

Central Corneal Thickness in Sudanese Population

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Abstract

Aims: To determine the mean central corneal thickness (CCT) among Sudanese non-glaucomatous population and to correlate between CCT and age, gender, intraocular pressure (IOP) and refractive error.

Material and methods: This cross-sectional study included 94 eyes of 94 non-glaucomatous patients selected over a period of three months. Refraction, slit-lamp examination, CCT and IOP measurements were done. Descriptive analysis and bivariate correlational analysis were done using SPSS (version 10.0) programme. A *p*-value of <0.05 was considered significant. *Results:* Of 94 patients, 53 (56.4%) were younger than 40 years of age, 60 (63.8%) were males and 63 (67.0%) were either house wives or indoor workers. Majority of patients were emmetropes (42.6%) followed by hypermetropes (39.4%), and myopes (18%). The overall mean CCT was $530.15 \pm 58.10 \mu\text{m}$. Myopic patients had the thinnest CCT with a mean value of $449.65 \pm 39.27 \mu\text{m}$ followed by emmetropes with a mean value of $542.66 \pm 46.35 \mu\text{m}$ and hypermetropes with a mean value of $557.67 \pm 41.83 \mu\text{m}$. No significant correlation was found between CCT and age ($p=0.993$), gender ($p=1.00$) and occupation ($p=0.662$). However, a strong positive correlation was found between CCT and IOP ($p<0.001$, $r=0.72$). *Conclusion:* Sudanese CCT is comparable to African American figures. There is a strong correlation between CCT and IOP among non-glaucomatous population.

Keywords: Central corneal thickness; glaucoma; intraocular pressure; Sudanese population.

INTRODUCTION

In glaucomatous patients, progressive optic nerve cupping may occur without recordable visual field loss, because perimetry results (whether automated or manual) are subjective, and they depend on variable patient and perimetrist factors.¹ Patient's factors include attentiveness and response time which depends on patient's psychological and physical condition; retinal sensitivity which greatly varies depending on age, time of the day and/or demographic and geographical setting of each individual patient; eye fixation which also depends on

patient's psychophysical condition. Perimetrist factors include the perimetrist during manual perimetry may administer the test slightly differently at different times; different technicians or physicians may also vary from one another in their performance. Despite the great current advances in optic nerve imaging technology, measurement of intraocular pressure (IOP) has not evolved recently. Goldmann applanation tonometer was the gold-standard for the last 50 years. In routine clinical practice, IOP is used not only in the diagnosis of glaucoma but also to assess its response to treatment and the

progression of this disease. It was found that Goldmann applanation tonometer most accurately reflects 'true' intra-cameral IOP when CCT is 520 μm and that deviation from this value results in an over- or under-estimation of IOP by as much as 7 mmHg per 100 μm .²

The relationship between central corneal thickness and IOP was well established, in Ocular Hypertension Treatment Study (OHTS) from the United States in which 1,636 patients were followed for a minimum of 5 years and CCT was identified as a predictor for conversion to POAG; with subjects with thin corneas being more likely to convert. However, the mechanism by which CCT exerts this risk was not known.³ In view of the lack of any data in Sudanese population; this study was designed to estimate the CCT values in normal (non-glaucomatous) Sudanese patients, and to correlate between CCT and IOP in them.

MATERIAL AND METHODS

This cross-sectional study was conducted in Sudan Eye Center, Khartoum, Sudan over a period of three months (from 1st October, 2007 to 31st December, 2007) to determine the relationship between the central corneal thickness and the measurement of intraocular pressure, using Goldman applanation tonometry. Known cases of open angle glaucoma, patients who underwent any kind of surgery that needs corneal incision, patients with corneal ectasia (such as keratoconus) or any other corneal disease and patients with history of ocular trauma were excluded from this study.

Patients were briefed about the study and verbal consent was taken before examining

the patients. After filling in the designed questionnaire, refraction was done using Accuref-K 9001, Shin-Nippon auto-refractometer, Slit lamp examination was performed to rule out the presence of any corneal pathology or other exclusion criteria. One eye was selected randomly, and Central Corneal Thickness (CCT) was measured for that eye using UP-1000, Nidek Pachymeter. Intraocular pressure was then measured using Goldmann applanation tonometer in the same eye.

Descriptive analysis of demographic variables was done, followed by Pearson's bivariate correlational analysis between CCT and IOP, age, gender, refractive error and occupation using SPSS (version 10.0) programme. A p-value of <0.05 was considered significant.

RESULTS

Ninety four (94) individuals were included in the study. Of which, 53 (56.4%) were younger than 40 years of age (table 1), 60 (63.8%) were males and 34 were females (36.2%); 63 (67%) were either house wives or indoor workers and 31 (33%) were outdoor workers.

Majority of patients in our study population were emmetropes (42.6%) followed by hypermetropes (39.4%) and myopes (18.1%). Among the study population, CCT ranged between 420 μm and 610 μm , with a mean value of $530.15 \pm 58.10 \mu\text{m}$. Among the refractive errors, myopic patients had the thinnest CCT with a mean value of $449.65 \pm 39.27 \mu\text{m}$ followed by emmetropes with a mean value of $542.66 \pm 46.35 \mu\text{m}$ and hypermetropes with a mean value of $557.67 \pm 41.83 \mu\text{m}$ (Table 1).

Table 1. Showing mean corneal thickness (CCT) in different refractive errors.

Variable	Number	Mean CCT \pm SD	p value
Myopia	17	449.65 \pm 39.26	<0.001
Emmetropia	50	542.66 \pm 46.35	
Hypermetropia	27	557.67 \pm 41.83	

No significant correlation was found between age and CCT (p=0.903); gender and CCT (p=1.00),

and occupation and CCT (p=0.662). However, a strong positive correlation was

found between CCT and IOP ($p < 0.001$, $r = 0.72$).

DISCUSSION

Central corneal thickness (CCT) has been proposed recently as an important factor in the diagnosis of glaucoma diagnosis. In addition to its effect on IOP measurement, it was found to be an independent risk factor. The CCT values in different races in the world is shown in Table 2; with Blacks having the thinnest CCT,^{4,5} Caucasians next⁵ and Chinese having the thickest reported.⁶ In our study, the mean CCT in Sudanese non-glaucomatous population was found to be $530.2 \pm 58.1 \mu\text{m}$, which is comparable to the CCT of African Americans (right eye, $531.0 \pm 36.3 \mu\text{m}$; left eye, $530.0 \pm 34.6 \mu\text{m}$).⁴

We found no significant correlation between CCT and age. This is consistent with Iyamu et al⁷ who also found no significant correlation between these two variables. On the other hand, the lack of significant correlation between CCT and gender in our study is not consistent with Lekskul et al⁸ who found a significant correlation between these two variables ($p < 0.01$). In their study, the multivariate linear regression of data from 467 participants indicated that increasing age would decrease the CCT by $0.28 \mu\text{m}$ per year. Our study did not support the assumption that excessive exposure to ultraviolet light might affect the corneal thickness, as we found no significant correlation between outdoor workers and CCT ($p = 0.662$).

Table 2: A comparison of central corneal thickness in different races.

Author	Year	Race	Mean CCT
La Rosa et al ⁴	2001	African American	$531.0 \mu\text{m} - 530.0 \mu\text{m}$
Nemesure et al ⁵	2004	Black	$529.8 \mu\text{m}$
		Mixed Black and White	$537.8 \mu\text{m}$
		White	$545.2 \mu\text{m}$
Wong et al ⁶	2002	Chinese	$555.1 \mu\text{m}$
Present study	2009	Sudanese	$530.2 \mu\text{m}$

We found that myopes have the thinnest corneas followed by emetropes and hypermetropes. This is consistent with the findings of Nemesure et al⁵ who noticed that CCT was directly related to refractive error. In contrary, Price et al⁹ reported that CCT does not appear to be correlated with refraction. The thin central corneal thickness and thin lamina cribrosa in highly myopic eyes may explain the presumably increased susceptibility to glaucoma in highly myopic eyes compared with non-highly myopic eyes.⁹

In our study a strong association was found between the CCT and the measurement of IOP using Goldmann applanation tonometer. This result is consistent with other studies. Kohlhaas et al¹⁰ found that the difference between measured and real IOP was

significantly dependent on CCT ($P < 0.001$). Their study was a masked, prospective clinical trial, in which they examined 125 eyes of 125 patients scheduled for cataract surgery. Corneal curvature was measured by keratometry and axial length by A-scan ultrasonography. By cannulating the anterior chamber before surgery, intraocular pressure (IOP) was set to 20, 35, and 50 mm Hg in a closed system by means of a water column. After measuring thickness, the IOP was measured with an applanation tonometer. In another study done by Lleó A et al,¹¹ a significant but weak correlation between CCT and IOP in normal subjects was found ($r = 0.184$, $p < 0.001$).

In our study, we had a significant strong correlation between these two variables ($r = 0.72$, $p < 0.001$)

Intraocular pressure is an important risk factor that has a significant influence on the diagnosis and follow-up of ocular hypertension (OHT) and glaucoma patients. As the IOP is the key parameter for making the diagnosis of OHT, as well as essential for following patients of known glaucoma, knowledge of the CCT would appear important to know the validity of the IOP readings. The IOP varies during the day time, but it does not appear to affect the reliability of the measurements of our study because all of our subjects were examined in the night time only. Therefore, a single measurement of IOP is likely to be adequate.

In clinical practice, it is assumed that all eyes behave in the same manner on applanation. However, if a cornea is thicker, it would be expected that a larger force would be required to applanate it. Other anatomical factors, such as the physical characteristics and distribution of the collagens and glycosaminoglycans composing the cornea, or the presence or absence of such structures as Bowman's layer, may also affect the resistance of the cornea to indentation. A proportion of the eyes may have a measurement error from a cornea that is thick and stiff and therefore more difficult to applanate.

Finally, there is a crucial question i.e. would routine CCT measurements be carried out by ophthalmologists in glaucoma clinics in all the patients? Our results have shown that the IOP readings taken with Goldmann applanation tonometer strongly correlated with the central corneal thickness. Thus, there is enough information to recommend routine measurements of CCT in every patient visiting glaucoma clinic, not only on subjects with suspected intraocular pressure pathologies. Furthermore, we believe that measurement of CCT by ophthalmologists may re-label many patients from glaucoma suspect category to glaucomatous patients if we find their CCTs is sufficiently thin to give

false low readings of IOP. On the other hand, ocular hypertensive patients may be in fact healthy, if we demonstrate their high IOP to be a product of their thick corneas. Because of the proved effect of CCT on the aggressiveness of glaucoma, we feel that a Pachymeter should be essential equipment in Ophthalmic clinics. The cost of such an item to an eye department/ eye centre is very little compared to being able to confidently relax or better judgment in the diagnosis of glaucoma/ follow-up treatment of the patients.

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