

Relationship between Corneal Thickness, Corneal Curvature, and Intraocular Pressure before and after Laser Treatment for Simple Myopia

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Abstract

Purpose: To determine the relationship of central corneal thickness (CCT), curvature (CC), and intraocular pressure (IOP) as determinative factors for corneal biomechanics and in refractive surgery.

Methods: The study investigated 48 eyes from subjects who visited the Excimer Laser Surgery Clinic at the Department of Ophthalmology. The refractive error, IOP, CCT, and CC were measured in all participants. After 3 months, all examinations were repeated.

Results: Linear regression demonstrated a significant positive relationship between pre- and postoperative CCT, CC, and IOP values. The IOP showed a significant correlation with CCT ($P=0.033$) for pre-PRK, but no significant relationship was seen post-PRK. The CCT also correlated significantly with CC both pre- and post-PRK ($P<0.05$).

Conclusion: The IOP was significantly correlated with CCT before PRK, but its behavior differed after surgery. Nearly the same correlation was seen between CCT and CC before and after the PRK; nevertheless, IOP measurements should be calculated or estimated more precisely after PRK based on CCT corrections. (*Eye Science 2014; 29:70–73*)

Keywords: central corneal thickness; intraocular pressure; photorefractive keratectomy; simple myopia

Introduction

The use of lasers for refractive surgery of the

cornea has increased in the Kurdistan region of Iraq in recent years. This is due to a better understanding of the corneal biomechanical properties-especially corneal thickness (CCT), corneal curvature (CC), and intraocular pressure (IOP)-which are highly important in refractive surgery for determining patient eligibility, choice of surgical technique, risk for late complications, and the amount of ablation.

Myopia is now a common and almost inevitable pathologic change of the eye, especially in Asian countries undergoing rapid development^{1,2}. Both genetic and environmental factors are thought to contribute to myopia³. The increasing rates of myopia have also increased the popularity of refractive surgery such as photorefractive keratectomy (PRK). Although the true etiology of myopia is still unknown, the cornea is responsible for approximately two-thirds of optical refraction and its role in myopia has consequently been studied intensely over the years¹⁻³. Consequently, when undertaking refractive surgery procedures to correct myopia, CCT is an important consideration in order to prevent the cornea from becoming too thin after the treatment⁴. The normal characteristics of the cornea vary from one patient to another; depending mostly on the ethnicity of the population. Standard values and ranges of CCT and their relationship to the degree of myopia among normal populations should be available in every country, see Table 1.

On the other hand, interest has also increased in CCT because of its influence on the accuracy of intraocular pressure (IOP) measurement. Previous studies have demonstrated a positive correlation between

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CCT and IOP measured by applanation, such that true IOP is overestimated in thicker corneas and underestimated in thinner ones⁹.

In general, the conclusions of investigation into the relationship between CCT and corneal curvature (CC) drawn in several earlier studies can be divided into three groups: the first^{10,11} reported that CCT was positively correlated with CC; the second group^{12,13} showed a weak correlation between CCT and CC; and the third group^{12,14-16} reported no correlation between CCT and CC. Different methodologies could explain these discrepancies among previous investigations.

The primary aim of the present study is to determine a standard value for corneal thickness and to investigate the relationship of CCT and CC with IOP among patients with simple myopia in Arbil City in the Kurdistan region of Iraq.

Materials and methods

This is a prospective cross sectional study of 48 eyes (27 males and 21 females) selected from the patients who visited the Excimer Laser Surgery Clinic at the Department of Ophthalmology, Aljumhory Hospital, Arbil City, Kurdistan Region-Iraq, from August 2011 to August 2012. The following data were collected from the preoperative examination: personal details, age, sex, refractive error, IOP, CCT, and CC.

The refractive error was measured using an autorefractor/keratometer (TOPCON-KR-8800). The IOP was measured with a computerized Non-Contact Tonometer (NCT-NIDEK, CT-80, Japan). The CCT was measured with an ultrasound pachymeter (NIDEK-UP1000) and the smallest measurement was used. The CC was measured using an OPD SCAN-II for corneal topography. Surgery was performed with an excimer laser instrument (QUEST NIDEK, Gamagori, Japan). We conducted a postoperative examination, including IOP, CCT and CC measurements, 3 months after the operation.

The paired *t*-test was used to compare preoperative (pre-PRK) and postoperative (post-PRK) IOP, CCT, and CC values. The Pearson correlation coefficient was used to verify the correlations between the IOP and CCT preoperatively and postoperatively, be-

tween the IOP and CC preoperatively and postoperatively, and between the CCT and CC preoperatively and postoperatively. A value of $P < 0.05$ indicated statistical significance.

Results

The distribution of the refractive error for simple myopia is shown in Figure 1. The CCT, CC, and IOP values obtained pre- and post-PRK are presented in Table 2.

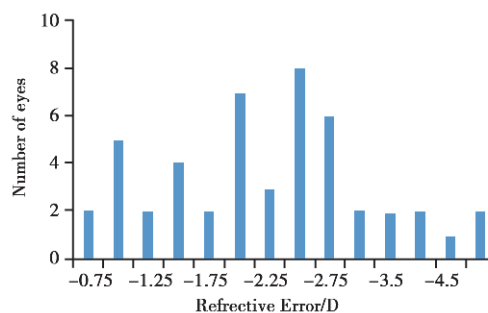


Figure 1 Simple myopic refractive error distribution in participants

Table 1 The CCT (μm) for different ethnicities

Mean CCT/ μm	Race	Year	Author
530.2	Sudanese	2009	Nazim et al. ^[5]
555.1	Chinese	2002	Wong et al. ^[6]
525-557	Hispanic	2013	Ortiz et al. ^[7]
531.7	Japanese	2011	Archana et al. ^[8]
550.6	Filipino	2011	Archana et al. ^[8]

Table 2 The mean, standard deviation, value of paired *t*-test, and *r* and *P* values for CCT, IOP, and CC pre- and post-photorefractive keratectomy (PRK)

	Mean	SD	<i>r</i>	Sig
CCT(μm)-Pre	556.17	26.494	0.628	$P < 0.001$
CCT(μm)-Post	513.94	35.410		
IOP(mmHg)-Pre	15.19	1.511	0.671	$P < 0.001$
IOP(mmHg)-Post	12.54	1.429		
CC mm)-Pre	7.6721	0.27341	0.751	$P < 0.001$
CC(mm)-Post	8.0767	0.39555		

CCT=central corneal thickness, CC=corneal curvature, IOP=Intraocular Pressure; *r*=correlation coefficient.

Linear regression indicated a significant positive relationship between pre- and post-operative values for CCT, CC, and IOP ($P < 0.001$)

Discussion

The evaluation of the cornea in refractive surgery

Table 3 The values of r and P for different relationships between IOP, CCT, and CC pre- and post-photorefractive keratectomy (PRK)

	Pre-PRK		Post-PRK	
	r	P	r	P
IOP vs. CCT	-0.308*	0.033	-0.174	0.236
IOP vs. CC	-0.059	0.692	-0.146	0.321
CCT vs. CC	0.355*	0.013	-0.298*	0.039

* 2-tailed statistical significance by Pearson's correlation test. CCT=central corneal thickness; CC=corneal curvature; IOP=Intraocular Pressure; r =Pearson's correlation coefficient.

is very critical. Characteristics of the cornea can be divided into several aspects, such as the geometrical and optical properties. The geometrical property is a basic property and defines the gross anatomy of the cornea. In contrast, the optical property is an intrinsic property and defines how light should be refracted through the corneal surface. These properties are very important to the refractive surgeon, as a good surgical outcome requires that both properties be within normal limits¹⁷.

The CC and CCT are among the most important geometrical properties of the cornea. Therefore, the correlations among the biometric parameters CCT, CC, and IOP were tested with a Spearman coefficient of correlation. A two-tailed probability of 0.01 was considered statistically significant. As shown in Table 2, a significant negative correlation was observed between IOP and CCT ($r=-0.308, P=0.033$) pre-PRK, but no insignificant correlation ($r=-0.174, P=0.236$) was observed post-PRK. Figure 1 shows that a thick CCT had the largest IOP value pre-PRK, whereas a thin CCT had the smallest IOP value post-PRK. This reduction in IOP could be caused by the change in corneal thickness, but it most likely also arose due to a change in corneal rigidity¹⁸.

Agudelo et al¹. suggested that the IOP reduction could be explained by a reduction in the elastic forces of the eye walls. Elastic forces of a structure are quantified by Young's elasticity modulus and by thickness and length. The observed decrease in IOP with a decrease in CCT is in good agreement with the results of Change et al⁹. who indicated that patients with thin CCT may be at greater risk of being undertreated because these patients have the largest chance of having a clinically significant underesti-

mation of their IOP. The lack of statistical significance shown in Figure.1 between IOP and CC in both pre-PRK ($r=0.059, P=0.692$) and post-PRK($r=-0.146, P=0.321$) conditions agrees with the findings of Ehlers et al²⁰. who reported no relationship between CC and IOP in their study of 29 eyes. On the other hand, the CCT showed a positive significant correlation with CC pre-PRK ($r=0.355, P=0.013$) and a negative but not statistically significant correlation in the post-PRK condition ($r=-0.298, P=0.039$), see Figure 8. Similar results were reported by Tomidokoro et al²¹. in the Tajimi Study from Japan and by Chen et al²². in the Taipei study from Taiwan.

In conclusion, the present study demonstrated that the IOP after PRK was decreased in proportion to the corneal thickness and the decrease in corneal curvature when compared with the preoperative IOP. Linear regression demonstrated a significant positive relationship between pre- and postoperative (statistically significant $P<0.001$, student's t -test) values for the CCT, CC, and IOP. No relationship was evident between CC and IOP, whereas CCT correlated positively with CC pre-PRK and negatively (but not significantly) post-PRK. A significant negative correlation was noted between IOP and CCT pre-PRK, but no significant correlation was found post-PRK.

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