Original article

Central corneal thickness among glaucoma patients attending Menelik II Hospital, Addis Ababa, Ethiopia

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Abstract

Background: Glaucoma is one of the leading causes of blindness. Intra-ocular pressure is the main and only manageable of all risk factors for glaucoma. The central corneal thickness has been shown to affect the intra-ocular pressure measurement and is different among different ethnic population and subtypes of glaucoma. The central corneal thickness of different subtypes of glaucoma at Menelik II Hospital has not been determined.

Objective: The objective of this study was to measure the mean central corneal thickness of different sub types of glaucoma and ocular hypertension of patients attending Menelik Hospital.

Participants and Methods: A cross sectional comparative hospital-based study was carried out at the glaucoma clinic of Menelik II Hospital to assess the pattern of central corneal thickness of patients with different subtypes of glaucoma from 01 May 2014 to 30 August 2014. Central corneal thickness was determined by taking average of six measurements using ultrasonic Pachymetry. All consecutive open angle glaucoma patients and age matched non-glaucoma patients were included in the study. Eyes with incisional surgery, corneal diseases or trauma were excluded. Data was collected entered, cleaned and analyzed using SPSS windows version 16. Level of significance was taken at 5% for association of corneal thickness measurement and glaucoma subtypes.

Results: One hundred fourteen patients were examined. Twenty-three had primary open angle glaucoma, 16 had pseudoexfoliative glaucoma, 15 had Ocular hypertension, 32 had Normal tension glaucoma, and 28 were non-glaucoma patients. The mean Central corneal thickness for the group with Ocular hypertension, Primary open angle glaucoma, Pseudoexfoliative glaucoma, Normal tension glaucoma and non- glaucoma was 562.5±24.5μm, 517.5±27.5μm, 512.5±32.1μm, 488.0±32.4 μm, and 516.2±23.4μm respectively. Mean central corneal thickness in the ocular hypertension group was significantly higher (P<0.001) than primary open angle glaucoma, pseudoexfoliative glaucoma, normal tension glaucoma subtypes and non-glaucoma patients. Patients with normal tension glaucoma had significantly lower mean central corneal thickness (P<0.001) than primary open angle glaucoma, pseudoexfoliative glaucoma, subtypes, ocular hypertension and non-glaucoma group.

Conclusions: Patients with ocular hypertension had a higher mean central corneal thickness. By contrast, the mean central corneal thickness of patients with normal tension glaucoma was relatively low. [*Ethiop. J. Health Dev.* 2018;32(1):54-59]

Key words: Central corneal thickness glaucoma, intraocular pressure, pachymetry

Introduction

The term glaucoma refers to a group of eye diseases that has a characteristic optic neuropathy associated with visual field loss. The diagnosis of glaucoma is based on a combination of factors including intra-ocular pressure (IOP), optic disc (nerve fiber layer) damage and specific field defect (1). Baseline age, vertical and horizontal Cup to Disk ratio (CD ratio), pattern standard deviation (PSD), central corneal thickness (CCT) and IOP are good predictors for the onset of Primary open angle glaucoma (POAG) in the Ocular Hypertension Treatment Study (2).

The global prevalence of glaucoma for population aged 40-80 years is 3.54%. The prevalence of POAG is highest in Africa (4.20%). In 2013, the number of people (aged 40-80 years) with glaucoma worldwide was estimated to be 64.3 million. This number was estimated to increase to 76.0 million in 2020 and 111.8 million in 2040 (3).

Intraocular pressure is a key element in the management of glaucoma (4) and it should, therefore, be measured using a reliable technique with high degree of accuracy. Studies have shown the existence of variation in the mean central corneal thickness (CCT) among individuals with healthy eyes (5,6), in patients with different types of glaucoma and presence of pseudo-exfoliation syndrome (5).

The Goldmann applanation tonometry is an important instrument that permits an accurate measurement of intraocular pressure in the human eye. The development of this instrument was based on careful consideration of the optimal area of the cornea to be flattened to minimize the inward force caused by surface tension of the tears and the outward force caused by the elasticity of the cornea (7). The inventors of Goldmann tonometer (Goldmann and Schmidt) believed that significant variations in corneal thickness were uncommon and assumed a corneal thickness of 520 μm in calibration of the applanation tonometry. As clinical measurement of corneal thickness has become widely available, several studies have found a positive relation between corneal thickness and applanation pressure (8-12). Central corneal thickness is believed to influence the

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intraocular pressure measured through the cornea with an overestimation in thicker corneas and an underestimation in the thinner ones. There are also suggestions of the influence of CCT not related to tonometry (13), though, that having thin CCT is associated with the development and progression of glaucoma (14,15).

Corneal pachymetry is a measurement of the thickness of the cornea using a contact method of ultrasound or light contact corneal so called confocal microscopy (confosacan) or the different noncontact methods of optical biometry-scheimpflug camera Sirius and pentacam. Ultrasonic pachymetry is both easier and accurate (16).

Across ethnicity, the prevalence of POAG was distinctively higher among the people of African ancestry, similar to an earlier POAG report (17). Ethiopia, among the highly populated African nations, will therefore have a large number of people with open angle glaucoma. CCT data among Africans in general and Ethiopian glaucoma patients in particular are scare or lacking. This study was therefore inspired by the need to establish the CCT among open angle glaucoma patients at Menelik II Hospital. The rationale to do this is to improve diagnosis and management of different subtypes of glaucoma which helps to estimate average corneal thickness of Ethiopians.

Methods

A cross sectional comparative hospital-based study was conducted among glaucoma and non- glaucoma patients at glaucoma clinic of Menelik II Hospital between 01 May – 30 August 2014. Three groups of participants were considered in the study. One group had patients who were previously diagnosed with open angle glaucoma and ocular hypertension. This group consisted of patients who visited the clinic to get the effects of earlier treatment monitored. In the second group were patients who were diagnosed with glaucoma during the study period. The third group had age-matched non-glaucoma patients.

To begin the study, the proposal for the study had, first, to get approved by research and publication committee of the department of Ophthalmology, Addis Ababa University. Following that, but prior to data collect, verbal consent for participation in the study was obtained from the study participants. This was made possible after the participants were assured they would remain anonymous.

During the data collection, eyes with any history of incisional surgery, corneal diseases and injury were not used as data sources. All the patients in the study had a comprehensive eye examination - an evaluation of visual acuity on the Snellen chart, evaluation of anterior segment with slit lamp biomicroscopy, fundus examination with a 90 diopter Volk lens, IOP measurement with Goldmann applanation tonometer and gonioscopy evaluation using Zeiss four mirror and Goldmann lens. Glaucoma sub specialists or residents of glaucoma clinic carried out comprehensive eye examination.

Data for the study was collected using structured questionnaire. The questionnaire had spaces for participants to provide information on their age, sex and ethnicity. The principal investigator measured thickness of the central corneal using DGH 500 digital ultrasonic pachymeter, following topical tetracaine application in the cul-de-sac. Six measurements of the thickness of the central corneal were taken for each of the participants. This was done after gentle contact of the probe into the central cornea perpendicularly at the center of the pupil. The participants were allowed to blink their eyes between measurements to avoid dryness of the cornea. The average of the measurements was taken for all measured individuals. during the measurement, one eye of each patient was randomly selected using rand measure in simple calculator for data analysis.

Primary open angle glaucoma was operationally defined as an IOP of 22 mm hg or higher in the presence of glaucomatous disc or field defect and an open angle on gonioscopy. Similarly, pseudo exfoliation glaucoma was defined as an IOP of 22 mm hg or higher in the presence of glaucomatous disc or field defect, an open angle on gonioscopy and the presence of Pseudo exfoliation material on pupillary margin or on the lens capsule on dilated examination. Normal tension glaucoma was defined as the typical glaucomatous disc and field changes with an IOP measurement of 21 mm hg or lower on diurnal measurement and an open angle on gonioscopy. Ocular hypertension was defined as an IOP of 22 mm hg or higher with normal disc and visual fields and open angle on gonioscopy.

SPSS windows version 16 was used to analyze the data collected for the study. Frequency and association between CCT and socio-demographic factors was determined using chi-squared test. Relationship between CCT of different subtypes of glaucoma was made by f-test. Significance was taken if $P < 0.05$.

Results

A total of one hundred and fourteen eyes were examined for central corneal thickness (CCT) in this study. The mean age of the patients was 56.2±14.5 years (Range=12-82 years). Males were 50 (43.9%) and females were 64(56.1%). This means that male - female ratio was 0.87:1. Slightly over half, i.e., 58 (50.9%) of the participants were Amhara while 30 (26.3%) of them were Oromo. Of the 114 participants who were examined for CCT, 23(20.2%), 16(14%), 15(13.2%) and 32(28.1%) had Primary open angle glaucoma, Pseudoexfoliative glaucoma, Ocular hypertension, and Normal tension glaucoma respectively. The remaining 28(24.6%) were non-glaucoma patients. (Table 1 summarizes this).

Table 1: **Age and sex distribution, Ethnicity and diagnosis of Glaucoma patients attending Menelik II Hospital, Addis Ababa, Ethiopia. May-August, 2014**

Age group (years)	Gender		Total (% column)
	Male (% column)	Female (% column)	
10-29	1 (2)	3(4.7)	4(1.8)
30-39	2(4)	8(12.5)	10(8.8)
40-49	9(18)	15(23.4)	24(21.1)
50-59	12(24)	11(17.2)	23(20.2)
60-69	13(26)	15(23.4)	28(24.6)
70-100	13(26)	12(18.8)	25(21.9)
Ethnicity			
Amhara	17(32.2)	25(39.1)	42(36.0)
Oromo	19(35.8)	11(17.2)	30(25.6)
Tigre	5(9.4)	9(14.1)	14(12.0)
Gurage	5(9.4)	7(10.9)	12(10.2)
Others	7(13.2)	9(18.7)	16(16.2)
Diagnosis			
POAG	14(28.0)	9(14.1)	23(20.2)
PXG	8(16.0)	8(12.5)	16(14.0)
OHTN	8(16.0)	7(10.9)	15(13.2)
NTG	13(26.0)	19(29.7)	32(28.1)
NORM	7(14.0)	21(32.8)	28(24.6)

The mean IOP measurement in the group with ocular hypertension was 27.8±2.6 mm Hg, and that of POAG and PXF were 29.9±5.2 mmHg and 35.4±10.0 mmHg respectively, compared to 13.8±2.4 mm Hg in the non-glaucoma group and 15.3±3.7 mm Hg in patients with normal tension glaucoma. Patients with ocular hypertension, primary open angle glaucoma, and pseudo-exfoliation glaucoma had a significantly higher intraocular pressure measurement (P<0.001) than those with the controls and low-tension glaucoma groups (Table 2).

Table 2: **Mean IOP and Age distribution of the different types of glaucoma. Menelik II Hospital, Addis Ababa, Ethiopia. May-August, 2014**

	POAG	PXG	OHTN	NTG	NON-GLAU
Age(Years)	n (%)	n (%)	n (%)	n (%)	n (%)
10-39	0(0)	0(0)	2(13.3)	5(15.6)	7(25.0)
40-59	13(56.5)	7(43.8)	9(60.0)	15(46.9)	10(35.7)
60+	10(43.5)	9(56.2)	4(26.7)	12(37.5)	11(39.3)
Mean age (SD)	60.0(11.1)	60.9(12.9)	51.0(11.7)	56.8(13.7)	52.2(18.7)
P-Value	0.268	0.206	0.065	0.275	____
Mean IOP (mmHg)	29.9(5.2)	35.4(10.0)	27.8(2.6)	15.3(3.7)	13.8(2.4)
P-Value (x^2)	0.000	0.000	0.000	0.085	_

The mean central corneal thickness for the group with ocular hypertension, Primary open angle glaucoma, Pseudo-exfoliation glaucoma, normal tension glaucoma and the non-glaucoma group was 562.5±24.5 µm, 517.5±27.5 µm, 512.5±32.1 µm, 488.0±32.4 µm, and 516.2±23.4 µm respectively. The Mean CCT in the ocular hypertension group was significantly higher (P<0.001) than primary open angle glaucoma, pseudoexfoliative glaucoma, normal tension glaucoma and non-glaucoma groups. Mean CCT in the normal tension glaucoma group was significantly lower (P<0.001) than primary open angle glaucoma, pseudoexfoliative glaucoma, ocular hypertension and the non-glaucoma group. Patients with pseudo-exfoliation glaucoma were found to have lower mean CCT than primary open angle glaucoma. However, the association was not statistically significant (p =0.605) (Table 3).

Table 3: **Mean Central corneal thicknesses (CCT) in different sub-types of glaucoma and non-glaucoma patients. Menelik II Hospital, Addis Ababa, Ethiopia. May-August, 2014**

	POAG	PXG	OHTN	NTG	NON-GLAUC
Mean CCT µm (SD)	517.5(27.5)	512.5(32.1)	562.5(24.5)	488.0(32.4)	516.2(23.4)
P Value	0.859	0.660	0.000	0.000	
P Value		0.605	0.000	0.001	0.859
Range CCT (µm)	460.8-559.9	467.0-570.0	531.0-599.5	436.1-580.5	467.9-562.0
95% CI (µm)	504.4-533.1	491.8-525.7	531.6-624.1	445.0-474.6	500.6-529.2

Discussion

The mean central corneal thickness measurement of this study for the group with ocular hypertension, primary open angle glaucoma, pseudoexfoliative glaucoma, normal tension glaucoma and non-glaucoma was 562±24.5µm, 517±27.5µm, 512±32.1µm, 488±32.4µm, and 516±23.4µm respectively. The mean CCT of African-derived populations has been shown to be less than that of the whites in all major studies (16,17). The mean CCT in this study, excluding participants with OHTN and NTG, was 515.8±26.7µm. This is thinner than that of Caucasians (16).

A comparison of CCT of patients with primary open angle glaucoma against CCT of non-glaucoma patients showed no significant difference. The mean difference between the POAG and the non-glaucoma groups in this study was 1.3 µm, compared to approximately 3-9 µm reported by other investigators (18-22). This could be due to the lower mean CCT in the patients considered in this study, compared to the relatively higher values in the western countries.

The mean CCT values measured by ultrasonic pachymetry in this study increased significantly in the eyes with ocular hypertension and decreased in the eyes with normal tension glaucoma compared with the non-glaucoma, primary open angle glaucoma and Pseudoexfoliative glaucoma (see table 3). This finding agrees with the finding noted in many other similar studies (18,19.23-26). The importance of central corneal thickness in the discrimination between normal tension glaucoma, primary open angle glaucoma, and ocular hypertension has also been recognized in other studies (19-22,27). In patients with normal tension glaucoma, mean central corneal thickness was markedly reduced, leading to an underestimation of IOP measurements. By contrast, in patients with ocular hypertension, higher central corneal thickness values were obtained, causing an overestimation of IOP readings gained with a standard Goldmann applanation tonometer.

Ehlers and coworkers (28) interpolated that deviation from the influence of CCT of 520 µm yields an over or underestimation of IOP by applanation tonometry of approximately 0.7 mm Hg per 10 µm. Other studies also have confirmed the results published by Ehlers *et al (29-33).* Application of Ehlers et al.'s work to the participants of this study reveals that 37.5% of the patients with NTG have corrected IOP measurement of 21 mm Hg or greater and 33.3% of the patients with Ocular hypertension have a corrected IOP of less than 21 mm Hg.

In consistence with the result of this study, most recently, Argus has shown that increased CCT leads to artificially high estimations of IOP. Argus also applied the previous work of Ehlers et al [22 and] showed that 30% of his study patients with ocular hypertension and IOP measurements of 21 mm Hg or greater had IOP measurements of 18 mm Hg or lower when they were adjusted for CCT (20). Copt RP et al. (19), on their part, considered 115 glaucoma patients in their study. They reported that 31% of the patients initially thought to have normal tension glaucoma actually met the criteria for primary open angle glaucoma after correcting the applanation tonometer readings. In addition, 56% of the patients in Copt RP et al.'s study (19) with the original diagnosis of ocular hypertension were reported to have normal values of corrected intraocular pressure. This may explain why only a few patients with OHT develop visual field loss (33).

Leon W. Herndon and his colleagues found that a higher proportion of patients (65%) with ocular hypertension, compared to the patients who were noted to have an IOP greater than 21 mm Hg in the present study, actually had a corrected IOP of less than or equal to 21 mm Hg. Furthermore, Leon W. Herndon went back through each medical record and found the highest recorded IOP measurement in 55% to be less than or equal to 21 mm Hg when corrected for the CCT (18).

The present researchers also found a lower mean CCT in patients with pseudo-exfoliative glaucoma when compared to that of POAG patients and the non-glaucoma group. The difference was, however, not statistically significant (P-value=0.605&0.660). Reports in the literature of CCT in pseudoexfoliative glaucoma are controversial. Ehlers et al. found higher CCT values for pseudo-exfoliation glaucoma. It should be noted that this difference, like the difference reported in the present study, was not statistical significant (28). In another study, Herndon and coworkers reported almost identical values of CCT for pseudo exfoliation glaucoma and POAG, with the PXG patients being a subset of the POAG group (18). According to Martin B. and colleagues, patients with

pseudo-exfoliation glaucoma have a mean CCT which is statistically significantly lower than in the POAG ($p < 0.05$) and the control group ($p < 0.0001$). The reason for the significant reduction of CCT in PXF glaucoma remains unclear and requires a further investigation (34).

Two limitations of the present study are worth mentioning. One, the setting of patient selection was clinic-based. Two, the study had a relatively small sample size. However, beyond the proper evaluation made by glaucoma specialists during the diagnosis, the study involved no surgical intervention that could affect the measurement. This could be mentioned as one major aspect of the strength of the study.

In conclusion, the finding of this study revealed that patients who attend glaucoma clinic at Menelik Hospital with Ocular Hypertension (OHTN) and NTG have higher and lower mean CCT respectively than the non-glaucoma, POAG and PXG groups. It is important to note that CCT is a clinically relevant variable, and therefore, pachymetry be included in the assessment of glaucoma patients with presumed ocular hypertension and normal tension glaucoma. Glaucoma awareness and screening as well as CCT are important interventions are of public health importance.

A further study with a better design and a larger sample size that includes all sub-types of glaucoma is recommended. A study that includes all sub-types of glaucoma is hoped to give more accurate and representative value of cases of glaucoma in Ethiopian.

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