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[Omar Al Emam](#)^{*}, Dana Al Junaidi, Yousra Haddeh

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Article

The Correlation between Central Corneal Thickness and Intraocular Pressure among Syrians: A Cross Sectional Study

Omar Al Emam ^{1,*}, Dana Al Junaidi ¹ and Yousra Hasan Haddeh ^{2,3}

¹ Syrian Private University, Faculty of Medicine, Damascus, Syria.

² Department of Ophthalmology, Faculty of Medicine, Damascus University

³ Department of Ophthalmology, Faculty of Medicine, Syrian Private University

* Correspondence: omaralemam12@gmail.com

Abstract: Introduction: intraocular pressure (IOP) measurement is an essential part glaucoma's diagnosis and follow-up. Goldmann applanation tonometry (GAT) is the gold standard for IOP measurement but it's affected by many factors like central corneal thickness (CCT). Racial differences in CCT are reported but the Syrian population was never studied. **Research design and methods:** 57 subjects with 114 eyes visiting Damascus hospital were examined and 100 eyes were included. IOP was measured using GAT and CCT was measured using OCULUS Pentacam AXL Corneal Topography, demographic data and history of ocular surgery, systemic co-morbidities and history of medications were collected. IOP values were corrected for CCT. **Results:** 56% were males, the mean age was 48.1. 24% of subjects had hypertension. Males had higher CCT with 557.23 ± 25.33 compared with 531.34 ± 41.88 for females. There was a moderately positive correlation between CCT and IOP ($r=0.232$, $p=0.02$), CCT and IOP values were linearly correlated (ANOVA, $p=0.02$). **Conclusions:** This study showed that the correlation between CCT and IOP is present in the Syrian population. Males had a slightly thicker corneas than females and CCT didn't significantly change with age.

Keywords: intraocular pressure; central corneal thickness

Introduction

Intraocular pressure (IOP) is an essential measurement in diagnosing glaucoma [1] and in postoperative follow-up of patients who underwent intraocular surgery [2]. Goldmann applanation tonometry (GAT) is considered the gold standard measurement for IOP since it is valid and reproducible [3]. A lot of measurements and values are altered with different IOP values such as systemic blood pressure [4] and Central corneal thickness [5] and many IOP disturbances can be seen in different ocular pathologies such as uveitis and retinal detachment [6]. When developing GAT, Goldmann assumed a standard central corneal thickness (CCT) of 520μ and he predicted that an altered CCT can falsely alter the measurement of IOP since a thicker cornea requires more pressure to be applanated [7]. This theory was later proved in many studies [8,9].

The measurement of CCT is essential before excimer laser surgery and refractive surgery since a decreased CCT can be a contraindication for the procedure [10]. These procedures are expected to affect the CCT which in turn can alter the measured values of IOP using GAT since these procedures flatten the central cornea giving lesser IOP values because less pressure is needed to applanate the cornea [11]. In turn patients with increased IOP had higher values of CCT meaning an overestimation of IOP is possible in this group of patients even though patients with normal pressure glaucoma had thinner corneas compared to the general population [7]. Bearing in mind the aforementioned data, many authors recommend that a CCT measurement is used to interpret IOP values to avoid any under or overestimations of IOP [12].

Many published studies had already studied the correlation between IOP and CCT. But to our knowledge none were done on a Syrian population and since many interracial differences [12] were found regarding CCT, this kind of data is needed to guide clinical practice. The authors conducted this study to investigate the correlation between CCT and IOP in Syria and its relationship with other factors such as age, gender, systemic co-morbidities and used medications.

Methods

This study is a prospective cross-sectional study that involves patients and their companions who visited Damascus (Almujtahid) hospital in Damascus, Syria between January 1st and March the 30th of 2024. 114 eyes of 57 subjects were examined by the same two researchers OM and DJ to minimize examiners bias as much as possible. The inclusion criteria were subjects that visited the hospital with no present ocular pathology.

The exclusion criteria were the following:

1. extreme myopia, or extreme hyperopia
2. Eyes that underwent surgery
3. subjects suffering from traumatic eye injuries
4. usage of ocular topical medications in the last 4 weeks
5. patients diagnosed with any type of glaucoma
6. patients suffering from corneal degenerations or dystrophies.

Patients' age, medications usage and systemic co-morbidities were gathered using a face-to-face interview with subjects CCT was examined using OCULUS Pentacam AXL Corneal Topography. three readings were taken for each eye and the mean was used for data analysis.

IOP was measured using GAT. Two readings were taken for each eye by the same researcher using the same equipment, the readings were taken between 8 am and 12 am to minimize the effect of circadian rhythm of IOP. IOP values were corrected for CCT using the following formula:

$$\text{IOPmod} = \text{measured IOP} + 520 - \text{CCT}/71$$

Results

The Sample characteristics are summarized in Table 1. 50 subjects with 100 eyes were included. The characteristics include gender, age, systemic comorbidities, used medications, IOP Mod and CCT.

56% of the sample were males while 44% were females. The mean age of the sample was 48.1 with a standard deviation of 13.84. comorbidities were not present in 64% of sample while 24% suffered from hypertension. More details are in the table below.

There was a statistically significant difference in the mean of CCT ($p < 0.001$) between males (557.23±25.33) and females (531.34±41.88) respectively. On the other hand, no statistically significant difference ($p = 0.5$) regarding CCT in relation to age.

Correlation studies between CCT and IOPmod revealed a moderately positive correlation (Pearson correlation coefficient $r = 0.232$, $p = 0.02$) moreover, linear regression analysis showed that CCT and IOPmod were correlated linearly (ANOVA, $p = 0.02$)

Table 1. Sample characteristics.

Mean (standard deviation)	Reptations n (percentage)		Variables
48.1 (13.84)	-	-	Age
-	28 (56%)	Male	Gender
	22 (44%)	Female	
-	32 (64%)	Non-present	Systemic co-morbidities
	12 (24%)	Hypertension	
	5 (10%)	Diabetes mellites	
	1 (2%)	Hypothyroidism	
-	36 (72%)	Non-present	Medication History
-	10 (20%)	Antihypertensives	
	3 (6%)	Diabetes medications	
	1 (2%)	Levothyroxine	

15.7 (4.0)	-	-	IOP mod
545.7 (35.8)	-	-	CCT

Discussion

Since an increased IOP is the main characteristic in glaucoma, the diagnosis and follow up of glaucoma patients is dependent on an accurate measurement of IOP [13].

Goldmann applanation tonometry (GAT) is an accurate method to measure IOP and it's considered the golden standard even though GAT requires a local anesthetic and it can be difficult to use on non-compliant patients [14]. GAT depends on Imbert-Fick principle [15] which states that the internal pressure (P_o) in a spherical body with an infinitely thin, dry and elastic membrane wall, equals the force (W) exerted on this body divided by the applanation surface (A) [16].

Even though the human eyeball does not exhibit any of those characteristics perfectly [17], Goldmann applanation tonometry can be explained by this principle but corneal properties such as elasticity, rigidity and thickness can influence IOP measurement with GAT [18,19].

Eyes with thicker corneas require increased applied pressure using GAT showing an overestimated value of IOP [20] while thinner corneas cause underestimated values [20]. in addition, to thinner cornea's association with developing glaucoma's complications such as optic neuropathy and visual field damage [21].

The loss of corneal thickness could be iatrogenic such as excimer laser surgery and photorefractive surgery where parts of the cornea loses its thickness and curvature which in turn can alter measured IOP [22], showcasing the importance of clinical history in patients that require a measurement of IOP. Because of this correlation, subjects who underwent any surgical interventions on the eye were excluded from the study. Furthermore, subjects with present ocular pathologies were also excluded since the pathology it self may effect the IOP or CCT or medications used for treatment especially if administrated topically [23] explaining why these subjects were excluded.

In our sample the mean CCT was 557 for males and 531 for females. Males having a thicker cornea is consistent with a study from the United States [24] while studies reported a non-significant difference between the two genders in China [25] and Spain [26] . Although a significant difference maybe present, its clinical importance is not clear.

There was no significant difference regarding the age of subjects. This result is also consistent with other studies from Egypt [21] and that reported a stale CCT values with age and a study from the United States reported the relationship as non-linear [24] , while other studies reported a decrease in CCT with increased age form Barbados [27] and Lithuania [28]. These studies explained this decrease by the degenerative loss of aminoglycans in the stroma, the consequent loss of water and the loss in keratocyte density, but this datum was not noted in our sample.

The mean CCT (the mean of males' mean and females' mean) was 544 which was close to the mean reported for subjects of Hispanic descent [24]. This can be explained by the effect of heat and humidity on corneal morphology [29].

There was a statistically significant moderately positive correlation between CCT and IOP. This result is consistent with other studies form Nigeria [30], Iran [31] and the United States [32].

Conclusions

This study showed that the correlation between CCT and IOP is present in the Syrian population. Males had a slightly thicker corneas than females and CCT didn't significantly change with age

Limitations

The sample in this study relatively small due to many subjects' refusal to partake in the study. Future research with bigger samples is recommended

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Consent for Publication: Not applicable.

Competing Interests: The authors declare no competing interests.

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