Correlation between Central Corneal Thickness and Refractive Indices in a Laser Refractive Surgery Population

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Abstract

***Purpose*:** To evaluate the correlation of central corneal thickness (CCT) with refractive error and keratometry in a group of patients eligible for laser keratorefractive surgery, which may serve as a bias in studies on intraocular pressure (IOP) measurement

***Methods*:** In a cross sectional observational study, the right eyes of 340 patients who underwent laser keratorefractive surgery during the year 2006 were included. The CCT was measured with ultrasound pachymetry. The refractive error, including sphere, cylinder, and spherical equivalent (SE), based on cycloplegic refraction. Keratometry (K) readings were derived from topography printouts. The correlation between refractive indices and CCT was investigated in all cases and also in refractive subgroups.

***Results*:** The mean±SD age of the patients was 28.7±7.7 years, ranging from 18 to 55 years. Seventy percent of the patients were female. The mean cycloplegic SE and CCT were -3.2±2.3 diopters (D) and 549.5±33.6 µm, respectively. A borderline negative correlation between age and CCT was observed (r=-0.1, P=0.05). None of the other parameters including gender, amount of refractive error (Sphere, cylinder and axis), and K-readings showed any significant correlation with CCT (P>0.05) in the whole group or different subgroups.

***Conclusion*:** In this refractive surgery population, refractive indices did not show any significant correlation with CCT. This suggests that the correlation between CCT and IOP which has been found by other investigations in similar populations is in accordance to our findings.

***Keywords*:** Central Corneal Thickness, Corneal Curvature, Keratometry, Refractive Error, Keratometry reading

Iranian Journal of Ophthalmology 2010;22(4):43-48 © 2010 by the Iranian Society of Ophthalmology

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Received: June 15, 2010
Accepted: November 4, 2010

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This study was presented at the 2007 ESCRS meeting in Stockholm, Sweden.
Financial Support: None
Financial Disclosure: None

Published by Otagh-e-Chap Inc.

Introduction

The assessment of corneal thickness has gained importance in different fields of ophthalmology in recent years, and measurement of the central corneal thickness (CCT) has become an important part of a routine examination in glaucoma management and refractive surgery. Many studies have shown the effect of corneal thickness and characteristics on measurements of intraocular pressure (IOP) performed by most tonometry techniques.[1-9] Also, low CCT values have been suggested as a risk factor for glaucoma.[10-12] It is therefore essential to determine factors associated with the corneal thickness. Some studies have evaluated associations between the CCT and different factors such as the corneal curvature, the amount of refractive error, age, gender, and race. In many cases, the results are inconclusive and at times, conflicting. The present study was designed to investigate any possible association between refractive errors, corneal curvature, and the CCT.

Methods

In a retrospective approach, 400 records of patients who had undergone laser refractive surgery at Noor Eye Hospital during 2006 were reviewed. From these, data on the right eyes of 340 patients were extracted and used in the analyses. Records of the 60 excluded patients lacked some of the required data.

The extracted data included demographic information and results of the preoperative cycloplegic refraction tests including the spherical error, the cylinder and the spherical equivalent (SE). All recorded preoperative CCT measurements had been done with an ultrasonic pachymeter (UP1000, Nidek). Preoperative keratometry (K) readings were derived from topography maps (EyeSys-2000 topographer, EyeSys Laboratories, Houston, Texas, USA) and for each patient the maximum and minimum K-reading and their mean (Mean K) was entered in the analyses.

Based on their refraction results, patients were divided into five groups: eyes with cycloplegic refractive cylinder≥4.0 diopters (D) were fit in the astigmatic group. The rest of the cases were divided into 4 groups based on the cycloplegic SE: low myopia (0.0>SE>-3.0 D), moderate myopia (-3.0≥SE≥-6.0) high myopia (SE<-6.0) and hyperopia (SE>0.0).

Data analysis was done with the SPSS software version 11.0. Analysis of variance (ANOVA) was used to determine age differences in different refractive subgroups. The χ^2 test was performed to assess gender differences in refractive subgroups. Linear regression analysis was used to detect any possible association between CCT and other studied parameters. Difference of SE between two genders was probed with the T-test. In all analyses, a P<0.05 was considered statistically significant.

Results

Of the 340 patients, 69.7% were women and 30.3% were men. The mean age of the study subjects was 28.7±7.7 (Range, 18 to 55) years. The mean preoperative cycloplegic SE was -3.2±2.3 (Range, -10.63 to +4.75) D, and the mean preoperative CCT in the total population was 549 ±33.6 (Range, 467 to 672) µm. The average mean K in these 340 people was 43.9±1.5 (Range, 40.1 to 47.6) D. The gender ratio, the mean age, SE, CCT, mean K, and the number of patients in the whole group and each refraction group is summarized in table 1.

In studying the refraction, analysis of variance showed a statistically significant difference in the age of the different refraction groups with the age being highest in the hyperopic group (f=38.8, P<0.001). In the linear regression analysis, there was a 0.01 D increase in the SE per year of age in the total sample (P<0.001). There were no significant differences among refractive groups in terms of gender (χ^2=5.7, P=0.224). In the total sample population, the mean SE was -3.36±2.26 D in women and -2.87±2.46 D in men (t=-1.78, P=0.077), which were not statistically significantly different.

The main objective of the study was to determine any possible correlation between CCT and refractive indices. Table 2 contains data on the correlation between the cylinder error and the CCT in the astigmatic group (Astigmatism≥4.0 D) and the SE and the CCT in the other 4 refraction groups, and shows there were no statistically significant correlation between CCT and cylinder or SE in studied subgroups (Pearson test, P>0.05). Based on linear regression analysis, the correlation between SE and CCT was not statistically significant either (r=0.89, P=0.1, β=-0.006).

In the analyses with the keratometry readings, we found no significant correlation between CCT and the minimum, maximum, or mean K readings derived from EyeSys topography maps in any refractive group or the total sample (Pearson test, P>0.05).

In terms of age and gender, there was a borderline inverse correlation between age and CCT in the linear regression analysis (r=-0.1, P=0.053, β=-0.46). The mean CCT was 551±33.9 µm in women and 546±32.8 µm in men. The inter-gender difference in CCT was not statistically significant (P=0.212, t=1.25).

Regression analysis also showed a significant correlation between age and mean K; 0.033 D increase in mean K per year of age (χ^2=0.165, P=0.002, 95% confidence interval= 0.012 to 0.053).

Table 1. The number of patients, gender ratio, and the mean age, cylinder error, spherical equivalent, central corneal thickness, mean keratometry reading in each of the 5 refraction groups

	Number	Gender ratio	Age (Year)	SE (Diopter)	CE (Diopter)	CCT (Micron)	Mean K (Diopter)
Low myopia (0.0>SE≥-3.0)	130	2.25	28.3±6.5	-2.0±0.7	0.8±0.9	549±34	43.8±1.5
Moderate myopia (-3.0>SE≥-6.0)	152	2.8	27.6±7.0	-4.3±0.8	0.8±0.8	548±31	43.9±1.6
High myopia (-6.0>SE)	28	2.5	26.6±5.8	-7.6±1.2	1.5±0.9	560±40	44.7±1.3
Hyperopia (SE>0.0)	14	1	46.2±6.0	2.9±1.4	0.8±0.8	550±39	44.1±1.3
Astigmatism (CE≥4.0 D)	16	1.14	30.7±8.8	-1.0±3.0	4.4±0.4	546±29	43.7±1.2
Total	340	2.32	28.7±7.7	-3.2±2.3		549±33	43.9±1.5

CE: Cylinder error
SE: Spherical equivalent
CCT: Central corneal thickness
Mean K: Mean keratometry reading

Table 2. Correlation between the cylinder error and the central corneal thickness in the astigmatic group, and the spherical equivalent and the central corneal thickness in the other 4 refractive groups

	Pearson coefficient	95% confidence interval	P-value	r
Low myopia (0.0>SE≥-3.0)	0.000	-0.004 to 0.003	0.932	-0.008
Moderate myopia (-3.0>SE≥-6.0)	-0.001	-0.005 to 0.003	0.728	-0.028
High myopia (-6.0>SE)	-0.004	-0.016 to 0.009	0.563	-0.116
Hyperopia (SE>0.0)	-0.005	-0.022 to 0.022	0.627	0.137
Astigmatism (CE≥4.0 D)	0.000	-0.008 to 0.009	0.966	0.039
Total	-0.006	-0.014 to 0.001	0.101	-0.089

CE: Cylinder error
CCT: Central corneal thickness
SE: Spherical equivalent

Discussion

Assessment of the corneal thickness plays an important role in glaucoma management and refractive surgery. The CCT has a wide range among the normal population, and many factors have been reported to be correlated with it. Most reports agree that a correlation exists between CCT and IOP measurements with most tonometers. While new tonometers are gradually introduced, and novel techniques are used to measure the IOP, many studies are conducted to compare them with the Goldmann applanation tonometer which is still considered the standard method, and determine the factors that might affect their performance. The factors investigated in these studies include the corneal thickness, corneal curvature, refractive errors, and biodynamic properties of the cornea such as corneal hysteresis (CH), and the corneal resistance factor (CRF), and how they affect the IOP, and its measurement readings. Reported results are inconclusive, and some contradict each other. It is still not clear which factors must be considered when measuring the IOP with different methods. The CCT has been found to influence IOP readings, and if other factors such as refractive error, corneal curvature, and biomechanical properties are correlated with the CCT, they can serve as a confounding factor in these studies. In the present study, we aimed at finding any possible correlation between the CCT and refractive errors, and corneal curvature.

The mean CCT in the studied eyes was 549±33.6 µm. Data on the studied eyes was extracted from a population of patients who had had refractive surgery, and therefore did not include extreme values. Still the mean thickness was similar to that reported in population-based studies. Mercieca et al[13] performed a study in Africa and reported a mean CCT of 532 µm in their population. The mean CCT in the study by Aghaian et al[14] was 549.9 µm for the total studied population, 555.6 µm for the Chinese subgroup, 550.4 µm for Caucasians, 550.6 µm for Filipinos, 548.1 µm for Hispanics, 531.7 µm for the Japanese, and 521.0 µm for the black people. In one study, Suzuki et al[15] reported the mean CCT in a Japanese population to be 517.5±29.8 µm. In the study by Nemura and colleagues,[16] the mean CCT was 516±33 µm. The CCT seems to vary in different races.

In the present study we found a borderline negative correlation between age and CCT. Lenskul et al[17] reported that CCT decreases 0.28 microns per year. Reduction of CCT with advancing age has been shown in many studies. Foster et al[18] reported a significant decrease in CCT with age: about 5 µm / decade in men and 6 µm / decade in women but some studies[19,20] failed to show this effect. However, since our study sample comprised rather younger people seeking keratorefractive surgery, results regarding the effect of age on the corneal thickness are limited to the studied age range.

In our study we did not find any significant correlation between CCT and gender (mean CCT 546±32.8 µm and 551±33.9 µm in men and women, respectively, $P>0.05$). Many studies have found higher CCT readings among men compared to women.[15,16,21-23] The difference may be attributed to the different sampling methods.

Not many studies have evaluated the relationship between CCT and refraction. In the present study, we found no significant association between the CCT and the amount of refractive error. This had previously been reported by other studies as well.[14,23-28] However Suzuki et al[15] found a weak negative correlation between CCT and refractive error in men but not in women (Higher CCT in myopic eyes than emmetropic eyes in men, $r=-0.045$). Nomura et al[16] also reported higher CCT values in moderate myopia than in emmetropic and hyperopic eyes. Brandt et al[29] reported a significant correlation between CCT and refraction ($r=-0.10$, $P=0.0008$) in the ocular hypertension study which was not significant in the multivariate mixed model. In contrast, Nemesure et al[30] found that the central cornea was thinner in more negative refractive errors than less negative or more positive refractive errors. These very contradictory results show the need for further studies in this field.

In the present study we found no correlation between CCT and the mean k. Studies which evaluated the relationship between CCT and keratometry show similar contradictions. Torres et al[31] found no difference in CCT based on K-readings. Altinok et al[32] reported finding a relationship between CCT with horizontal and vertical

K-readings in the correlation analysis, but in the multivariate regression analysis only the vertical K-reading appeared to correlate with the corneal thickness.

Conclusion

In conclusion, in our refractive surgery population, CCT neither had a significant correlation with refractive errors nor with K-readings. The shortcoming of the present study, however, was its sample population, and so its results could only be applicable to similar keratorefractive populations.

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