

The pattern of central corneal thickness in patients attending a Tertiary Hospital in Dar-Es-Salaam

Annamary Stanislaus ^{1,*}, Ntsilane Susan Mosenene ¹, Celina Mhina ¹, John Stanslaus Kisimbi ¹, Frederick Robert Burgess ², Milka Madaha Mafwiri ¹, Dilawar Padhan ¹ and Anna John Sanyiwa ¹

¹ Department of Ophthalmology, Muhimbili University of Health & Allied Sciences. Box 65001, Dar es Salaam Tanzania.

² School of Medicine, University of St Andrews, UK

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Abstract

Background: Central Corneal Thickness (CCT) is an indicator of corneal health status as well as being an essential tool in assessment and management of corneal diseases. It is an important factor in the diagnosis and management of glaucoma as it affects the measurement of intraocular pressure. However, the pattern of central corneal thickness in our population is not known. Our study aimed to describe the CCT measurements and their variation with age and sex among patients attending the eye clinic at Muhimbili National Hospital (MNH), in Dar es Salaam, Tanzania.

Methodology: A hospital-based descriptive, cross-sectional study used convenient sampling to recruit adult patients aged 18 years and above, presenting to the MNH between August 2016 and January 2017. Visual acuity assessment, Goldman applanation tonometry and CCT assessment using an ultrasound pachymeter were performed. Patients with previous intraocular surgery were excluded.

Results: A total of 398 patients (208 males and 190 females) were recruited. The mean CCT was $526.64 \pm 38.30 \mu\text{m}$; being $523.99 \pm 38.20 \mu\text{m}$ for males and $529.7 \pm 38.3 \mu\text{m}$ for females. 226 (56.85%) had CCT of less than $520 \mu\text{m}$. There was no statistically significant difference in CCT between gender. The proportion of patients with thinner CCT increased with increasing age from 25.8% in those < 30 years to 75% in those aged 71 years and above. The mean CCT decreased with increasing age with $P\text{-value} < 0.001$.

Conclusion: The average CCT in patients attending Muhimbili National Hospital is $526.64 \mu\text{m}$ (SD 38.30) which is generally thin, inversely proportion to age and similar that of other Africans and African-Americans. This finding has implications for the management of glaucoma in this population.

Keywords: Central Corneal Thickness; age; Africans

1. Introduction

Central Corneal Thickness (CCT) is a measure of the thickness of the cornea at the center. The thickness of the cornea is largely determined by the degree of hydration. The human cornea is thinner at the center and gets progressively thicker towards the periphery. Normally, the peripheral corneal thickness range from 0.68 to 0.89 mm, while CCT ranges from 0.52 to 0.61 mm [1,2]. The average CCT is $540 \mu\text{m}$ although this varies between individuals according to age group, gender and ethnicity.

* Corresponding author: Annamary Stanislaus

Department of Ophthalmology, Muhimbili University of Health & Allied Sciences. Box 65001, Dar es Salaam Tanzania.

The effect of gender on CCT is controversial with some studies showing no significant correlation between gender and CCT[3] while others show a modest effect of gender on CCT. Some studies report slightly thicker corneas in men[4] whilst other studies have shown thicker CCT among females than males[5]. People of African origin have been noted to have thinner CCT compared to Caucasians[6].

Central corneal thickness is an important indicator of corneal health status as well as being an essential tool in assessment and management of corneal diseases as it gives an estimate of the corneal barrier and endothelial pump function[7]. Additionally, CCT is important when determining a patient's eligibility and choosing the modality of laser refractive surgery[8].

Central corneal thickness (CCT) has recently emerged as an important factor in the diagnosis and management of glaucoma as it has been established that it affects the measurement of intraocular pressure (IOP)[9]. Thicker corneas resist the indentation inherent in nearly all methods of IOP measurements. Conversely, thinner corneas undergo higher indentation during assessment, giving falsely low IOP [10]. Further research has shown that CCT is reduced in patients with the diagnosis of "low tension glaucoma," suggesting that, in at least some of these individuals, IOP is being underestimated because of thin corneas[11].

As a key element in the management of glaucoma, IOP should be measured using a reliable technique with a high degree of accuracy. Though Goldman applanation tonometry (GAT) is the most widely used and current "gold standard" for IOP measurement, readings of IOP made with GAT are affected by CCT[11]. IOP correction values for various CCT measures[12]are routinely used.

Despite having many patients with open angle glaucoma, including the low-tension type, at Hospital MNH eye clinic, CCT is not assessed to help in the diagnosis and management of these patients. Moreover, there are no studies reported on the pattern of CCT in this population. Knowing the pattern of CCT in our setting will help to identify patients who are more likely to develop glaucoma, and to properly manage patients with low tension glaucoma who might seem to have falsely low IOP due to their thin corneas. The aims of the study were to specifically describe the CCT measurements and to determine the variation of CCT with age and sex among patients attending the eye clinic at MNH.

2. Methodology

2.1. Study setting and design

This was a descriptive, hospital-based cross-sectional study which was conducted at MNH, Dar es Salaam, Tanzania. The hospital serves patients from Dar-es-Salaam and other regions across the country. Data was collected from the adult eye clinic which attends an average of 70 adult patients (aged 18 years and above) daily from Monday to Friday. The estimated sample size to give precision of 0.05 at 95% CI was 384 patients.

2.2. Study population

All patients attending the adult eye clinic during the study period were eligible for the study.

Inclusion criteria: Convenience sampling was used to recruit all adult patients aged 18 years and above who were attending the adult eye clinic at MNH on Mondays and Wednesdays during the study period, August 2016 to January 2017.

Exclusion criteria: Patients with any corneal pathology and those who had undergone intraocular surgery were excluded as intraocular surgery affects endothelial cell count and may reduce CCT.

2.3. Data collection procedures

Eligible patients were informed about the study. Patients who consented were recruited and ocular assessment commenced. Visual acuity was taken using Snellen's charts for literate and illiterate patients. A Topcon slit lamp biomicroscope was used for examination of the anterior segment of the eye to detect any corneal pathology. The IOP of each eye was measured using the Goldman applanation tonometer. The tonometer was calibrated prior to the commencement of the study to ensure quality results. Central Corneal Thickness was measured using an ultrasound pachymeter (model 55B; DGH Technology, Inc.). A drop of topical anaesthesia was applied to the eye then a sterile pachymeter tip gently touched the cornea. Five readings were taken and the mean was recorded as the CCT of that particular patient. CCT was classified as: thin (<520 µm), normal (520-560 µm) and thick (>560 µm). All information was recorded on a questionnaire.

2.4. Data analysis

Data were analysed using the Statistical Package for Social Sciences (SPSS 20.0, Chicago, IL). Means were used for continuous data while categorical data are presented as percentages. Correlation between age, sex and CCT were ascertained using chi squared test where a two-sided p-value of less than 0.05 was considered statistically significant.

2.5. Ethical considerations

The Research and Publications Committee of MUHAS granted ethical approval for the study. Permission to conduct the study at MNH was given by the Chief Executive Director. All patients consented before inclusion in the study. Confidentiality was maintained throughout data collection and management.

3. Results

A total of 398 patients were recruited and were all included in the analysis. The age range was 18-95 years. The study population mean age was 53.92(SD 18.44), while the mean age for males and females was 52.75(SD 16.25), and 54.10(SD 18.52) respectively. The majority (48.7%) of patients were aged between 51 and 70 years. There were slightly more males (52.3%) than females (Table 1).

Table 1 The socio-demographic characteristics of the study population (N=398).

Character	Frequency (n)	Percentage (%)
Age category (Years)		
Less than 30	62	15.6
31 to 50	82	20.6
51 to 70	194	48.7
71 and above	60	15.1
Sex		
Male	208	52.3
Female	190	47.7

More than half (56.8%) of patients had CCT of less than 520 µm, and only 9% had CCT of more than 560 µm (Figure 1.).

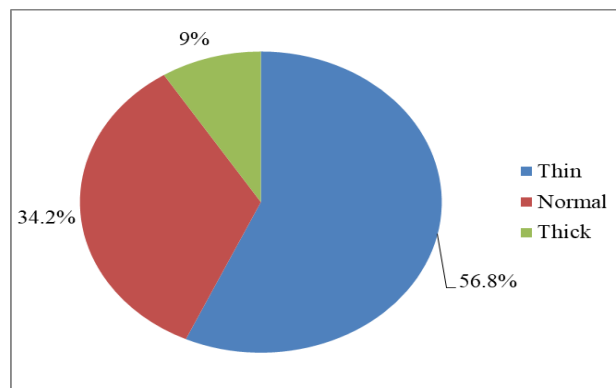


Figure 1 Central Corneal Thickness measurements among patients attending ophthalmology clinic at Muhimbili National Hospital.

Table 2 Mean CCT of the study population.

Variable	Thin	Normal	Thick	Overall (μm)
	<520 μm ,	520-560 μm	>560 μm .	
Mean CCT (μm)				
Mean (SD) (μm)	499.03 (36.4)	532.01 (6.4)	554.11 (41.7)	526.64 (38.30)
Minimum CCT	428.00	520.00	560.00	428.00
Maximum CCT	519.00	559.00	625.00	625.00

The overall mean CCT was $526.64 \pm 38.30 \mu\text{m}$ (range 428 μm -625 μm).

Table 3 Variation of Central Corneal Thickness with Age

Character	CCT			TOTAL	Mean (SD) (μm)
	Thin <520 μm ,	Normal 520-560 μm ,	Thick >560 μm ,		
Age (years)	(No, %)	(No, %)	(No, %)		
< 30	16 (25.8)	23 (37.1)	23 (37.1)	62(100)	546.8 (43.6)
31 to 50	30 (36.6)	44 (53.7)	8 (9.8)	82(100)	528.1 (37.6)
51 to 70	135 (69.6)	54 (27.8)	5 (2.6)	194(100)	523.7 (33.9)
71 and above	45 (75)	15 (25)	0 (0)	60(100)	513.4 (39.6)
Total	226(56.8)	136(34.2)	36(9)	398	
p-value	<0.001	0.002	<0.001		<0.001

The proportion of patients with thin CCT increased with increasing age group from 25.8% in those <30 years to 75% in those aged 71 years and above. The mean CCT decreased with increasing age from 546.8 μm in those of less than 30 years to 513.4 μm in those aged 71 years and above. This variation was statistically significance with p-value <0.001.

The mean CCT for males was slightly lower than for females (523.9 μm (SD 38.2) vs. 529.7 μm (SD 38.3)) and the proportion of male patients with thin CCT was slightly higher than females (61.1% vs. 52.1%), but this was not statistically significant (p=0.065). The proportion of females with normal and thick CCT was 35.3% and 12.6% respectively. The proportion of males with normal and thick CCT was 33.2% and 5.8% respectively, although there was no statistical significance in these differences between genders.

In univariate analysis, different factors were found have a statistically significant association with thin CCT. Compared to patients aged less than 30 years, those aged 50 years and above were 6 times more likely to have thin CCT while the odds of having thin CCT among those aged more than 70 years was 8 times higher. The odds of having a thin CCT for patients with a history of glaucoma was 1.5 while it was twice for intra ocular pressure of 21-25mmHg compared to IOP of less than 15 mmHg (Table 4).

In multivariate analysis age was the only factor which was found to have statistically significant association with thin CCT (OR 4.4, 95% CI 2.4-8.2, p<0.001). Neither having primary open angle glaucoma (OR 1.3, 95% CI 0.9-2.0, p=0.203) nor higher IOP (OR 1.2, 95% CI 0.8-2.0, p=0.402) was statistically significantly associated with thin CCT.

Table 4 Univariate analysis on thin CCT.

Variable	Odds Ratio	95% Confidence Interval		p-value
		Lower	Upper	
Age category (Years)				
Less than 30	1.000			
31 to 50	1.659	0.803	3.424	0.171
51 to 70	6.578	3.448	12.55	<0.001
71 and above	8.625	3.816	19.50	<0.001
Sex				
Male	1.000			
Female	0.694	0.466	1.033	0.072
History of POAG				
No	1.000			
Yes	1.643	1.084	2.941	0.019
Intra-ocular pressure (mmHg)				
<15	1.000			
15 – 20	0.969	0.597	1.571	0.898
21 – 25	2.442	1.336	4.467	0.004
26 – 30	1.050	0.302	3.655	0.939
>30	0.350	0.103	1.187	0.092

4. Discussion

To our knowledge, this was the first study conducted on the pattern of CCT in Tanzania. Understanding the pattern of CCT of any given population is important in order to predict the risk of glaucoma in that population. Racial variation has been reported to have influence on CCT[13]. This implies that the mean CCT in different populations will be different. In this study the mean central corneal thickness was 526.64(38.30) μm . This result is similar to that of previous studies among Africans and African-Americans in USA[13] and Cameroon[14]. However the mean CCT of our study population was thinner than those among Caucasians[15].

Our results show that more than half (56.8%) of the study population had thin corneas (with CCT of less than 520 μm) while only 9% had thick corneas (with CCT of more than 560 μm). These findings are in agreement with the previous findings that Africans and African-Americans have thinner CCTs[6]. In a study comparing Caucasians and Afro-Americans LaRosa et al showed that African-Americans had thinner CCT measurements than Caucasians[13]. The reason for the thinner corneas among the black population is not clearly known but genetic factors have been proposed as one of the causes [16]. In the current study, CCT was observed from 428 to 625 μm which supports the hypothesis of the existence of structural variations among different people even of the same ethnic and racial group[1].

The age range in this study was 18 years to 95 years with a mean age of 53.92 (SD 18.44) years. This study demonstrated a significant decrease in CCT with increasing age whereby elderly patients were found to have thinner CCT as compared to younger patients. Furthermore, in this study, a higher proportion (81.7%) of patients aged 71 years and above had CCT of less than 520 μm and this age group also had the lowest mean CCT. This was in contrast to younger patients of less than 30 years in whom only about 1/3 (36.6%) of patients had thin CCT and their mean CCT was comparatively higher (513.4(SD 39.6) μm vs. 546.8 (SD 43.6) μm). This was similar to previous studies done in Ethiopia [17] and America[6] that demonstrated that age affects CCT. In univariate analysis, being older than 50 years increased

the risk of having a thin cornea by 6-fold while at 70+ years, the risk was 8 times higher. In multivariate analysis age was the only factor that was found to affect CCT and this was statistically significant.

Reduction of CCT in older people can be explained by the reduction in the density of keratocytes, the major cellular component of the cornea stroma, and by the possible destruction of collagen fibers as part of the normal aging process. Additionally, old people are exposed to environmental factors for longer periods which can influence the structure of the cornea and hence reduce CCT[18].

Results of this study showed no statistically significant difference in mean CCT between males and females, similar to previous studies[3]. Majority of studies that analyzed the effect of sex on CCT were done among young populations; one of the reasons for this variation has been reported to be due to hormonal differences[7]. The population in the current study were adults aged 18 years and above with more than half (63.8%) of them being more than 50 years. This age group has different hormonal characteristics compared to younger people[3].

This study was a hospital based study where all patients attended for various eye conditions likely to cause selection bias. This was minimized by excluding eye conditions with a potential to affect CCT.

5. Conclusion

The mean CCT value in this study is 526.64(SD 38.30) μm . This is generally thin but closely matches with that of other Africans and African-Americans. The CCT was inversely proportion to age. There was no significant variation between CCT and sex. This finding is important in identification and management of patients with glaucoma and thin corneas. Measurements of the IOP for such patients need to be corrected for corneal thickness. This will only be possible if pachymeters for measuring CCT are available in ophthalmology clinics to facilitate CCT measurements and consequently accurate IOP measurements, and therefore the appropriate management of glaucoma.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors have no proprietary interest in any materials mentioned in this article.

Statement of ethical clearance

The Research and Publications Committee of MUHAS granted ethical approval for the study. Permission to conduct the study at MNH was given by the Chief Executive Director. All patients consented before inclusion in the study. Confidentiality was maintained throughout data collection and management.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

Authors' contributions

AS: designed the study, collected data, performed data analysis, and wrote the report and prepared the manuscript. SM, CM, JSK, MMM, DH, and AJS: participated in the study design, data collection, report writing and manuscript preparation. FB: Participated in preparation of the manuscript.

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