Original

Central Corneal Thickness in Adult Non-Glaucomatous Blacks in South-Western Nigeria- a Hospital-Based Study

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Abstract

Background: Central corneal thickness is an important measurement in glaucoma management, corneal refractive surgery and monitoring of corneal pathologies. It varies from place to place, even in the same country and race to race. There is a need to determine the peculiar central corneal thickness of blacks in different parts of the country.

Methods: The study was a cross-sectional study between January 2023 and July 2024 and included all consecutive adult non-glaucomatous patients aged 18 years and above with no systemic disease, corneal pathology, previous corneal surgery, or ocular trauma. Information obtained included age, sex, history of systemic disease, eye trauma, previous eye disease or surgery. They all had a comprehensive eye examination. Ultrasonic pachymetry was performed using PacScan digital biometry model 300AP plus with a composite probe.

Results: Three hundred and sixty-eight eyes of 184 participants were included in the study. The mean age was 58.9 years (SD±13.9) and a male:female ratio of 1.5:1. The mean CCT (± SD) was 525.0µm (±33.0) (males 528.8µm (± 39.0) and females 519.0 µm (±23.0). Majority, 254(69%) had thin cornea (less than 535µm) while 50(13.6%), 52 (14.1%), 12 (3.3%) had normal (CCT 535 -560µm), thick (CCT 561 -600µm) and very thick (CCT greater than 600µm) cornea respectively. There was a statistically significant association between CCT, age (P=0.012) and sex (P=0.001).

Conclusion: The study has shown that the majority of blacks in our environment have thin cornea. Practitioners must always remember this in glaucoma workups.

Keywords: Central corneal thickness, non-glaucomatous blacks, Osogbo, South-western Nigeria.

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Introduction

The cornea is an avascular and transparent tissue that is thinner centrally and thicker peripherally.[1] The center of cornea is an important area that is used to determine the level of the intraocular pressure (IOP) which is an important measurement in glaucoma.

Central corneal thickness (CCT) is an important measurement in glaucoma management, corneal refractive surgery and monitoring of corneal pathologies.[3] It is a determining factor in IOP measurement. The thicker the cornea, the higher the IOP and vice versa. Africans have been said to have thinner cornea than Caucasians.[4, 5] On the average, CCT measures between 540μm and 560μm.[1, 2, 4, 5] A thick cornea is 565μm and above while a very thick cornea is more than 600μm.[6] Thin cornea (less than 535μm) is one of the risk factors for development of glaucoma as the IOP is falsely low when measured.

Measurement of the thickness of cornea is also important diagnostically and therapeutically while dealing with corneal refractive surgery and managing corneal pathologies such as oedema. In the surgery of Laser Assisted In situ Keratomileusis (LASIK), CCT enables the decision on the amount of stroma to be ablated in order to prevent corneal thinning.[7, 8]
Several factors have been found to affect CCT which include race, age, sex, drugs, time of day, blink rate, measuring equipment and ethnicity.[4, 9, 10,11, 12] Central corneal thickness varies from one ethnic group to the other. In the South-Southern part of Nigeria,[13, 14] a mean CCT of 550.0± 36.3 μm and 547.0 ± 29.5μm was found in 2010 and 2013 respectively.[13, 14]

This is comparable to findings in non -glaucomatous Caucasians 562.8 ± 31.1 μm, Hispanics 563.6 ± 29.1 μm and Asian ethnic subpopulations 555.9 ± 31.8 μm[15] but contrary to findings in Lagos, (529.3 ± 35.4μm),[16] South-East (533.05 ± 33.92μm),[17] other parts of Sub-Saharan Africa such as Cameroon (529.29 ± 35.90),[18] and African Americans (524.8 ± 38.4 μm)[15]

Mean CCT decreases with age but there is no significant sex difference in African Americans, Caucasians, Hispanics, Filipinos, Chinese and Japanese[15]
In view of this variability between different races and even within same race, there is a need to determine the peculiar CCT of each part of Nigeria as earlier suggested.[3] This will enable the use of peculiar CCT in diagnostic and therapeutic processes in our community.
Central corneal thickness can be measured in many ways. Ultrasound pachymetry is the most common method and the gold standard. It is non-invasive, portable, easy to use and efficient.
However, it can cause discomfort despite topical anaesthesia, infection, erosion and errors through indentation of corneal surface.[19, 20] Corneal thickness can also be measured by using a non-contact device- the Pentacam HR (Oculus) which is not available in our hospital.[21] However, it has been found that CCT measured with Pentacam HR and Ultrasound Pachymeter are closely related and can be interchanged.[22]

The aim of this study was to determine the mean CCT in non-glaucomatous patients in Osogbo and evaluate the relationship between mean CCT and sociodemographic factors. This will provide insight into the nature of CCT in this locality for purposes of diagnosis and treatment and compare with findings in other parts of Nigeria and other countries.

Methods

The study was carried out in the eye clinics of a teaching hospital and private specialist hospital in Osogbo, Osun state, Nigeria. Osun state is in the South-Western part of Nigeria with an area of 8,551.7km^2 and an estimated population of 4.3 million.[23]

It shares boundaries with Ekiti and Ondo states in the East, Kwara state in the North, Ogun state in the South and Oyo state in the West. Osogbo is the capital of Osun state.

The teaching hospital is a tertiary hospital with 320 beds while the specialist hospital is a 20 bedded hospital located in the Western part of Osogbo. They are both located in the capital of Osun state and receive patients from all over Osun state and nearby states.

Study design:
This was a hospital-based, cross-sectional study involving all consecutive patients that fulfilled the study inclusion criteria and seen in the two hospitals.
Included in the study were patients aged 18 years and above, who did not have glaucoma or ocular hypertension, who did not have history of systemic diseases such as Diabetes Mellitus, Hypertension, Rheumatoid arthritis, who did not have corneal pathology such as ectasia, encroaching pterygium and infection and who did not have history of contact lens wear

Patients younger than 18 years, glaucoma patients, those who systemic diseases and history of previous history of ocular surgeries or trauma were excluded from the study.

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Study Sample:

The sample was calculated using:

$$n = \left(\frac{Z \times \sigma}{E}\right)^2$$

where:

- Z = Desired confidence level = 1.96 for 95% confidence)
- σ = estimated standard deviation of the Central Corneal Thickness in Lagos[16] = 35.4
- E = desired margin of error (precision) which was 5µm

$$n = \left(\frac{1.96 \times 35.4}{5}\right)^2$$

= 193

+10% attrition =193 + 19 =212

All consecutive patients aged 18 years and above, seen in the two hospitals and who satisfy all the criteria listed above were included in the study until the sample size was completed.

Ocular and medical history was obtained using interviewer administered structured questionnaire (Appendix A) divided into the following sections: Socio-demography, history, physical examination and ocular examination was used to collect data.

Information obtained included age, sex, history of diabetes, hypertension and any other systemic disease, contact lens use, eye trauma and previous eye disease or surgery. Other information included blood pressure, visual acuity with or without PH or glasses, anterior segment examination, posterior segment examination and pachymetry (CCT).

The Nurses assessed visual acuity and took blood pressure. Distance visual acuity was assessed using the standard Snellen's literate and "E" Optotype placed at six meters away in broad day light depending on whether or not the participant is literate or not. Each eye was assessed separately. The test was adequately explained to the participants in the local language making sure each of them understood the test before starting. Each participant was tested without any aid. Those who could not see better than or equal to 6/12 were tested with Pin hole (PH). Those who normally wore glasses for distant vision were tested with their glasses. Near visual acuity was assessed using near vision chart.

Anterior segment examination was done by the authors using bright pen torch and Haag Streit 900 Slit lamp biomicroscope. Findings were recorded as stipulated in the questionnaire. Fundus examination was done using a + 78D or +90D Volk lens. Intraocular pressure was measured with Goldmann applanation tonometer.

Central cornea thickness:

Topical anaesthetic agent (Amethocaine HCL 0.5%) was instilled into the conjunctival sac and patients were instructed to close the eyes for about 2 minutes. Participant's biodata were entered into the machine and the procedure was performed. Ultrasonic pachymetry (CCT) was performed using PacScan digital biometry model 300AP plus with a composite probe.

The tip of the probe was gently placed perpendicular to the central cornea with the patient looking straight ahead. Five measurements as specified on the machine was taken in each eye and the average was entered into the questionnaire. Hypochlorite solution (1:10 dilution) was used to sterilize the tip of probe between patients.

Analysis of data was done using SPSS version 23. Continuous variables were analyzed as means (± standard deviation). Categorical variables were analyzed as frequencies and proportions. Chi-square test was used to compare categorical data with level of significance drawn at $P \leq 0.05$.

Ethical considerations:

Adequate explanation was given to the patients about the procedure and a verbal informed consent was obtained before inclusion. Approval was sort from the ethical committee of the Uniosun teaching hospital, Osogbo, Nigeria and all methods complied strictly with tenets of Helsinki declaration. No penalty was be given to those who declined inclusion. They were seen and treated accordingly.

Results

Three hundred and sixty-eight eyes of 184 participants were included in the study. There were 110(59.8%) males and 74(40.2%) females giving a male: female ratio of 1.5:1. Table 1.

Table 1 shows the majority, 114(62%) were in the 51–70-year age range while the mean age was 58.9 years (SD±13.9). Figure 1 shows majority of the Male were between 61-80 compared to females in which majority were between 51 and 70 years.

The mean CCT (± SD) was 525.0µm (±33.0) generally. (Table 2) The mean CCT for males was 528.8µm (± 39.0) while females had a mean CCT of 519.0 µm (±23.0)

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Two hundred and fifty-four (69%), 50(13.6%), 52 (14.1%) and 12 (3.3%) eyes were thin (less than 535µm), normal (CCT 535 -560µm), thick (CCT 561 -600µm) and very thick (CCT greater than 600µm) respectively. Table 2

The association between age and CCT was significant (p = 0.012) while the association between CCT and sex was very significant (p = 0.001). Table 3

Table 1: Age and sex distribution of participants

Variable	Frequency	Percentage
Gender		
Male	110	59.8
Female	74	40.2
Age group		
<31	4	2.2
31-40	17	9.2
41-50	15	8.2
51-60	51	27.7
61-70	63	34.2
71-80	26	14.1
81-90	8	4.4

Mean age ± SD = 58.9 ± 13.9

Table 1 above shows the demographic characteristics of the respondents. Greater than half were males (59.8%) while 40.2% were females. As regards the age group, majority, 114(62%) were in the 51–70 years range while the mean age was 58.9years (SD±13.9)

Table 2: Distribution of Central cornea thickness of eyes

Variables	Frequency	Percentage	Mean ± STD	range (Min-Max)
CCT				
<535	254	69.0	525.0±33.0	410-636
535-560	50	13.6		
561-600	52	14.1		
>600	12	3.3		

Table 2 shows the distribution of central corneal thickness in the eyes

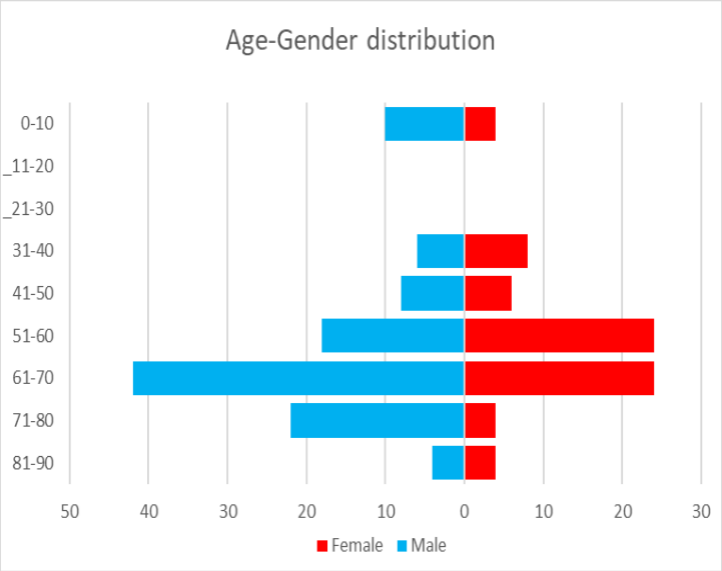

Figure 1: Age/Sex distribution of participants

Figure 1 above shows the distribution of age by gender.

Table 3: Association between age, sex and mean CCT of eyes

Variable	Mean CCT – freq (%)		Statistics
	≤560 µm	>560 µm	
Gender			
Male	92 (83.6)	18 (16.4)	X^2=11.037, p=0.012
Female	72 (97.3)	2 (2.7)	
Age Group			
<31	12 (85.7)	2 (14.3)	X^2=83.774, p<0.001
31-60	70 (100)	0 (0)	
61 and above	82 (82.8)	18 (17.2)	

Table 3 shows association between demographic characteristics and respondents mean CCT. There was statistically significant association between respondent's gender and mean CCT (X^2=11.037, p=0.012).

Also, a statistically significant association exists between respondent's age and mean CCT (X^2=83.774, p<0.001).

Discussion

Estimating the central cornea thickness of patients especially blacks is an important test in glaucoma management, corneal refractive surgery and monitoring of corneal pathologies. In fact, every new patient suspected of glaucoma must have, as part of workup, the measurement of central cornea thickness. In glaucoma

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management, the measurement of intraocular pressure is based on the amount of force that will flatten or depress corneal surface, and this is influenced by the thickness of the cornea. The thicker the cornea, the more force needed and hence the higher the pressure.

Three hundred and sixty-eight eyes of 184 participants were included in this study with a Male: Female ratio of 1.5:1 This preponderance of males may be because men seek help with their visual problems in relation to official duties more than women who may be full housewives and traders.

The mean CCT (± SD) was 525.0µm (±33.0) which is thinner than the accepted normal thickness of 535 to 560µm. It is also less than the findings in Chinese (552.3 µm±33.4) but similar to findings in Lagos, (529.3 ± 35.4µm),[16] other parts of Sub-Saharan Africa such as Cameroon (529.29 ± 35.90),[18] and African Americans (524.8 ± 38.4 µm)[15] and almost similar to what was found in Malays (540,9±33.6 µm) and Indians (540.4± 33.6 µm).[1]

A thin CCT has been identified as a predictive factor for the development of Primary Open Angle glaucoma by the Ocular Hypertensive treatment study (OHTS).[24]
Sixty-nine percent of eyes had a CCT less than 535µm in this study while another 13.6% had CCT between 535 and 560µm.

In a study,[25] ocular hypertensive patient with a CCT of 555µm and less had 3 times increased risk of developing glaucoma within 5 years compared with those with CCT greater than 588µm. It is therefore important in support of previous knowledge and most especially in our environment where the majority have thin corneae, that ocular hypertensive patients with thin CCT should be regularly and even more regularly screened for glaucoma.

This is also true for those that are not ocular hypertensives in our environment where most patients have thin CCT and come late in the disease because chronic open angle glaucoma (COAG) which is the commonest type of glaucoma is the silent type.[26]
In this study, mean CCT for males (528.8µm (± 39.0) was higher than for females (519.0 µm (±23.0) and there was a statistically significant relationship between sex (P=0.012) and age (P=0.001). Elderly patients had thinner corneae than younger ones. Also, men had thicker corneae than women in this study. This is similar to findings in some studies[27,28,29] but contrary in some[30] in which women had thicker cornea than men while other studies found no differences between men and women.[15, 31] The reason for this variation is not fully understood but may be due to hormonal variations in females, genetics and slight differences in eye size between gender. There is a need for further studies on gender differences of CCT in future.
A decreasing CCT with age at the rate of 2-10 µm per decade has been documented in several studies[32, 33] while others have shown no association between age and CCT.[34, 35]

Strengths and limitations of the Study
This study is the first to estimate the average central cornea thickness in Osogbo. It has shown that the CCT is thin, and caution should be taken to send patients away without examining their discs. However, a population-based study is needed in the future.

Conclusion
This study has shown that majority of blacks in our environment have in fact very thin cornea and practitioners must bear this in mind all the time in glaucoma workup. Normal or low intraocular pressure in patients at risk of glaucoma must not be discarded without thorough glaucoma workup that includes among other things, CCT, central visual field and optical coherence tomography. Ocular hypertensives must have CCT done and must be reviewed quite often to detect conversion to glaucoma.

Declarations
Authors' Contribution: The first author conceptualised the topic, searched the literature, collected data and wrote the article. The second author also searched the literature, collected data and wrote the article.
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