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The relation between central corneal thickness and axial length in a sample of Erbil population

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Ari Hassib Muhammad* Ahmed Kareem Joma ** Ahmed Ismail Abdulgani **

Abstract

Background and objective: A thin central corneal thickness has been reported to be a risk factor for developing primary open-angle glaucoma. This has led to a hypothesis that thinning of the cornea may be an indication of generalized weakness of the ocular integument. This study was conducted to explore the relationship between central corneal thickness and axial length in a sample of Erbil population.

Methods: This is an observational cross sectional prospective study that was conducted from October 2012 to March 2013 and included 260 eyes of 130 patients. The mean age (± SD) was 37.8 ± 17.7 years for males and 35.4 ± 15.5 years for females. Axial length was measured with A-scan ultrasound biometry and central corneal thickness with ultrasonic Pachymeter.

Results: The mean central corneal thickness (± SD) was 542.8 ± 36 μm in male eyes and 530.1 ± 32.5 μm in female eyes. The mean axial length (± SD) was 23.38 ± 1.1 mm in male eyes, 23.15 ± 1.2 mm in female eyes. Central corneal thickness was not correlated with axial length (Pearson correlation coefficient r = 0.037, *P* = 0.558).

Conclusion: Central corneal thickness and axial length of the eye are two independent measurements. Thin corneas are not related to longer eye.

Keywords: Central corneal thickness, Axial length, Age, Sex.

Introduction

The axial length (AL) of the eye is the distance between the anterior and posterior poles of the eye,[1] and it is typically defined as the distance from the anterior corneal surface to the anterior surface of the retina.[2,3] In vivo, it is measured either by ultrasonography or by partial coherence interferometry. The AL of the eye at birth is approximately 17 mm and reaches approximately 24 mm in adulthood. It is typically longer than 24 mm in myopes and shorter than 24 mm in hyperopes. Each one millimeter of change in AL of the eye corresponds to approximately 2.5 diopters (D) change in refractive power of the eye.[4] From birth to age six years, the AL of the eye grows by approximately 5 mm, and one might expect from this a high prevalence of myopia in infants. However, most children are actually emmetropic, with only a 2% incidence of myopia at six years. This phenomenon is due to a still undetermined mechanism called emmetropization. During that first six years of life, a compensatory loss of 4 D of corneal power and 2 D of lens power keeps most eyes close to emmetropia. It appears that the immature human eye develops so as to reduce refractive errors. The cornea is a transparent, avascular tissue that measures 11-12 mm horizontally and 10-11 mm vertically. Its refractive index is 1.376, although, in calibrating a keratometer, a refractive index of 1.3375 is used to account for the combined optical power of the anterior and posterior curvatures of the cornea. The average radius of curvature of the central cornea is 7.8 mm. The cornea thus contributes 74%, or 43.25 D, of the total 58.60 dioptric power of a normal human eye.[5] Normal central

* Erbil directorate of health, Erbil, Iraq
** Department of surgery, College of medicine, Hawler Medical University, Erbil, Iraq

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corneal thickness is 490-560μm.[6] Central cornea thickness (CCT) is an important indicator of corneal health status and it is essential tool in the assessment and management of corneal disease and helps to estimate the corneal barrier and endothelial pump function.[7] Since the first description of optical pachymetry in the 1950s, measurements of central corneal thickness (CCT) have become part of the clinical evaluation of ophthalmic patients.[8] A pachymetry is an ultrasonic device that uses ultrasound to determine the thickness of the cornea in any given location. Over the years, the field of pachymetry has developed further with the introduction of new and more sophisticated pachymeters.[7] With the advent of laser refractive surgery, there has been an increased interest in CCT, because an accurate measurement of CCT is essential in assessing a patient's eligibility for laser refractive surgery and in preventing possible surgical complications.[9] CCT is also a measure of corneal rigidity and consequently has an impact on the accuracy of intraocular pressure (IOP) measurement by Applanation tonometry. Numerous studies have demonstrated that thicker corneas with greater rigidity may offer a greater resistance when subjected to Applanation, resulting in a falsely higher IOP reading.[10-12] In fact, many studies have suggested that CCT is greater in patients with ocular hypertension than in the general population.[13-16] The cornea consists of the following layers; (i) the epithelium, which is stratified squamous non-keratinized type, (ii) the Bowman layer, which is a cellular, (iii) the stroma, which consists of regularly orientated layers of collagen fibrils in ground substance, (iv) the Descement membrane, which consists of latticework of collagen fibrils and (v) the endothelium, which consists of a single layer of hexagonal cells.[17] The mean corneal thickness varies with race, averaging roughly 536 μm for African American patients and 553 μm for whites. The mean central thickness is also around 550 μm in both Asian and Hispanic population.[18] A thin CCT has been reported to be a risk factor for developing primary open-angle glaucoma among ocular hypertensive eyes.[19] Association between thin cornea and weak sclera contributing to vulnerability of lamina cribrosa has been postulated.[20] This fact has led to the postulation that CCT is a predictive factor in the progression to glaucoma as well as a risk factor in glaucomatous eyes.[21] This has further led to a hypothesis that thinness of the cornea may be an indication of generalized weakness of the ocular integument associated with longer eyes with a thin scleral bed of lamina cribrosa.[22] To date, no study has been conducted among Erbil population to determine the CCT and AL and their relationships. The aim of this study was to explore the relationship between central corneal thickness and AL of the eye and to determine whether there is an association between corneal thickness and AL of human eyes with age and sex.

Methods

This cross sectional study was conducted at the outpatient clinic of Erbil and Rizgary teaching hospitals during the period between October 2012 and March 2013. Two hundred sixty eyes of 130 patients were randomly chosen from patients visiting both hospitals from different locations of Erbil city. Subjects included in this study were those who had healthy eye with normal clear cornea. Patients with pre-existing ocular pathologies, history of contact lens wear, history of previous ophthalmic surgery, trauma, patients with diabetes, ectesia, high myopia, high IOP, infections or inflammatory conjunctival or uveal disease, keratoconus and other corneal dystrophy along with known glaucomatous subjects were excluded from the study. Slit lamp examination was done to rule out corneal and anterior segment pathologies. Posterior segment examination was done by indirect ophthalmoscopy using + 90 Diopter lenses. The IOP was measured using Topcon CT-80 air puff

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tonometry. Refraction was done using Topcon KR-8800 autorefracto-keratometry. Best corrected visual acuity was obtained with Snellen's chart. After anesthetizing the cornea with topical tetracaine 0.5% and the subject was comfortably seated with the head upright looking in primary position of gaze looking to a colored point on the wall behind the devices, AL was taken using biometry by contact A-scan ultrasound Tomey AL-100 and measured in mm. The probe was sterilized with 70% alcohol and placed in the center of the topically anesthetized cornea perpendicular to the pupil axis. Three readings were taken for each patient. CCT was measured with ultrasonic Pachymeter SP-100, probe frequency of 20 MHz. The probe was sterilized with 70% alcohol. The Pachymeter probe was placed on the center of the cornea. Centration of the pachymetry on the cornea was judged using the pupil along the visual axis. Five time application was done for each eye, at each application the Pachymeter recorded three readings and displayed the average, the smallest was considered as that corresponding to. the real center of the cornea. The study proposal was approved by the Research Ethics Committee of the College of Medicine at Hawler Medical University A written consent was obtained from every patient to participate in the study. All selected participants were cooperative and agreed to participate in the study. Data were analyzed using the statistical package for the social sciences (version 18). A *P* value of ≤0.05 was considered as statistically significant. Person correlation coefficient was calculated to show the strength of association between two numerical variables which are AL in mm and CCT in µm, (r-value more than 0.7 was considered as strong correlation).

Results

Of the 130 participants (260 eyes), 62 (47.7%) were males and 68 (52.3%) were females (Figure 1). The mean age (± SD) of the sample was 36.6 ± 16.5 years with a median of 46 years and a range between 7 and 79 years. The mean age (± SD) was 37.8 ± 17.7 years for males and 35.4 ± 15.5 years for females (Table 1).

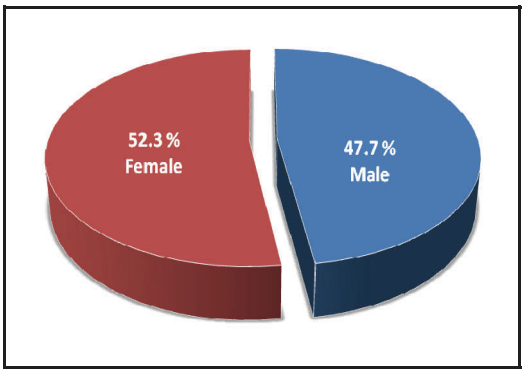

Figure 1: Distribution of sample by gender.

Table 1: Mean age ±SD in males and females.

Gender	Mean age ± SD	No.
Males	37.8 ± 17.7 years	62
Females	35.4 ± 15.5 years	68
Total	**36.6 ± 16.5 years**	**130**

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The higher percentage of participants (33.8%) were in the 2nd decade of life, while 16.2% were in the 7th decade and only 9.2% were in the 6th decade (Table 2). Among the study population, AL ranged between 18.79 mm and 27.4 mm. The peak incidence of AL value was between 23 mm and 23.9 mm (Figure 2). The mean CCT (± SD) was 542.8 ± 36 µm in male eyes, 530.1 ± 32.5 µm in female eyes and 536.2 ± 34.8 µm in the total sample with statistically significant gender variation in mean central corneal thickness (*P* = 0.003) as shown in Table 3. The mean AL (± SD) was 23.38 ± 1.1 mm in male eyes, 23.15 ± 1.2 mm in female eyes and 23.2 ± 1.1 mm in the total sample with no significant gender variation in mean AL (*P* = 0.107) as shown in Table 4.

Table 2: Frequencies of different age groups.

Age in years	Frequency	Percentage
< 20	15	11.5
20-29	44	33.8
30-39	21	16.2
40-49	17	13.1
50-59	12	9.2
60+	21	16.2
Total	**130**	**100.0**

Table 3: Mean central corneal thickness in male and female eyes.

Gender	Mean CCT ± SD	No. of eyes
Male	542.8 ± 36 µm	124
Female	530.1 ± 32.5 µm	136
Total	**536.2 ± 34.8 µm**	**260**
P value	0.003	

Table 4: Mean AL in male and female eyes.

Gender	Mean AL ±SD	No. of eyes
Male	23.38 ± 1.1	124
Female	23.15 ± 1.2	136
Total	**23.26 ± 1.1**	**260**
P value	0.107	

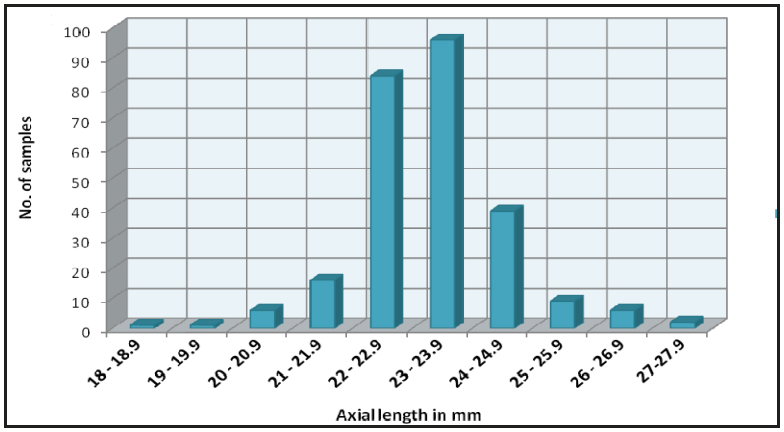

Figure 2: Distribution of sample by the average value of AL.

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The mean IOP (± SD) was 15.73 ± 3.6 mmHg for male eyes, 15.7 ± 3.44 mmHg for female eyes and 15.71 ± 3.51 mmHg for both genders with no significant gender variation in mean IOP (*P* = 0.949) as shown in Table 5. The majority of the eyes were myopes (66.2%), followed by emmetrops (17.7%), and hypermetrops (16.2%). Among the refractive errors, myopic patients had the thinnest central corneal thickness with a mean value (± SD) of 533.7 ± 38 µm followed by emmetrops with a mean value (± SD) of 539.5 ± 24.5 µm and hypermetrops with a mean value (± SD) of 542.4 ± 29.4 µm. No significant variation were found in the mean CCT among the emmetrops, myopes and hypermetrops (*P* = 0.274) and shown Table 6. Among the study population, AL ranged between 18.79 mm and 27.4 mm. The mean AL was 23.2 ± 1.1 mm. CCT ranged between 433 µm and 662 µm. Mean CCT was 536.2 ± 34.8 µm. There was no significant correlation between central corneal thickness and AL (r = 0.037, *P* = 0.558) as shown in Figure 3. Significant correlation was found between CCT and age (r = - 0.277, P <0.001), but no significant correlation was found between AL and age (r = - 0.093, *P* = 0.135) as shown in Table 7.

Table 5: Mean IOP in male and female eyes.

Gender	Mean IOP ±SD	No. of eyes
Males	15.73 ± 3.6mmHg	124
Females	15.7 ± 3.44 mmHg	136
Total	**15.71 ± 3.51 mm Hg**	**260**
P value	0.94	

Table 6: Mean central corneal thickness in different refractive errors

Refractive error	Number(eyes)	Mean CCT± SD	*P* value
Myopia (axial)	172	533.7 ± 38	0.274
Emmetropia	46	539.5 ± 24.5	
Hypermetropia (axial)	42	542.4 ± 29.4	
Total	**260**	**536.2 ± 34.8**	

Table 7: Relations of central corneal thickness and AL with age.

Dependant variable	Independent variable	R	*P* value
CCT	Age	- 0.277	<0.001
AL	Age	- 0.093	0.135

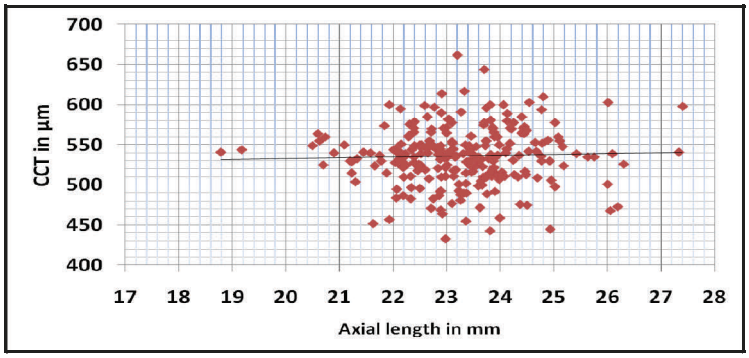

Figure 3: Correlation between central corneal thickness and AL.

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Discussion

Eyes with a thinner CCT have been associated with a greater incidence of glaucoma with a higher morbidity. The Ocular Hypertension Treatment Study has recently recognized central corneal thickness as another risk factor for the development of primary open angle glaucoma in eyes with ocular hypertension.[23] Central corneal thickness in the general population is related to many demographic and ocular factors, and this should be considered when evaluating the health of the cornea. Recent studies have shown that gender, race and/or ethnicity, and age may influence CCT.[24-28] Specifically, the most consistent relationships suggest that CCT is thinner in older individuals.[27] Studies on CCT values in different races in the world revealed that blacks having the thinnest CCT (529.8μm), Caucasians next (545.2 μm),[29] and Chinese having the thickest reported values (555.1 μm).[30] In this study, the mean CCT±SD was found to be 536.2 ± 34.8 μm. Therefore Erbil population has comparatively thinner corneas when compared to other Caucasians, this could be due to racial genetic variations. Several studies have revealed a significant correlation between CCT and gender, reporting that CCT is slightly higher in men compared with women,[31] whereas other investigators did not notice a difference between men and women.[32] In this study, a statistically significant gender difference was found in mean CCT; mean CCT ± SD in men was 542.8 ± 36 μm while mean CCT±SD in women was 530.1 ± 32.5 μm. CCT was not correlated with AL in any group. This finding agrees with the conclusion of Shimmyo and Orloff[23] who found that CCT and AL are two independent factors, and thin corneas are not associated necessarily with longer eyes. In the current study, myopic patients have the thinnest corneas followed by emmetrops and hypermetrops. This is consistent with the findings of Nemesure and Barbados Eye Study Group[29] who noticed that CCT was directly related to axial refractive error. In contrary, Price[33] reported that CCT does not appear to be correlated with refraction. Statistically significant correlation was found between CCT and age which is compatible with studies carried out on Asian populations[25,31] as well as the Barbados Eye Studies[29] which reported a decrease of CCT with age. This can be explained by degeneration of collagen fibers and decrease in interfibrillary distance in addition to decreased keratocyte density in the cornea with increasing age. Of the 130 cases enrolled in this study, the peak incidence of age and the peak incidence of myopia was in the third decade of life 20 -29 years (37/44 participants) and this is compatible with Xie et al and many other studies which show that myopia is common among young.[34] Gender distribution showed a higher number of female (45 cases) to male patients (41 cases). A significant correlation of myopia with the gender have been detected (P <0.01), which is compatible with Hyman et al[35]. Such result could be attributed to several factors like hormonal effect and lack of outdoor activities. As of this time we do not know why there is an increased susceptibility to glaucoma damage in the optic nerve in patients with thinner corneal. It may be that patients with thinner corneal also have thinner scleras, which make them more susceptible to glaucomatous damage.[18]

Conclusion

CCT and AL of the eye are two independent measurements. Thin corneas are not necessarily related to longer eye. However, central corneal thickness decreases with increasing age, thinner cornea is associated with older ages, and corneal thickness is higher in men compared with women. Myopic patients have the thinnest corneas followed by emmetrops and hypermetrops. Erbil population has comparatively thinner corneas when compared to other Caucasians. A systematic research need to be

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done taking in consideration other ocular biomechanical parameters, such as stromal structure, other ocular axes, including specific age group and specific sex. A study is also needed between CCT and AL of different types of axial myopics; mild, moderate and severe. Because of the proved effect of CCT as a risk factor of glaucoma, Pachymeter should be essential equipment in ophthalmic clinics. Very few ophthalmology departments in Erbil city are equipped with Pachymeters, so it's necessary that every ophthalmology unit to be equipped with a Pachymeter.

Conflicts of interest

The authors report no conflicts of interest.

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