Relationship between Central Corneal Thickness and Intraocular Pressure in Non-Glaucoma Patients Attending Clinic at Federal Medical Centre, Owerri.

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ABSTRACT

Aim: To determine the relationship between central corneal thickness and intraocular pressure among non-glaucoma patients seen at the eye clinic of Federal Medical Centre, Owerri.

Methods: This is a hospital based descriptive, cross-sectional study on 175 non-glaucomatous patients that attended the eye clinic at Federal Medical Centre, Owerri from July, 2013 to October, 2013 who met the inclusion criteria. Purposive sampling method was used. Central corneal thickness was measured using ultrasound pachymeter and intraocular pressure measured by applanation tonometry. Data was entered and analyzed using SPSS version 19.0 Statistical software.

Results: A higher proportion of the respondents were in the age group 41-50 years (20.6%). The age range was 15-80 years, with mean age of 41.41 ± 18.08 years. There were more females (66.9%) than males (33.1%) with the male: female ratio of 1:2.02. There were no significant difference in the intraocular pressures between the two eyes of the respondents (p=0.318), but a significant difference in the central corneal thickness (p=0.001). There was a positive correlation (r = 0.095) between central corneal thickness and IOP, that for every unit rise in central corneal thickness there is a rise in the IOP by 0.006. This then showed that with every unit rise in the central corneal thickness, the mean corrected intraocular pressure decreased by 0.060 mmHg. This was also statistically significant (p < 0.001).

Conclusion: There was a positive correlation between central corneal thickness and intraocular pressure in non-glaucomatous patients. It is therefore, imperative that every patient undergoes pachymetric evaluation as part of routine clinic investigation as this will help in early detection of patients who may be at risk of developing primary open angle glaucoma.

Key words: central corneal thickness, intraocular pressure, glaucoma

INTRODUCTION

In healthy individuals, corneal thickness is the result of tissue mass, collagen fibrils, inter-fibrillary substance and the water content of the corneal stroma. The central corneal thickness (CCT) has been largely addressed as a fixed biometric entity that is believed to be an inherited parameter[1]. Furthermore, for the majority of individuals there seems to be little changes in CCT with aging, beyond the infant years[2]. The average central corneal thickness measures from 535µm to 565µm[3].

Central corneal thickness is known to affect the accuracy of intraocular pressure (IOP)

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measurements by applanation tonometry.[4,5] A thicker cornea requires greater force to applanate and conversely, a thinner cornea is more easily flattened; thinner cornea results in apparently lower IOP readings and thicker corneas cause artificially high IOP readings.[4-7] A thin cornea is a significant risk factor for the development of glaucoma[8]. The Goldmann Applanation Tonometry (GAT) is based on the Imbert-Fick law, which assumes that the cornea has a dry surface, is infinitely thin, and behaves as a "membrane" where the applanating pressure will equal the IOP[4]. In practice, a resistance force, because of the thickness of the cornea and a surface tension force, the result of the tear film, act upon the applanator causing this membrane assumption to be incorrect. These forces balance each other for the GAT (applanation diameter of 3.06 mm) when the CCT is 520µm, providing a "reference" value where the applanating pressure does equal the IOP[4]. GAT has been accepted as the gold standard of tonometry for some time[9,10].

There are different risk factors (thin central corneal thickness, advancing age, race and refractive error) that are known to affect the intraocular measurement by Goldmann Applanation tonometry[5,10,11]. It has been noticed that some patients especially non-glaucoma patients whose intraocular pressures were considered normal or low actually had high IOP after pachymetric evaluation. It is therefore imperative that we find out how central corneal thickness affects the intraocular pressure in our environment using Federal Medical Centre, Owerri as a study centre. The results of this study will also provide a normative data base for future comparison of results.

METHODS

This is a hospital based descriptive, cross-sectional study on175 non-glaucoma patients that attended the eye clinic at Federal Medical Centre, Owerri from July, 2013 to October, 2013. All consecutive new and follow up patients that met the inclusion criteria and who were seen at the eye clinic of FMC, Owerri within the study period from whom written consent were obtained formed the study population.

Inclusion criteria

1. Being 15 years and above
2. Consenting to the study by signing or thumb-printing the informed consent.

Exclusion criteria

To eliminate possible confounding factors, individuals with the following were excluded from the study:

1. Significant corneal pathology that might influence the corneal thickness or topography like[12]:
   a. corneal opacity/scar.
   b. corneal ulcer.
   c. corneal degenerative changes.
   d. keratoconus.
   e. pterygium that has gone beyond the incipient stage.
2. History of previous corneal or intraocular surgery.
3. History of ocular trauma.
4. History of use of contact lens within 2 or 3 weeks of measurement for soft and hard contact lenses respectively.
5. Patients with suspicious optic nerve head (vertical cup-disc ratio of >0.4 and asymmetry of ≥0.2)[13,14] or known Glaucoma patients.
6. Patients with repeated IOP of >21 mmHg.[14-16]

A structured interviewer-administered questionnaire and protocol form were used for data collection. Ocular examinations performed on all participants included their visual acuity, pen light and slit-lamp examination of the anterior and posterior segment, central corneal thickness using ultrasound pachymeter and intraocular pressure by Goldmann applanation tonometry. Participants with repeated intraocular pressure of > 21.0 mm Hg[14] in the two eyes were excluded from the study. All measurements of IOP were taken between 9am and 12pm, just like in CCT to prevent diurnal variation.[17] Central corneal thickness was measured with the Sonomed Pacscan 300 AP (Sonomed Escalon Medical Inc., NY, USA). After anaesthetizing the cornea with tetracaine 1% dropped in the lower fornix, each patient was asked to seat comfortably on the

examination chair and to blink before CCT measurements. This was to avoid any error because of corneal drying, as was performed by Copt et al[18]. The patients were required to look straight ahead on a colored target that was placed directly opposite them. The pachymeter probe was cleaned with methylated spirit-soaked swab, wiped with normal saline-soaked swab to avoid irritation of the cornea and placed on the centre of the cornea. Care was taken to apply the ultrasound pachymeter probe as perpendicular to the central cornea as possible. Centration of the probe on the central cornea was judged using the pupillary axis. Measured CCT for the subject was taken as the average of five different readings and recorded in microns (μm). All CCT examinations were done at approximately the same time of the day (examination times ranged from 9 am to 12noon) and any diurnal effect on the pachymetric subject measurements was avoided[19]. The probe was cleaned and dis-infected after every patient. Data was entered and analysed using SPSS version 19.0 Statistical software. Data was presented as rates, ratios and proportions in tables and figures. Comparison of variables was carried out using appropriate statistical methods. P values of 0.05 and below was considered statistically significant. The analysis included Chi-square, Fisher's exact test, and Analysis of Variance with Tukey post-hoc test, Student-t test and the computation of Pearson's linear correlation or coefficient of correlation(r).

RESULTS:

A total of 175 subjects met the inclusion criteria and all of them (100%) participated in the study. There were more females 117 (66.9%) than males 58 (33.1%) giving a male: female ratio of 1: 2.02. The age range was 15-80 years, with mean age of 41.41 ± 18.08 years.

TABLE 1: Socio-demographic characteristics of the respondents in FMC, Owerri.

Characteristics	Frequency (n = 175)	Percentage (%)
Age group (years)		
11 – 20	34	19.4
21 – 30	24	13.7
31 – 40	27	15.4
41 – 50	36	20.6
51 – 60	23	13.1
61 – 70	19	10.9
71 – 80	12	6.9
Sex		
Male	58	33.1
Female	117	66.9

***Mean (SD) = 41.41 (18.08) years**

Table 1 shows that highest proportion 36 (20.6%) of the respondents were in the age group 41 – 50 years; followed by those 34 (19.4%) in the age group 11 – 20 years; while the least 12 (6.9%) represented were those in the age group 71 – 80 years.

TABLE 2: Summary statistics for Intraocular Pressure and Central Corneal Thickness of the respondents in FMC, Owerri.

Measured variables	n	Mean (standard deviation) Right eye	Left eye	Pearson correlation	p-value*
Mean IOP (mmHg)	175	16.67 (2.95)	16.80 (2.80)	0.807	0.318
Central corneal thickness (μm)	175	534.30 (40.61)	528.71 (44.47)	0.872	0.001**
Corrected IOP (mmHg)	175	17.67 (3.97)	17.83 (3.95)	0.834	0.323

***paired t-test **statistically significant at the 0.05 level, Range of IOP 10-21, Range of CCT 434.5 to 622.5**

The mean IOP (mmHg) and the corrected IOP (mmHg) for the left eye were higher than those of the right eyes of the respondents (Table 2). These relationships were not statistically significant (p = 0.318, and 0.323 respectively).

The mean central corneal thickness of the right eye was higher than that of the left eye of the respondents. This relationship was statistically significant (p = 0.001).

TABLE 3: Predictors of mean measured Intraocular Pressure of respondents (Multivariate Linear Regression) in FMC, Owerri

Predictors	B (Regression coefficient)	p-value	95% CI for B	
			Lower Bound	Upper Bound
Constant	10.328	0.000	4.819	15.837
Central corneal thickness	0.009	0.082	-0.001	0.019
Age (years)	0.042	0.001	0.018	0.066
Refractive error (Dioptres)	-0.100	0.328	-0.301	0.101

R^2 (Coefficient of determination) = 5.9%

Table 3 shows the result of the multivariate linear regression which predicted 5.9% variation in the mean measured intra ocular pressure. With a unit rise in central corneal thickness, the mean measured IOP increased by 0.009 mmHg while controlling for age and refractive error which are independent variables that can affect the IOP. This was not statistically significant (p = 0.082).

TABLE 4: Predictors of mean corrected Intra Ocular Pressure of respondents (Multivariate Linear Regression) in FMC, Owerri.

Predictors	B (regression coefficient)	p-value	95% CI for B	
			Lower Bound	Upper Bound
Constant	48.062	0.000	42.366	53.757
Central Corneal Thickness	-0.060	0.000	-0.070	-0.050
Age (years)	0.039	0.002	0.014	0.064
Refractive error (Dioptres)	-0.096	0.362	-0.304	0.111

R^2 (Coefficient of determination) = 47.8%

Table 4 shows the result of the multivariate linear regression which predicted 47.8% variation in the mean corrected intraocular pressure. With a unit rise in central corneal thickness, the mean corrected IOP decreased by 0.060 while controlling for age and refractive error. This was statistically significant (p = 0.000).

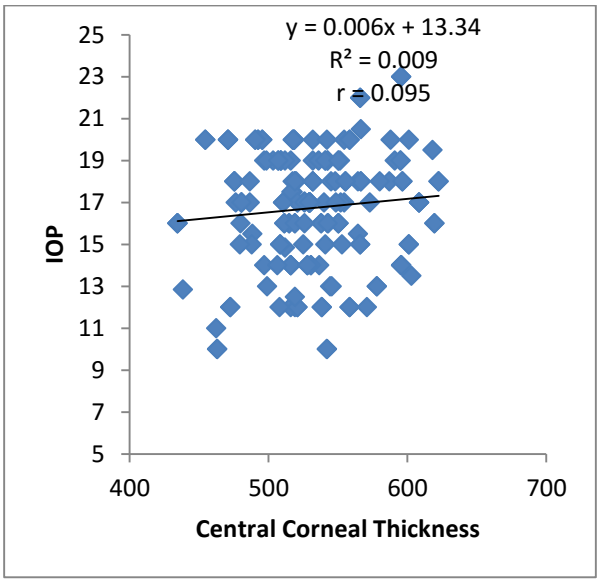

FIGURE 1: FIGURE: SCATTER PLOT OF CENTRAL CORNEAL THICKNESS AND INTRAOCULAR PRESSURE OF THE RESPONDENTS

There is a positive correlation (r = 0.095) between central corneal thickness and IOP, and for every one unit rise in central corneal thickness there is a rise in the IOP by 0.006.

DISCUSSION

This study was carried out among non-glaucomatous subjects who had met the inclusion criteria. It provided information on the relationship between central corneal thickness and intraocular pressure. This study is similar in design with other hospital-based studies,[20-23] but vary in sample size and age.

A total of 175 respondents participated in the study. The minimum and maximum ages of the respondents were 15 years and 80 years respectively. A higher proportion of the respondents were in the age group 41-50 years

(20.6%) with mean age of 41.41 ± 18.08 years. This is slightly similar to the mean age reported in similar studies in Nigeria by Nzelu-Egwuonwu[24] and Iyamu et al[23] where the mean age of the respondents were 45.4 ± 16.5 years and 45.3 ± 15.4 years respectively.

There were more females (66.9%) than males (33.1%) with a male: female ratio of 1:2.02. Other similar studies done in Nigeria also reported more females than males across all the age groups.[23] The reason for the higher population of females could be due to the fact that men are more into business and may not have the time to come to the eye clinic if the condition is not disabling.

In this study, with a unit rise in CCT, the mean measured IOP increased by 0.009 mmHg while controlling for age and refractive error as shown in table 3. This was not statistically significant (0.082). Conversely, with a unit rise in CCT, the mean corrected IOP decreased by 0.060 mmHg while controlling the age and refractive error as shown in table 4. This was statistically significant (p=000). Figure 1 showed that for every one unit rise in central corneal thickness there is a rise in the IOP by 0.006. It then showed that thinner corneas gave a falsely low IOP and a thick cornea overestimated the IOP. The reason for this finding could be due to the fact that thicker corneas require greater force to applanate while thinner corneas are more easily flattened[4]. Therefore, thinner corneas result in apparently lower IOP readings and thicker corneas cause artificially high IOP readings[4-7]. Studies in Sudan[25] and Cameroon[12] showed a strong positive correlation between CCT and IOP. In Nigeria, Babalola et al[26] reported that both Goldmann Applanation Tonometer (GAT) and Non-contact Tonometer (NCT) IOP tended to rise with increasing CCT, but NCT IOP was more significantly affected by CCT. Regression analysis showed that NCT IOP increased by 0.6 mmHg for every 10µm increase in CCT compared to 0.4 mmHg for GAT. Also, Nzelu-Egwuonwu[24] in a population-based study to determine the distribution of central corneal thickness and its correlating factors in Nigerians reported that the central corneal thickness positively correlated with IOP. Other studies that found a significant positive relationship between CCT and IOP were Nemesure et al[27], Brandt et al[28] in the Ocular Hypertension Treatment Study, and Lleo et al.[21]

.On the contrary, Feltgen et al[29] and Shah et al[22] found no relationship between CCT and IOP. Similarly, Adegbehingbe[20] and Iyamu et al[23] in their hospital-based studies did not find any significant association between CCT and IOP.

In conclusion, there is a significant positive correlation between central corneal thickness and intraocular pressure. The mean measured IOP of respondents increased with an increase in CCT. Thus, a thick cornea leads to an overestimation of IOP, and a thin one leads to an underestimation of IOP. It is pertinent therefore, that every patient that visits the eye clinic should have pachymetric evaluation as this will help in early detection of patients who may be at risk of developing primary open angle glaucoma.

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