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Analysis on the corneal thickness and anterior chamber depth of the Keratoconus using Pentacam

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Abstract

Purpose: To investigate the corneal thickness and anterior chamber depth (ACD) of eyes with Keratoconus in the Korean population with the Pentacam .
Methods: The subjects consisted of 84 eyes from Keratoconic adults aged 7-59 years during 2010. The thinnest area, apex zone, and pupil centre of the corneal thickness were measured using the Pentacam pachymetry. ACD value was also measured with Pentacam.
Results: There was a statistically significant relationship between thickness of the cornea at the apex area and the pupil centre ($p=0.0001$). However, there was no statistical difference ($p>0.5$) in the mean thickness of thinnest area, apex zone, pupil centre of cornea between right eye and left eye. Also, correlation between ACD and corneal thickness in all subjects had no statistical differences ($p>0.05$) in all subjects.
Conclusion: These results suggested that the regional thickness of cornea and ACD with Pentacam can provide correct and useful diagnostic information of the morphology of Keratoconus for the RGP contact lens and diagnosis of abnormal corneal refraction surgery.

Key words: ACD, apex area, Pentacam system, pupil center zone, thinnest area

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1. Introduction

Keratoconus has a congenital deformation of the anterior corneal morphology leading to myopia, irregular astigmatism, and eventually to a marked decrease in visual acuity[1-2].

For the clinical keratoconus research and diagnosis, the topographic system has provided excellent information about the fine structure of the cornea. The data acquired by topography tools has suggested significant important information in clinical diagnosis and management of keratoconus suspects[3], axial myopia[4], contactlenswear[5], and keratoplasty[6]. Ccorneal thickness of each region is an indicator of corneal hydration and metabolism[7].

On the other hand, the topographic results of the central corneal thickness have been used to analyze the diagnosis of the glaucoma[8] and intraocular pressure[9]. Distribution of the central and paracentral corneal thickness and curvature has been studied in the European population[10]. Especially, Age related changes in the central and peripheral corneal thickness seem to give the useful information to keratoplasty and refractive surgery[11]. Recently, the relationship between the central corneal thickness and the anterior corneal curvature has been studied through the pachymetry system[10].

Furthermore, ethnic differences in the central corneal thickness have been described throughout the European, Hong Kong Chinese, Chinese, Japanese and Americans[8]. Also, data on corneal pachymetry maps have been reported in Korean keratoconus population[12-13]. However, thethinnest, apex, and pupil center corneal thickness and anterior chamber depth values of Korean keratoconus have not been reported yet. In this study, we research characteristics of the central, apex, thinnest corneal thickness and anterior chamber depth in Korean keratoconus by using pachymetry data obtained from the Pentcam system. The purpose of our study was therefore to analysis in the thinnest, apex and pupil center corneal thickness and anterior chamber depth in Korean keratoconus subjects by the Pentacam system.

2. Materials and Methods

2.1. Subjects

This study included 84 keratoconus eyes of forty-nine Korean subjects, 35 had bilateral keratoconus and 14 had unilateral keratoconus. Keratoconus was diagnosed with both subjective criteria like stromal thinning, Vogt striae, iron ring, munson sign, scissoring on retinoscopy as well as with objective criteria like corneal curvature 47.0D or more on SimK. They have no ocular disease, medication, systemic disease, contact lens wear, and refractive surgery. The subject's age ranged from 7 to 59 years. To exclude ocular disease, we tested the visual acuity and the IOP, and examined the slit-lamp and the funduscopy.

2.2. Examination

The corneal thickness and ACD values at a distance of 5mm from central cornea were obtained by measurements of the Pentacam topography system (Bausch & Lomb, USA). The measurements were obtained for each eye. The Pachymetry was used for corneal topography measurements while the subjects were silently seated in a test room. The subjects were asked to keep both eyes open and focus on a light source in the center of the scan field. The measurements automatically operated when the correct alignment and focus of eye were achieved. The thicknesses at the thinnest area, apex zone, and pupil center

of cornea were recorded automatically and analyzed by a SPSS 14 and a micro-soft excel program. All measurements were made from 10:00 A.M. to 12:00 A.M. During the test, the temperature ranged from 18° to 21°C, and the humidity ranged from 40% to 50%. Only the scans with the quality factor of 95% or more were selected for the analysis.

2.3. Data analysis

Analyses were performed by using SPSS software. Descriptive data were expressed as mean±standard deviation. The Pearson correlation and t-test were used to compare measurements in three zones of corneal thickness and ACD. P values of less than 0.05 was considered as statistically significant.

3. Results

We acquired the corneal topographic data from 84 eyes (42 OD, 42 OS) with the mean age of 24.8±9.9 years (range 7-59 years). The mean age for the eyes was 24.3±9.2 years (range 7-54 years) for OD and 25.2±10.7 years (range 7-59 years) for OD. There was no significant difference in the mean age between OD and OS (p>0.523). The OD and OS distributions of the thinnest area, apex zone and pupil center of the corneal thickness for these subjects were summarized in Table 1, and figure 1.

Table1. The distribution of the corneal thicknesses and ACD values in Korean subjects.

Item	OD	OS	P-values
Ages	24.34±9.246	25.2±10.743	p=0.54
TA	484.90±72.644μm	482.075±64.391 μm	p=0.836
AT	495.80±72.374μm	494.375±55.666 μm	p=0.914
PZ	506.02±65.645μm	495.325±53.633μm	p=0.571
ACD	3.33±0.376 mm	3.308±0.359mm	p=0.778

thinnest corneal thickness, PA: apex zone thickness, PZ: pupil zone thickness, ACD: anterior chamber depth.

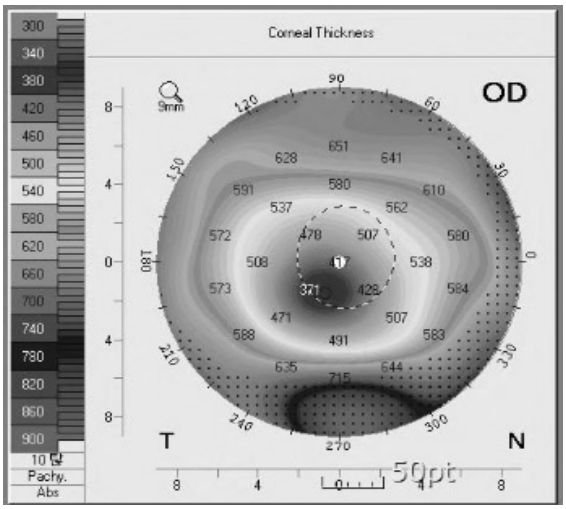

Fig.1. Typical keratoconus thickness with Pentacam topography system.

The average thinnest corneal thickness was 484.900±72.644μm (range, 549-406μm) and 482.075±64.391μm(range, 428-450μm) for OD and OS, respectively. The mean thinnest corneal thickness of all subjects was 483.489 μm (Figure 2).

There was no significant difference in the mean thinnest corneal thickness between OD and OS (P=0.836, T-test). Also the mean apex corneal thickness was 495.80±72.374μm and 494.375± 55.666μm for OD and OS, respectively. There was no significant difference in mean apex corneal thickness between OD and OS (p=0.914). Also the average pupil center thickness was 506.02±65.645μm and 495.325±53.633μm for OD and OS, respectively. There was no significant difference in mean pupil center thickness between OD and OS (p=0.571). On the other hand, mean of anterior corneal depth was 3.33±0.376 mm and 3.308±0.359mm for OD and OD. There was no significant difference in mean anterior chamber depth between OD and OS (p=0.778). However, correlation between ACD and corneal thickness in all subjects was had strong statistical differences (p>0.05) in all subjects.

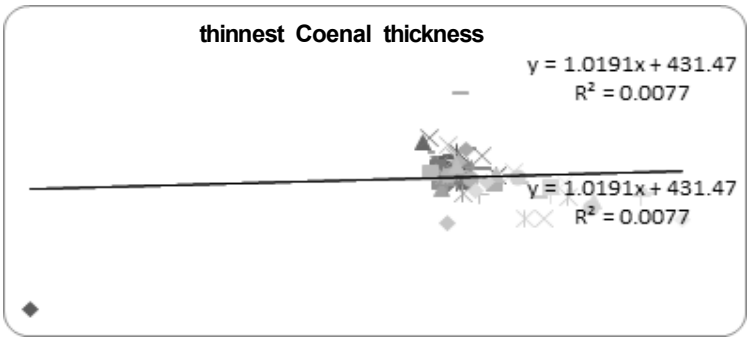

Fig. 2. The thinnest corneal thickness of keratoconus subjects

Table 2 showed that the correlation between thinnest cornea and anterior chamber depth had a statistical significance differences in OD (p=0.026) and OS (p=0.004, t-test). On the other hand, Table 2 showed that the correlation between apex region and anterior chamber depth had a statistical significance differences in OD (p=0.035, t-test) and OS (p=0.010). At the same time, Table 2 showed that the correlation between pupil zone and anterior chamber depth had a statistical significance differences in OD (p=0.009, t-test) and OS (p=0.004). As a results, in all subjects, Table 2 showed that the correlation between corneal thickness and ACD had strong significant differences (p>0.1).

Table 2. The relationship between corneal thicknesses and ACD values in Korean subjects.

Item	TA & ACD	AT & ACD	PCT & ACD
OD	0.026*	0.035*	0.009
OS	0.004*	0.010*	0.004*

*p<0.5

TA: thinnest corneal thickness, PA: apex thickness, PZ: pupil center thickness

Figure 3 showed thath the correlation between thinnest zone (TZ) and apex region (AR) of the corneal thickness had not a statistical significance differences (p=0.27, t-test). However, figure 4 showed thath the correlation between thinnest zone (TZ) and pupil center (PC) of the corneal thickness had a strong statistical significance differences (p=0.06). Also, TZ(x) and PC(Y) were positively correlated, and correlation coefficient was moderate (y=0.9006x + 56.359; p=0.06; Fig.4).

On the other hand, figure 5 showed thath the correlation between apex region (AR) and pupil center (PC) of the corneal thickness had not a statistical significance differences (p=0.47).

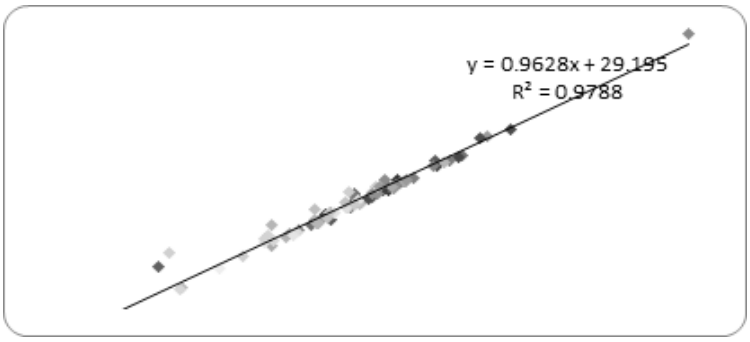

Fig.3. Correlation between the change in the thinnest zone (TZ) and apex region (AR) of the corneal thickness.

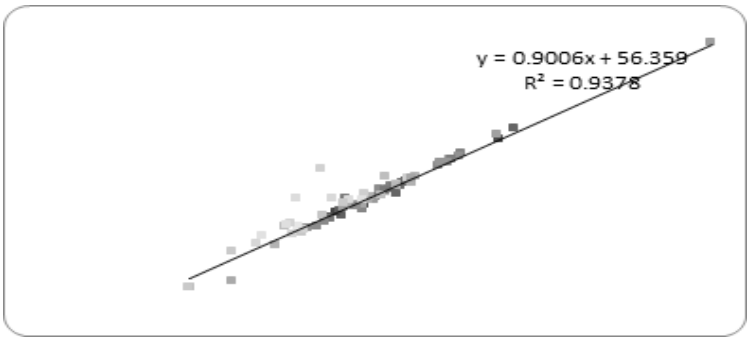

Fig.4. Correlation between the change in the thinnest zone (TZ) and pupil center region (PC) of the corneal thickness. P=0.06

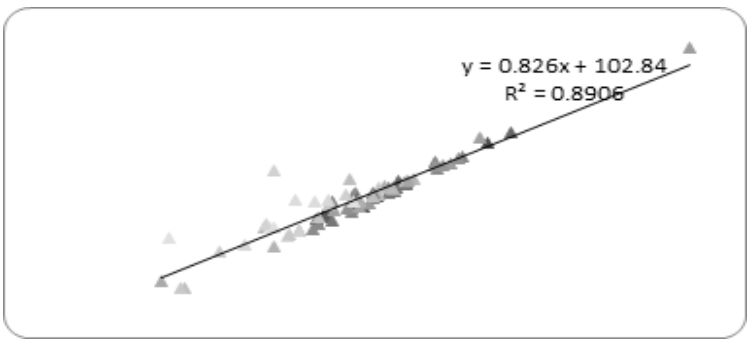

Fig.5. Correlation between the change in the apex region (AR) and pupil center region (PCR) of the corneal thickness.

4. Discussion

In this study, we carried out and analyzed the data of the relationship between corneal thickness and anterior chamber depth in keratoconus Korean population. For this study, we used the topography system because it easily measures the corneal thickness across the entire surface corneal shape[6]. We believe that topography measurements of corneal thickness are more reliable than ultrasound pachymetry tests. Because the defect of the ultrasound pachymetry is that the target of fixation light and the test area are only dependent on the user[14], therefore, some results of ultrasound pachymetry are unstable. On the other hand, we made specia[15] care to avoid outside condition changes that could change the physiologic corneal status because under stable physiologic states the corneal thickness is constant[15]. We especially made care to avoid situations where corneal hydration might be altered because such conditions have been associated with more changes in corneal thickness[10]. Therefore, temperature range during test was maintained as the same conditions (18℃ to 21℃), also the same applied for relative humidity (ranging from 40% to 50%). Furthermore, we performed the corneal topography test at a constant time to avoid the diurnal variation in corneal shape[16]. In the last few years, knowledge of corneal thickness has become increasingly important in clinical diagnosis and treatment[17]. So, pachymetry using the topography System become increasingly established. It shows good reproducibility and accuracy[18]. In this study, we present specific reference values for the Pentacam system and investigate the influence of both eyes on the corneal morphology. In our study, the mean thinnest corneal thickness at all subjects was 483.488±9.995μm. Haque et al.[19] study showed that the mean central corneal thickness of keratoconus was 494.2±50.0μm for Canadian, 451.07±61.01μm for Korean[12] from keratoconus population. We find out that the mean central corneal thickness of Koreans keratoconus was similar to Canadian. Maybe, we think that these results were not affected by the genetics factors of the difference race.

In normal subjects, Florian et al.[17] found that the sex or the side had significant influence on the central corneal thickness. Price et al.[20] had not detected differences in the central corneal thickness between female and male subjects. Nevertheless, Cosar et al.[8] detected significant differences in the central corneal thickness among hyperopic, myopic, emmetropic subjects, emmetropic corneas being the thinnest. In our study, we found that the central corneal thickness have not a significant difference between OD and OS in mean corneal thickness. However, we can find out that the mean cornea thickness at the thinnest (483.488±68.518μm), apex region (494.088±64.02 μm) and pupil center (500.673±59.639μm).

On the other hand, La Rossa FA et al. [21] reported that young Europeans differ in corneal thickness values between populations. They observed that African American patients had lower central corneal thickness values than Caucasian patients. However, we can find out that the mean corneal thickness of Korean keratoconus subjects have a similar to Canadian keratoconus population. As a results, we can suggest that corneal thickness of keratoconus have no ethnic problem.

The corneal thickness and anterior chamber depth knowledge of corneal data is becoming more important. Also the increasing use of corneal diagnosis of refractive surgery is responsible for this. Information about corneal thickness and ACD thus permits the postoperative refractive power to be predicted within certain limits.

In our study, we cannot identify a statistically significant difference at corneal thickness between

OD and OS measurements. Also we cannot identify a statistically significant difference at ACD between OD and OS measurements.

Arntz et al. [22] reported that the ACD of keratoconus subjects was 3.51mm. But, Leeatal.[12] was 3.31mm in Korean keratoconus population. On the other hand, we find out that the mean of anterior corneal depth in Korean keratoconus subjects was 3.33±0.376 mm and 3.308±0.359mm for OD and OD. In contrast, we found out that the corneal thickness and ACD had statistically significant differences in all subjects (P=0.00).

Florian et al. [17] reported that the peripheral corneal thickness may also prove useful in priding a better match between donor and host cornea and the information are related to anatomic changes also seems important to us with regard to refractive surgery. We think that corneal thickness and ACD was very useful information in regards to corneal diagnosis and treatment in clinic. However, several studies have not researched differences in central corneal thickness between female and male subjects[5)10)20)]. Nevertheless, we analyzed the difference between the mean central and ACD thickness obtained of each eye or individual. The difference between the central thickness and the ACD was also analyzed. In the corneal thickness and curvature studies, Giraldez Fernandez et al.[23] indicated that the change in central and paracentral corneal thickness was strongly correlated with corneal curvature, except for 2mm nasal and superior semi-meridians. ur study showed that the relationship between the several corneal thickness and ACD was statistically significant from 7 to 59 years of age (p=0.000).

5. Conclusions

In this study, we believe that the several values of Pentacam data were suitable for comparative study of corneal thickness in the Korean keratoconus subjects because they represent a both eyes cross-section of the keratoconus population. Also, the topographic study of keratoconus Korean subjects has shown that the difference between the several corneal thickness and ACD have significant difference (p>0.01) at OD and OS of all subjects. On the other hand, the OD and OS related changes in several corneal thickness in all subjects didn't have a statistically significant difference.

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