technique on an EAS 1000 (Nidek) system applying the Scheimpflug principle. One hundred and seventeen young highly myopic (≥ 8.0 D) patients and 32 mildly myopic (< -3.0 D) subjects were studied. There was no significant difference in central corneal thickness between the highly myopic and mildly myopic eyes. The corneal radius was slightly correlated with axial length, but not correlated with refractive status. The corneal radius of highly myopic eyes was steeper than that of mildly myopic eyes in males, however, it was not correlated with the severity of myopia in females. The ACD was slightly greater in highly myopic eyes. The width of the four anterior chamber angles were not correlated with the increasing of myopia. However, the temporal angle was wider in highly myopic eyes. These results suggest that only slight structural changes in the anterior segment are present in the highly myopic eyes. (Tzu Chi Med J 1997; 9: 99-105)

Key words: corneal thickness, corneal radius, anterior chamber depth, anterior chamber angle, Scheimpflug principle

INTRODUCTION

There have been only a few reports of which have analyzed the structural characteristics of the anterior segment of the human eye in myopia, and the relationship between changes in the anterior segment of the eye and the development of myopia are still unclear. Both

greater and less power of the corneal radius in highly myopia has been reported. In addition, the thickness of the cornea has been found to be diminished in highly myopia [1], but these differences have not been striking. The ACD was suggested to have a strong tendency being greater in high myopia [2]. The anatomy of the anterior chamber angle has been shown to have an im-

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pact upon the level of intraocular pressure, and a high incidence of ocular hypertension and open angle has been found in patients with high myopia [1]. However, the morphology of the chamber angle in myopic patients has not been extensively studied.

In order to explore the morphologic changes which occur in the anterior segment of myopes, we analyzed the data on corneal thickness, anterior corneal radius, ACD and four chamber angles using the image analysis technique of Scheimpflug which can produce a sufficient depth of focus to capture the entire anterior segment of the eye [3,4].

MATERIALS AND METHODS

One hundred and seventeen highly myopic patients (≥ -8.0 D) (male: 44, female: 73) and thirty-two mildly myopic subjects (< -3.0 D) (male: 19, female: 13), aged from 18 to 21 years old (mean 19.5) were enrolled in this study. Patients were excluded if they had any ocular disease or prior anterior segment surgery or corneal scar which would interfere with visualization.

All of subjects received the ocular examinations including postcycloplegic refraction measured by an autorefractometer and biometric axial length measured by A scan ultrasonography. The corneal thickness, anterior corneal radius, ACD, and anterior chamber angle were examined by Scheimpflug photography (Nidek, EAS-1000) (Fig 1,2). Images of the horizontal and vertical meridians were taken. Four segments of the anterior chamber angles (superior, inferior, nasal, temporal) were measured. All values were calculated from six separate measurements by the same technicians. Only data from the right eye of each patient was analyzed. The differences between the highly myopic and mildly myopic group were compared by two-tailed Student's t test. A p value of less than 0.05 was considered statistically significant. The correlation coefficient between corneal thickness, anterior corneal radius, ACD, four chamber angles with refractive status and axial length were also

analyzed among the highly myopic patients.

RESULTS

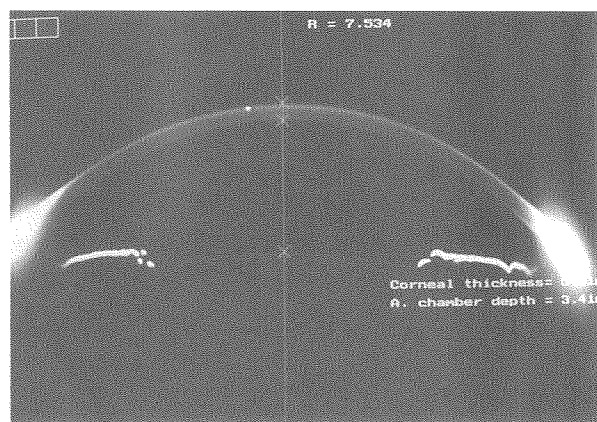


Fig 1. The anterior corneal radius, corneal thickness, and anterior chamber depth measured by the Scheimpflug anterior segment analysis system (Nidek, EAS-1000).

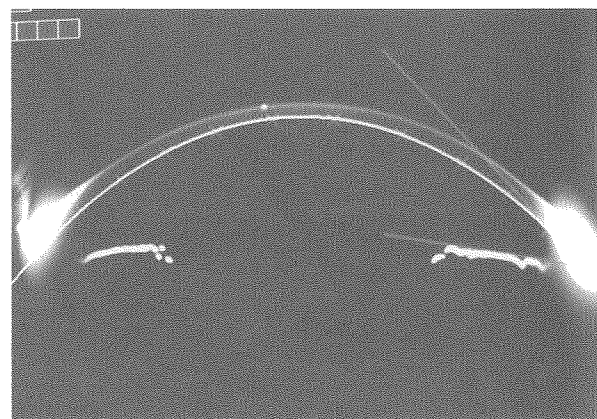


Fig 2. The anterior chamber angle measured by the Scheimpflug anterior segment analysis system (Nidek, EAS-1000).

A) Changes in the cornea*Corneal thickness:*

The mean corneal thickness in males was 0.62 +/- 0.03 mm (horizontal) and 0.62 +/- 0.03 mm (vertical) in high myopia group, and 0.62 +/- 0.06 mm (horizontal) and 0.62 +/- 0.05 mm (vertical) in the mild myopia group. No significant difference was found between the high and mild myopia groups in males. The mean corneal thickness in females was similar to males, 0.62 +/- 0.03 mm (horizontal) and 0.61 +/- 0.04 mm (vertical) in the high myopia group, and 0.63 +/- 0.03 mm (horizontal) and 0.62 +/- 0.03 mm (vertical) in the mild myopia group. No significant difference of corneal thickness was found between highly and mildly myopic female patients (Table 1).

We found no correlation between the corneal thickness and the refractive status or the axial length in highly myopic patients, regardless of gender. The correlation coefficients (R) between the corneal thickness and refractive status in males were 0.16 (horizontal) and 0.12 (vertical). These values were 0.12 (horizontal) and 0.11 (vertical) of value of the relationship between the corneal thickness and axial length. In females, the correlation coefficient between corneal thickness and refractive status was 0.14 (horizontal) and 0.14 (vertical); and these values were 0.15 (horizontal) and 0.21 (vertical) of the relationship between the corneal thickness and axial length.

Corneal radius:

The mean radius of the anterior cornea was 7.93 +/- 0.28 mm (horizontal) and 7.65 +/- 0.03 mm (vertical)

in the high myopia group, and 8.06 +/- 0.19 mm (horizontal) and 7.85 +/- 0.22 mm (vertical) in mild myopia group. The vertical meridian in the high myopia group was significantly greater than in the mild myopia group ($p < 0.05$). In females with high myopia, the horizontal mean was 7.83 +/- 0.27 mm and vertical mean was 7.54 +/- 0.26 mm and these values were not significantly different from those of females with mild myopia (Table 2).

We found no significant correlation between anterior corneal radius and refractive status. The correlation coefficient between the anterior radius of the cornea and refractive status in males was 0.26 (horizontal) and 0.16 (vertical), and it was 0.08 (horizontal) and 0.18 (vertical) in females. However, there was a significant correlation with axial length in males and females with high myopia with a correlation coefficient of 0.47 (horizontal) and 0.52 (vertical) in males; and 0.54 (horizontal) and 0.50 (vertical) in females.

B) Changes in anterior chamber depth

The mean depth of the anterior chamber in males was 3.35 +/- 0.19 mm (horizontal) and 3.26 +/- 0.20 mm (vertical) in the high myopia group, and 3.20 +/- 0.20 mm (horizontal), 3.14 +/- 0.19 mm (vertical) in the mild myopia group. There was a significant difference in ACD values between these two groups in males, which revealed that the ACD of the highly myopic males was greater than that of the mildly myopic males. In females, the ACD was 3.26 +/- 0.23 mm (horizontal) and 3.16 +/- 0.22 mm (vertical) in the high myopia group; 3.10 +/-

Table 1. The Mean Corneal Thickness (mm) of Myopic Eyes

	High myopic group	Mild myopic group
Male horizontal	0.62 +/- 0.03	0.62 +/- 0.06
Male vertical	0.62 +/- 0.03	0.62 +/- 0.05
Female horizontal	0.62 +/- 0.03	0.63 +/- 0.03
Female vertical	0.61 +/- 0.04	0.62 +/- 0.03

Table 2. The Mean Anterior Corneal Radius (mm) of Myopic Eyes

	High myopic group	Low myopic group
Male horizontal	7.93 +/- 0.28	8.06 +/- 0.19
Male vertical	7.65 +/- 0.03	7.85 +/- 0.22
Female horizontal	7.83 +/- 0.27	7.84 +/- 0.19
Female vertical	7.54 +/- 0.26	7.66 +/- 0.21

0.24 mm (horizontal) and 3.06 +/- 0.23 mm (vertical) in the mild myopia group. Thus, the ACD was also significantly greater in the highly myopic eyes of females (Table 3).

The correlation coefficient between ACD and refractive status was 0.15 (horizontal) and 0.07 (vertical) in males, and 0.08 (horizontal) and 0.13 (vertical) in females. There were not significant correlation between the ACD and the refractive status in highly myopic patients of both genders. The relationship between ACD and axial length was 0.20 (horizontal) and 0.19 (vertical) in males, and 0.08 (horizontal) and 0.05 (vertical) in females. Also, no significant correlation was found between ACD and axial length in the highly myopic group, regardless of gender.

C) Changes in the chamber angles

The temporal segment of the chamber angle was significantly wider in the high myopia group, but differences in other segments of the angle were not found. The temporal segment of the mean anterior chamber angle in males was 37.42 +/- 2.90 degrees (temporal) in

the high myopia group and 32.43 +/- 4.54 degrees in mild myopia group. In both males and females, the temporal angle in the high myopia group was wider than that of the mild myopia group, and no difference was found in the other three segments of the chamber angles. The mean values of the temporal angle in females was 35.36 +/- 4.56 degrees in the high myopia group and 32.31 +/- 4.92 degrees in the mild myopia group (Table 4).

The correlation coefficients between the chamber angles and the refractive status in males were 0.08 (superior), 0.05 (inferior), 0.18 (nasal), 0.07 (temporal); and were 0.05 (superior), 0.01 (inferior), 0.04 (nasal), 0.14 (temporal) in females. The correlation coefficients with axial length were 0.07 (superior), 0.27 (inferior), 0.02 (nasal), 0.11 (temporal) in males; and 0.12 (superior), 0.03 (inferior), 0.06 (nasal), 0.02 (temporal) in females. There was no significant correlation between the four anterior chamber angles and refractive status or axial length in either males or females group.

DISCUSSION

The relationship between cornea, anterior chamber depth (ACD) and the chamber angle structures to the myopia have not been extensively studied. This may be due to the inability of current technology to measure these structures with sufficient accuracy. In this study, we used a new anterior segment image processing technique which applies the Scheimpflug principle to mea-

Table 3. The Mean Anterior Chamber Depth (mm) of Myopic Eyes

	High myopia group	Mild myopia group
Male horizontal	3.35 +/- 0.19	3.20 +/- 0.20
Male vertical	3.26 +/- 0.20	3.14 +/- 0.19
Female horizontal	3.26 +/- 0.23	3.10 +/- 0.24
Female vertical	3.16 +/- 0.22	3.06 +/- 0.23

Table 4. The Mean Degrees of Anterior Chamber Angle in Myopic Eyes

	Superior angle	Inferior angle	Nasal angle	Temporal angle
Male high myopia	33.13 +/- 3.16	34.59 +/- 2.40	32.72 +/- 2.70	37.42 +/- 2.90
Male mild myopia	32.61 +/- 3.45	32.78 +/- 4.18	32.49 +/- 2.60	32.43 +/- 4.54
Female high myopia	33.15 +/- 3.59	34.19 +/- 3.30	32.03 +/- 4.02	35.36 +/- 4.56
Female mild myopia	32.28 +/- 3.80	33.68 +/- 6.83	32.79 +/- 3.23	32.31 +/- 4.92

sure and calculate the anterior segment from each angle view.

The corneal thickness has been reported to be diminished in high myopia [1]. Tokoro and co-workers [5] found that the thickness of the myopic cornea was 0.018 mm thinner than normal cornea. In contrast, we did not find any significant difference in the central corneal thickness between highly and mildly myopic eyes in this study. The corneal thickness in our result was higher than in previous reports in which it was measured by pachymeter. This discrepancy may have been due to the measurement error caused by the Scheimpflug machine, which calculated the precorneal tear film together with the corneal thickness.

The corneal radius and its relationship to the myopia have been reported to be greater [6] or less [1] than normal, and some reports could not find any significant difference [7]. The corneal radius of highly myopic eyes was found to be greater than that of the mildly myopic eyes in this study, but only in males. Also, our results show that the corneal radius was correlated with the axial length, but not correlated with the refractive status. This discrepancy may have been caused by the steeper corneal radius in some patients which were belong to the refractive myopia.

No significant correlation was found between corneal thickness, anterior corneal radius, ACD, anterior chamber angles and either ocular refraction or axial length in our study. This findings was similar to that of a previous report [8]. However, only corneal radius was significantly correlated with axial length. This indicated that a longer axial length was associated with a greater corneal radius.

A strong tendency toward deepening of the anterior chamber in high myopia has been reported [6]. Our results showed that ACD in highly myopic eyes was deeper than in mildly myopic eyes. However, there have been rare reported of shallow anterior chamber in pathologic myopia [1]. This may have been the result of anterior protrusion of a more spherically shaped lens.

The changes in the anatomy of the angle appear to depend extensively upon the level of intraocular pres-

sure [1]. The tendency toward significantly higher intraocular pressure in myopic eyes has been reported and an open angle was also found in the majority of cases of high myopia [1]. The anterior chamber depth in highly myopic eyes was greater than in mildly myopic eyes in our study. However, we did not detect any significant difference in the chamber angles between the high and mild myopia groups, only the temporal angle was wider in highly myopic eyes. The width of the four anterior chamber angles was not correlated with the severity of myopia.

In conclusion, our results suggested that only slight changes occur in the anterior segment together with deepening of the ACD and widening of the temporal chamber angle in highly myopic eyes. These results suggested that because of some angles derangement in some high myopic eyes, these patients may have a higher risk for the development of glaucoma.

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近視眼的前眼部變化—由 Scheimpflug 影像攝影系統分析之結果

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近視眼的角膜、前房深度、前房隅角的結構與正視眼是否不同，至今尚未明瞭。為了進一步瞭解其結構並求得較佳的顯像結果，我們使用依照Scheimpflug原理製造的前眼部攝影照像機測量前眼部的構造並加以分析。我們收集117位高度近視患者(大於-8.0D)及32位低度近視患者(小於-3.0D)加以比較。每位受測者皆有屈折度及眼軸長的數據。同時使用Nidek EAS-1000測量前眼部的構造。結果顯示在中心角膜厚度方面，在高度近視及低度近視患者之間，兩者無統計學上的差別。角膜曲率方面，在高度近視群中，與眼軸長有輕微相關性。高度近視眼的角膜曲率半徑較低度近視為陡，但只見於男性。前房深度方面，高度近視眼較低度近視眼為深。前房隅角方面，上、下、鼻、顛側隅角皆與近視度數的進展無相關性。但是高度近視的顛側隅角比較寬。由以上結果顯示在高度近視眼的前眼部並無太大的變化。(慈濟醫學 1997; 9: 99-105)

關鍵語：角膜厚度，角膜曲率，前房深度，前房隅角，Scheimpflug 影像照像機

