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THE RELATIONSHIP BETWEEN REFRACTIVE ERROR AND CENTRAL CORNEAL THICKNESS IN PATIENTS SEEN AT FEDERAL TEACHING HOSPITAL, OWERRI, IMO STATE

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Abstract

Background: Refractive error and central corneal thickness are factors that can affect vision relatedly. Refractive errors, including myopia, hyperopia and astigmatism are common visual anomalies that affect millions worldwide. Central corneal thickness influences the eye's biomechanical stability and susceptibility to various ocular conditions.
Objective: To determine the relationship between refractive error and central corneal thickness (CCT) in participants seen at Federal Teaching Hospital, Owerri.
Methods: This is an analytical, cross-sectional study of 175 non-glaucomatous patients. A purposive sampling method was used to recruit participants. Data was analyzed using SPSS version 19.0 Statistical software
Results: The highest proportion of participants were in the 41-50 years (20.6%)age group. The females were (66.9%) and males (33.1%). (M: F= 1.0:2.02).
The mean refractive error for the right and left eyes were -0.24DS and -0.19 DS respectively while the mean CCT for the right and left eyes were 534.30μm and 528.71μm respectively. There was no significant difference in the refractive error between the two eyes of the participants (p=0.443), but a significant difference in the central corneal thickness (p=0.001). There was a significant relationship between refractive errors and central corneal thickness (p=0.008). For every unit rise in refractive error in the positive direction, the central corneal thickness increased by 4.073μm, while controlling age meaning that the central corneal thickness is thicker in hyperopes than in myopes.
Conclusion and Recommendation: Myopes had thin central corneal thickness while Hyperopes had thicker central cornea. Myopes should have pachymetric evaluation considering that their thin cornea may result in underestimation of the intraocular pressure
Key words: Central corneal thickness, Hypermetropia, Myopia, Refractive error

INTRODUCTION

Refractive error is defined as a state in which the optical system of the non-accommodating eye fails to bring parallel rays of light to focus on the fovea[1].There are different types of refractive errors and these include myopia, hypermetropia and astigmatism. Myopia and hypermetropia are states of refractive error in which the optical system of the eye brings parallel rays of light into focus anterior and posterior to the fovea respectively resulting in blurred vision while astigmatism is inability of the eyes to form a point focus[1].

In 2010, the estimated number of people visually impaired in the world was 285 million from all causes, 39 million blind and 246 million with visual impairment2.Uncorrected refractive errors accounted for 43% of the visually impaired and 3% of the blind[2]. The report of the Nigeria National Blindness and Low Vision Survey showed that 61% of adults aged 40 years and above are visually impaired from uncorrected refractive errors[3].

Myopia is the most common refractive error in the general population and its prevalence varies according to age, gender and race[4,5]. Knowledge of the prevalence of myopia is important considering that there is a higher prevalence of open angle glaucoma among myopic eyes than in both hypermetropic and emmetropic eyes[6,7]

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[8]. Furthermore, for the majority of individuals there seems to be little changes in CCT with aging, beyond the infant years[9]. The average central corneal thickness measures from 535μm to

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565μm[10].

It has been reported in studies that myopes are more predisposed to developing primary open angle glaucoma[6,7,8]. While myopia and thin central cornea have been reported as risk factors for glaucoma, myopia has also been associated with the development of thin cornea[8].

The result of this study will help to explore the relationship between refractive error and central corneal thickness. The information from this study will unravel broader understanding of the relationship between myopes with thin cornea and open angle glaucoma and help fill the gap in knowledge as there has not been a similar work done in the locality

METHODS

This is a hospital based analytical, cross-sectional study of 175 non-glaucoma patients that attended the Eye clinic at Federal Teaching Hospital (FTH), Owerri over 3 months' period. All consecutive new and follow up patients that met the inclusion criteria and who were seen at the Eye clinic of FTH, Owerri within the study period and from whom written consent were obtained formed the study population.

Inclusion Criteria

1. Being 15 years and above
2. Diagnosis of refractive error with an Autorefractor done on patients that presented with poor vision

Exclusion Criteria

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

1. Participants with significant corneal pathology that might influence the corneal thickness or topography such as18.
   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)19,20or known Glaucoma patients
6. Presbyopia

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 non-cycloplegic refraction using autorefractor. (Zeiss Acuitus Model 5015)

Measurements of refractive status were taken with the auto-refractor after patients were seated comfortably on the machine with their chin and head well adjusted. Readings from the objective refraction using the auto-refractor were recorded. And then subjectively refined. For the purpose of comparison with other studies[7,21,22,23,24,] astigmatic refractions were calculated in dioptres sphere as the spherical equivalent (spherical refractive error plus 0.5 X cylindrical refractive error)[1] and refractive errors were categorized into myopia, emmetropia and hypermetropia depending on the degree of the error. Participants were also divided into three groups according to their refractive status: hyperopia, emmetropia and myopia as defined in the Blue Mountain Eye Study[7].

Central corneal thickness was measured with the Sonomed Pacscan 300 AP (Sonomed Escalon Medical Inc., NY, USA). after anaesthetizing the cornea with tetracaine 1% instilled into the lower fornix. The participants were made to seat comfortably on the examination chair and instructed to blink before the measurements. This was to avoid any error due to corneal drying, as was proposed by Copt et al[25]. The patients were required to look straight ahead on a colored target that was placed directly opposite them. The cleaned and sterilized pachymeter probe was applied perpendicular to the central cornea. and dis-infected after every subject. Centration of the probe on the central cornea was determined using the pupillary axis. The average of five different readings was recorded in microns (µm). A repeated daily CCT examinations were done between 9 am to 12noon so as to avoid any diurnal effect on the pachymetric measurements. [26].

Data was analyzed using SPSS version 19.0 Statistical software. The data were presented as rates, ratios and proportions in tables and figures. The comparison of variables was done using ANOVA, paired t-test and Pearson's correlation coefficient. A p-value of <0.05 was considered statistically significant.

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 1.0: 2.02. The age range was 15-80 years, with mean age of 41.41 ± 18.08 years. The prevalence of refractive error from our study was 50.9% with hypermetropia being the commonest refractive error (51.7%).

TABLE 1: AGE AND SEX DISTRIBUTION OF THE PARTICIPANTS IN FMC, OWERRI.

Characteristics	Frequency (n = 175)	Percentage
Age group (years)		
15 – 20	34	19.4
21 – 30	24	13.7
31 – 40	27	15.4
41 – 50	36	20.6B
51 – 60	23	13.1
61 – 70	19	10.9
71 – 80	12	6.9
Sex		
Male V	58	33.1
Female	117	66.9

Table 1 shows that higher proportion of the participants were in the age group 41 – 50 years; 36 (20.6%), followed by those in the age group 15 – 20 years; 34 (19.4%), while the least represented were those in the age group 71 – 80 years; 12 (6.9%).

TABLE 2: SUMMARY STATISTICS FOR REFRACTIVE ERROR AND CENTRAL CORNEAL THICKNESS OF THE PARTICIPANTS IN FMC, OWERRI.

Measured variables	N	Mean (standard deviation) Right eye	Left eye	Pearson correlation	p-value*
Refractive error (Dioptre)	175	-0.24 (2.23)	-0.19 (2.26)	0.906	0.443
Central corneal thickness (µm)	175	534.30 (40.61)	528.71 (44.47)	0.872	0.001**

***paired t-test **statistically significant at the 0.05 level, Range of refractive error -8.0DS to +4.63DS, Range of CCT 434.5 to 622.5**

The mean refractive error (dioptres) and the mean central corneal thickness of the right eye were higher than those of the left eye of the participants. This relationship was not statistically significant for refractive error (p = 0.443) but significant for central corneal thickness (p = 0.001). There was a statistically significant strong positive correlation between the right and the left eye of the participants across all the variables being measured with refractive error having the highest correlation (r = 0.906).

TABLE 3: STRATIFICATION OF REFRACTIONS AND CCT

SE of ranges of Refractive errors(DS	Mean CCT(µm	N	SD
>-5.0	498.5000	8	±27.99362
-5.0 to-3.25	534.3000	5	±47.52184
-3.0 to-0.25	533.6364	66	±45.09337
-0.24 to +0.24	503.5000	1	
+0.25 to +3.0	532.7258	93	38.48253
+3.25 to +5.0	543.2500	2	51.97235
Total	531.5029	175	41.23714

qSE- spherical equivalent, DS- dioptre sphere, SD- standard deviation, Range of Refractive error -8.0 to +4.63DS.

The table 3 shows the range of refraction, their corresponding mean CCT and standard deviation. The table also shows the frequency distribution of the refractive errors. Most of the respondents fell into the range of +0.25 to +3.0DS followed by -0.25 to -3.0DS. The central cornea was thinnest in the respondents with refraction of >-5.0DS and thickest in the respondents with refractions of +3.25DS to +5.0DS.

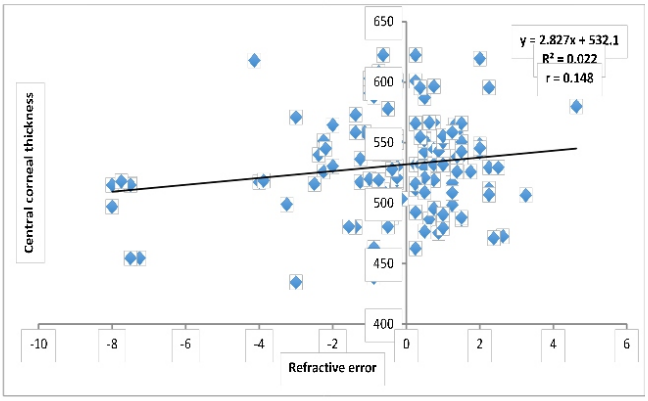
TABLE 4: RELATIONSHIP BETWEEN REFRACTIVE ERROR AND CENTRAL CORNEAL THICKNESS OF THE RESPONDENTS IN FMC, OWERRI.

	Mean (standard deviation)
Refractive status	CCT
Myopia	521.88 (48.49)
Emmetropia	536.98 (38.39)
Hypermetropia	530.26 (38.07)
p-value*	0.143

***F-test (ANOVA)**

Table 4 shows that the mean central corneal thickness was highest in the emmetropes, followed by hypermetropes and least in myopes. This relationship was not statistically significant (p = 0.143).

FIGURE 1: SCATTER PLOT OF REFRACTIVE ERROR AND CENTRAL CORNEAL THICKNESS OF THE RESPONDENTS



There is a positive correlation (r = 0.148) between refractive error and central corneal thickness, and for every one unit rise in refractive error in the positive direction (that is from myopia to hypermetropia) there a rise in the central corneal thickness by 2.827.

TABLE 5: PREDICTORS OF CENTRAL CORNEAL THICKNESS OF RESPONDENTS (MULTIVARIATE LINEAR REGRESSION) IN FMC, OWERRI.

Predictors	B (regression coefficients)	p-value	95% CI for B Lower Bound	Upper Bound
(Constant)	548.275	0.000	531.773	564.778
Age (years)	-0.384	0.039	-0.748	-0.019
Refractive error (DS)	4.073	0.008	1.066	7.079

R2 (coefficient of determination) = 3.5%

Table 5 shows the result of the multivariate linear regression which predicted 3.5% variation in the mean central corneal thickness. With a unit rise in refractive error in the positive direction, the central corneal thickness increased by 4.073, while controlling age. This was statistically significant (p = 0.008).

DISCUSSION

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[10]. Furthermore, for the majority of individuals there seems to be little changes in CCT with aging, beyond the infant years[11]. The average central corneal thickness measures from 535 μm to 565 μm [12]. The process by which myopia progresses does not to a measurable degree influence the CCT and high ametropia may bias the measurement of CCT especially after undergoing Laser-in-situ keratomileusis (LASIK)[15,16].

The impact of refractive error on the central corneal thickness has been a topic of interest in ophthalmology.

The definition of different refractive states used in this study was adopted from the Blue Mountain Eye Study[7]. This study is similar in design with other hospital-based studies[24,27,28,29], 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 Iyamu E. et al[23] and Nzelu-Egwuonwu[32] where the mean ages of the respondents were 45.3 ± 15.4 years and 45.4 ± 16.5 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[21,24,28]. 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.

The mean refractive errors for right eye (-0.24 ± 2.23) was lower than that of the right eye (-0.19 ±2.26). This was not statistically significant (p=0.443). The difference in the refractive errors between the eyes maybe due to genetic factors, variability in the eye growth or corneal differences. This is similar to what was found in a hospital-based study[33] done in Central Ghana and this could be due to the similarity in the study design as both are hospital-based studies and a not too large sample size. In contrast, studies[34,35] done among Chinese populations in Singapore and among Isreali adults recorded a statistically significant correlation. This could be due to the larger number of people studied.

The mean CCT of the right eye (534.3 ± 40.61) of the respondents was higher than the left eye (528.71 ±44.47). This relationship was statistically significant. In contrast, studies done by Iyamu E. et al in Edo State and Adegbehingbe SA in Oyo State found no significant correlation between the paired eyes of the patients. This could be due to the small sample populations they studied, but similar to what was reported in other studies[36,40] with much larger population as the index study. This CCT difference between the paired eyes which implies that one eye has a thinner cornea could be associated to a worse glaucoma in the thinner cornea eye

The mean CCT increased in the respondents from myopia to emmetropia as shown in tables 4 and figure 1, but this was not statistically significant (p=0.143). On further analysis by multivariate logistic regression, the mean CCT increased by 4.073μm for every unit rise refractive error (from myopia to hypermetropia) as shown in table 5. This was statistically significant (p=0.008). This finding showed that myopes had thinner CCT than emmetropes and hypermetropes. Similarly, Nemesure et al1[4] in the Barbados Eye Study and Alsbirk et al[36] in their studies reported that myopic eyes had significantly thinner corneas than eyes with less negative or more positive refractive errors. The similarity can be explained by the design, sample size and age distribution. . This result however, differed with that of Adegbehingbe SA[30], Iyamu E. et al[24], Cho P et al[41], Chen MJ et al[42] and Fam HB et al[43] whose reports did not show a significant association between refractive error and CCT. These studies were similar to the present study in design, the predominant age group, but differed in sample population and size. That could have accounted for the disparity in results. The corneas of myopes being thinner can be explained by the fact the axial length of their eyes is longer with stretching and thinning of the outer coats of the eyes[13].

CONCLUSION AND RECOMMENDATION:

The prevalence of refractive error from our study was 50.9% with hypermetropia being the commonest refractive error (51.7%). The findings in our study also showed a significant positive correlation between refractive error and CCT. The central corneal thickness was thinnest in myopes..

It is recommended therefore, based on the findings of this study that eye care practitioners take central corneal thickness into consideration when managing myopes. Regular monitoring of corneal thickness could aid in personalized treatment strategies and enhance the overall success and safety of refractive prodecures in individuals with myopia. It is also crucial that clinicians recognize the potential implications of the thin central corneal in myopes in the underestimation of their intraocular pressures. This is to identify those at risk of developing primary open angle glaucoma.

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