

Central Corneal Thickness in an Adult Non-Glaucomatous Ethnic Population in Nigeria

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Research Article

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Abstract

Purpose: To determine the mean central corneal thickness (CCT) of healthy adult Nigerians from the Igbo ethnic population in southeastern Nigeria which has the highest prevalence of glaucoma and to evaluate the relationship if any between mean CCT and patients' demographics.

Methods: A cross sectional study conducted at an eye screening center in Enugu Southeastern Nigeria. Subjects with healthy eyes from the Igbo ethnic population were recruited. Central corneal thickness was measured with ultrasound pachymetry (Sonomed PacScan plus, model 300AP+) on eligible subjects. Topical anesthetic was instilled and 3 measurements of corneal thickness were taken. The average thickness for each eye was calculated and the relationship between mean CCT, age and gender were studied.

Results: 706 eyes of 353 participants were examined. 52.7% of the subjects were females while 47.3% were males. The mean age of participants was 50.29 ± 16.58 years. The mean central corneal thickness (CCT) for RE was $527.68 \pm 36.88\mu\text{m}$ (95% CI: $523.83 - 531.55\mu\text{m}$) and $527.45 \pm 38.01\mu\text{m}$ for LE (95% CI: $523.47 - 531.43\mu\text{m}$). There was a decrease in CCT values with increasing age ($p= 0.016$, $p= 0.05$ for RE and left eyes respectively). Males had a significantly higher CCT compared to females for both right and left eyes ($p=0.004$, $p=0.007$).

Conclusion: Central corneal thickness values in the Igbo ethnic population of Southeast Nigeria, an ethnic group with the reported highest prevalence of glaucoma in Nigeria from our study is thinner than those reported from other regions both within Nigeria as well as some Sub-Saharan populations, Caucasians, Asians, and Hispanics but it is however comparable with values reported among Cameroonians and African Americans. CCT among Nigerian Igbos, seems to decrease with age and appears thicker in males compared with females.

Introduction

Central corneal thickness (CCT) is an important clinical ocular parameter that affects the accuracy of intraocular pressure (IOP) measurements obtained with Goldmann applanation tonometry (GAT) [1]. Goldmann applanation tonometer is calibrated for a central corneal thickness of 520 micrometer, based on this, thin CCT leads to an underestimation of intraocular pressure whereas thick CCT is associated with overestimation of intraocular pressure [2].

CCT measurement is taken into consideration in the screening, diagnosis and management of ocular hypertension and glaucoma [3, 4]. In refractive surgery procedures, CCT measurements are of importance when assessing a patient's eligibility, deciding the appropriate surgical procedure as well as preventing postoperative complications [4, 5].

Factors thought to affect CCT may include race, age, sex, anthropometric parameters, drugs, time of day, blink rate, measuring equipment and ethnicity [6].

CCT is considered an independent risk factor for the development of glaucoma and may represent a substantial mediator of the relationship between glaucoma and race [7]. Studies have postulated that certain racial or ethnic groups disproportionately suffer a higher prevalence of glaucoma and its complications [8, 9]. However, whether ethnic groups with higher prevalence of glaucoma possess identifiable anatomical features such as thinner CCT, optic nerve area and cup depth variations are clinical questions that are yet to be answered [10].

Studies have shown that CCT is associated with a strong heritability trait [11, 12]. Studies on racial and ethnic variations in CCT [13, 14] suggest that African Americans and populations with African ancestry may have thinner corneas than Caucasians [7, 15]. The populations highlighted above with thinner corneas have also been reported to harbor a higher incidence and prevalence of glaucoma [16].

The Nigerian national blindness and visual impairment survey is to date the largest population based visual impairment survey conducted on the African continent [17, 18]. According to the survey, the highest prevalence of glaucoma (6.1%) was reported among the Igbo ethnic population- a tribe domiciled predominantly within southeastern Nigeria. In addition to Igbo ethnicity, another independent risk factor for glaucoma reported in the Nigerian study was increasing age [18]. The Nigerian survey above highlights the occurrence of ethnic variations in the prevalence of glaucoma and glaucoma blindness in Nigeria which is the most populous African nation, however noted was the absence of data for central corneal thickness.

Some authors have reported central corneal thickness profiles among healthy Nigerians but the ethnic profiles of the subjects were not specified in those studies [19, 20].

In this study, we intend to determine the mean CCT of healthy adult Nigerians from the Igbo ethnic population in southeastern Nigeria and evaluate the relationship if any between mean CCT and patients' demographics.

Materials And Methods

This prospective cross-sectional study was conducted at an eye screening center in Enugu Southeast Nigeria from October 2016 to April 2017. Healthy volunteers who met the inclusion criteria were consecutively recruited over 7 months. These were subjects who came to the screening center for an eye check. Approval for the study was obtained from the Health research ethics committee of the University of Nigeria Teaching Hospital. Our study followed ethical guidelines provided in the Declaration of Helsinki. Verbal informed consent was obtained from all recruited volunteers.

Inclusion criteria: Volunteers were adults 18 years and above who were from the Igbo ethnic population residing within southeast Nigeria for 6 months or more, Igbo ethnicity was self-reported by the volunteers and their biologic parents.

Exclusion criteria: Participants with history of previous ocular surgery, ocular trauma, systemic comorbidity such as diabetes mellitus, history of contact lens use, glaucoma or family history of glaucoma, use of anti-glaucoma medications or other topical medications, corneal disorders, intraocular pressure ≥ 21 mmHg, visual acuity less than 6/12 in one or both eyes, refractive error greater than plus/minus 1.0DS were excluded.

Participants data including demographics with ocular, medical and family history as well as CCT were captured using a structured questionnaire.

All participants had their visual acuity measured with Snellen's chart, anterior segment examination with a slit lamp biomicroscope (model AIA-11 5SL Appasamy) and fundus examination with a +78D /+90D Volk lens. Intraocular pressure was measured with Goldmann applanation tonometer, whereas central corneal thickness was measured with ultrasound pachymetry (Sonomed PacScan plus, model 300AP+, probe frequency 20MHz) on eligible subjects. CCT measurement for all participants was performed between 9am and 2pm to avoid diurnal variation.

The CCT measurements were carried out with participants seated and head upright in the primary position of gaze. The probe was sterilized with 70 % ethyl alcohol and allowed to dry. The eye was anesthetized with proparacaine hydrochloride (Primax) and the tip of the probe was gently placed perpendicular to the center of the cornea after 5 mins (this was to avoid any variations in central corneal thickness that would occur with instillation of local anesthetic). Three readings were taken and the mean CCT recorded for each eye. The same procedure was carried out first for the right and then the left eye. All CCT measurements were performed by the same trained personnel to avoid inter observer bias.

STATISTICAL ANALYSIS

The data obtained was analyzed using IBM Statistical Package for Social Sciences (SPSS)

Version 20 statistical software program. CCT values for each eye was recorded. The mean CCT for the study group and standard deviation were calculated, one way ANOVA was performed to compare the Pachymetry across the age categories. A Post hoc Duncan multiple range test was performed to identify the age intervals responsible for significant change in CCT level. Student t-test was used to compare gender and pachymetry profiles. Level of significance was set at $p \leq 0.05$ and confidence level at 95%.

Results

A total of 706 eyes from 353 study participants were examined with mean age of 50.29 ± 16.58 years (range 18 – 88 years). There were 167 (47.3%) males and 186 (52.7%) females. (male: female 1:1.11).

CCT was normally distributed (Fig 1,2) and the mean CCT for all eyes studied was $527.5661 \pm 37.42345 \mu\text{m}$.

The mean central corneal thickness (CCT) for RE was $527.68 \pm 36.88\mu\text{m}$ (95% CI: 523.83 – 531.55 μm) and $527.45 \pm 38.01\mu\text{m}$ for LE (95% CI: 523.47 – 531.43 μm). Table 1

The mean CCT for males was $533.59 \pm 38.07\mu\text{m}$, (95% CI: 527.78 - 539.41 μm) and for females- $522.38 \pm 35.05\mu\text{m}$, (95% CI: 517.31-527.45 μm) for right eyes. Whereas for left eyes, the mean CCT was $533.22 \pm 39.51\mu\text{m}$,(95% CI: 527.18 – 539.26 μm) for males and $522.26 \pm 35.92 \mu\text{m}$, (95% CI: 517.06 – 527.46 μm) for females.

Males had a significantly higher CCT compared to females for both right and left eyes ($p=0.004$, $p=0.007$). Table 2, 3

There was also a significant inverse correlation between CCT values and age. Table 4,5 47.9% (169) right eyes and 49.9% (176) left eyes had a CCT less than 527 μm .

Discussion

Nigeria is a multiethnic, multicultural nation located in West Africa. It is populated by four dominant ethnic groups and over 300 smaller tribes. The major ethnic groups are Hausa/Fulani in the Northern region, Yoruba in the southwest region, Igbo in the southeast region and Ijaw in the south south region. [21]

In our index study on the CCT profile of healthy Nigerians of Igbo ethnicity, the central corneal thickness values measured among our participants was normally distributed. The mean age of participants was 50.29 ± 16.58 years and the Male: Female ratio 1:1.11. A mean CCT of $527.57 \pm 37.42\mu\text{m}$ measured among the participants is lower than values reported from other regions within our country [19, 20, 22]. For instance, a previous study with a smaller sample ($n = 34$) from the south south region of our country reported a mean CCT of $535 \pm 38\mu\text{m}$ [19]. Although the study did not evaluate specific ethnic profiles of the study participants, however, the population of the south south region is dominated by a distinct ethnic group-the Ijaw tribe. The non glaucomatous group had a small sample size ($n = 34$) with a higher mean age 63.1 ± 11.2 years compared to our study. Another study conducted in south south Nigeria recorded a CCT of $548.97 \pm 34.28\mu\text{m}$ [23] which is higher than our study, however mean age was slightly younger, 47.8 ± 16.8 years and there were more males recruited in the study. (77males 53 females) [23].

A hospital based study from northwest Nigeria, reported a higher mean CCT of $531.18 \pm 38.33\mu\text{m}$ for both eyes [24] compared to our study, however males had thinner CCT than females. The mean CCT found in this northern Nigeria study was for patients without glaucoma who were from a diverse ethnic origin in Nigeria [24].

Another study from northwest Nigeria [20] reported a slightly lower mean CCT of $526.90 \mu\text{m}$ for non-glaucomatous eyes compared to our study, however there were 3 times more females than males in the sample with comparable mean age.

Babalola et al in a study comparing two instruments for measuring IOP, reported a mean CCT of $537.91 \pm 38.4 \mu\text{m}$, [22] which is also higher than our study.

In addition, we also documented a lower mean CCT compared to that reported in Ibadan southwest Nigeria $530 \pm 0.032\mu\text{m}$ [25] and Lagos south western Nigeria ($529.3 \pm 35.4 \mu\text{m}$) [26]. However, these studies did not report ethnicity.

Central corneal thickness reported from studies among other populations within sub-saharan Africa appear higher than mean CCT value we found in our study. For instance, two studies from Ghana reported a mean CCT of $530.00 \mu\text{m}$ and $533.30 \mu\text{m}$, respectively [27], [28] however (there was no gender difference and CCT decreased with age)

The mean CCT among Cameroonians was $528.74 \pm 35.89 \mu\text{m}$ in both eyes. This was comparable to CCT in our study with CCT decreasing with age. However, there was no gender difference in CCT values, [29]. In addition, children (5-75years) were also recruited in this study and there were more females 66.4 % compared to males 33.6% [29].

Another study conducted in Ethiopia [30] recorded a lower mean CCT of $518.68 \pm 32.92 \mu\text{m}$ with CCT decreasing with age.

In addition, a study from South Africa conducted on black Africans [31] reported a lower mean CCT of $512.4 \pm 38.9 \mu\text{m}$ [31], however the sample was from a younger age group of 18-25years.

Another South African study also reported a lower mean CCT of $514.77 \pm 31.86 \mu\text{m}$ among Africans residing in South Africa, however it also included twenty one Africans from nine other sub Saharan African countries [32].

In contrast a study from Sudan recorded a thicker mean CCT of $530.15 \pm 58.10 \mu\text{m}$ although they had a small sample size ($n = 94$) with predominantly male participants compared to our study but it also found no significant correlation between CCT, gender and age [33]. Similarly, CCT was thicker in a cohort of south Egyptian subjects with a mean of $530.06 \pm 38.03\mu\text{m}$ [34] and there was significant correlation between CCT, age and gender.

The Barbados eye study [35] reported a higher mean CCT of $530.0 \pm 37.7 \mu\text{m}$ for non glaucoma patients but this included blacks, mixed ethnicity and whites. There was no gender difference reported and the mean CCT decreased with age.

La Rosa et al reported a higher mean CCT of $533.8 \pm 33.9 \mu\text{m}$ in African Americans and $555.9 \pm 33.2 \mu\text{m}$ in Caucasians [36] compared to our study, but the sample size was small ($n = 26, 51$ respectively for both races)

CCT in ethnic Igbos is thinner than the non -glaucomatous Caucasians $562.8 \pm 31.1 \mu\text{m}$, Hispanics $563.6 \pm 29.1 \mu\text{m}$ and Asian ethnic subpopulations $555.9 \pm 31.8 \mu\text{m}$ [15] but comparable to African Americans

524.8 ± 38.4 μm [15] with the mean CCT values decreasing with age in those groups although there is no gender difference.

Shimmyo et al [37] compared CCT between whites, Asians, Hispanics, and African Americans, the mean CCT for African Americans was 535.46 ± 33.39 μm which was higher than ours however the mean age of African Americans was much younger (37.2 ± 9.8 years).

A lower mean CCT among our study participants who are exclusively from the Igbo ethnic group may partly explain the reported high prevalence of glaucoma among this ethnic group and lower recorded intraocular pressure [38] when compared to the other ethnic groups in Nigeria. In this regard, thin CCT profile may represent in our opinion a distinctive ethnic/ racial marker or predictor of glaucoma burden for Igbo's living within the southeast region [38].

We found a significantly thicker mean CCT among males (533.59 ± 38.07μm, (95% CI: 527.78–539.41μm) when compared to females (522.38 ± 35.05μm, (95% CI: 517.31-527.45μm), p value 0.004, 0.007 for right and left eyes respectively. This finding is in contrast to those from previous studies on the subject by other authors [27, 29, 33]. A thicker CCT found among our male participants may suggest some protection from the disease on the basis of their CCT profile, however this is not corroborated by finding that being male was also a risk factor for glaucoma. This is without prejudice to the role of other determinants or markers of increased glaucoma risk.

Iyamu et al [23] in their study on a cohort of patients from south south Nigeria found no gender difference. The study from north west Nigeria, cited previously also reported no gender difference in CCT profiles, however the authors noted that the study participants were diverse in their ethnic profiles as well [20].In addition, a study from Ghana reported no difference in gender for CCT [28].

Some studies however, have reported gender differences in CCT with males having thicker CCT than females [25] and females having thicker CCT than males [30, 31].

CCT values among our study participants also had an inverse relationship with age and this was also significant. This inverse relationship occurred in both males and females. There was an earlier decline in CCT with age noted in females (28-37years age group) compared to males (48-57years age group).

A similar inverse relationship between age and mean CCT values has been reported by some other studies [23, 28, 29].

Environmental factors and outdoor activities have been postulated to account for the decline in CCT with age [39, 40]. Hahn et al attributed this change to a decline in the density of keratocytes and a breakdown of corneal collagen fibrils with age [39].

Conclusion

Central corneal thickness values in the Igbo ethnic population of Southeast Nigeria, an ethnic group with the reported highest prevalence of glaucoma in Nigeria from our study is thinner than those reported from other regions both within Nigeria as well as some Sub-Saharan populations, Caucasians, Asians, and Hispanics but it is however comparable with values reported among Cameroonians and African Americans. CCT among Nigerian Igbos, seems to decrease with age and appears thicker in males compared with females.

Declarations

Funding: No funding was received for conducting this study.

Conflicts of interest: The authors have no relevant financial or non-financial interests to disclose.

Ethical approval: Approval was obtained from the health research ethics committee of University of Nigeria Teaching Hospital. The procedures used in this study adhered to the tenets of the Declaration of Helsinki.

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

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Tables

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Figures

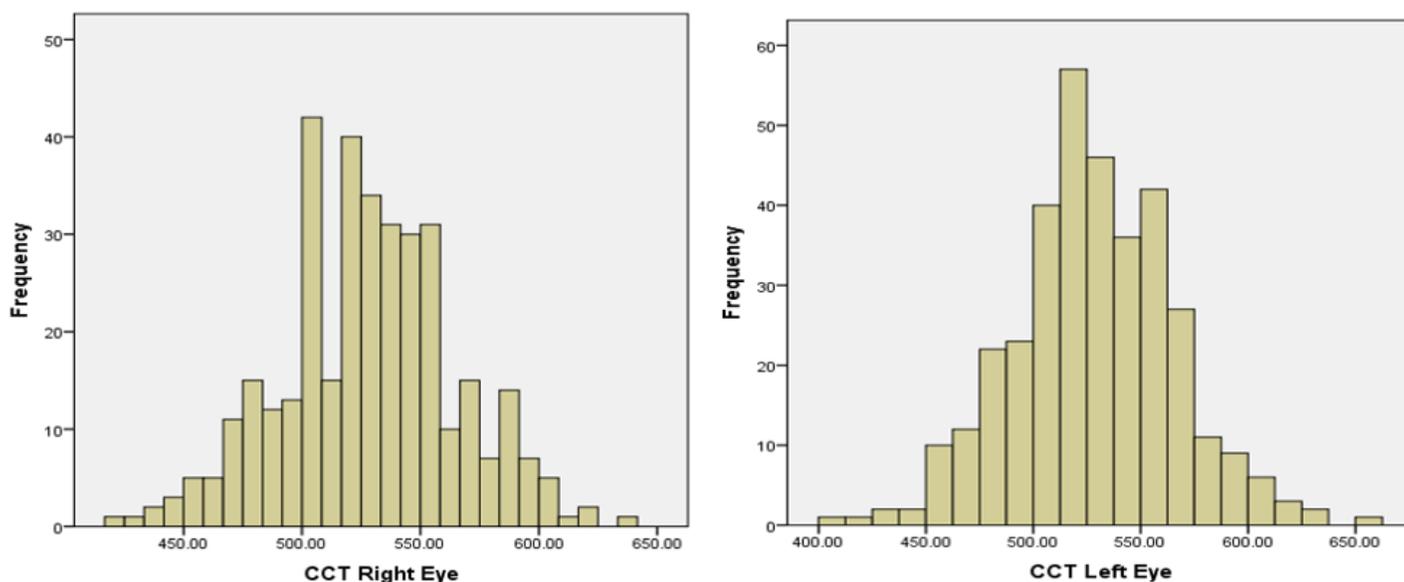


Figure 1

Distribution of central corneal thickness readings among study participants

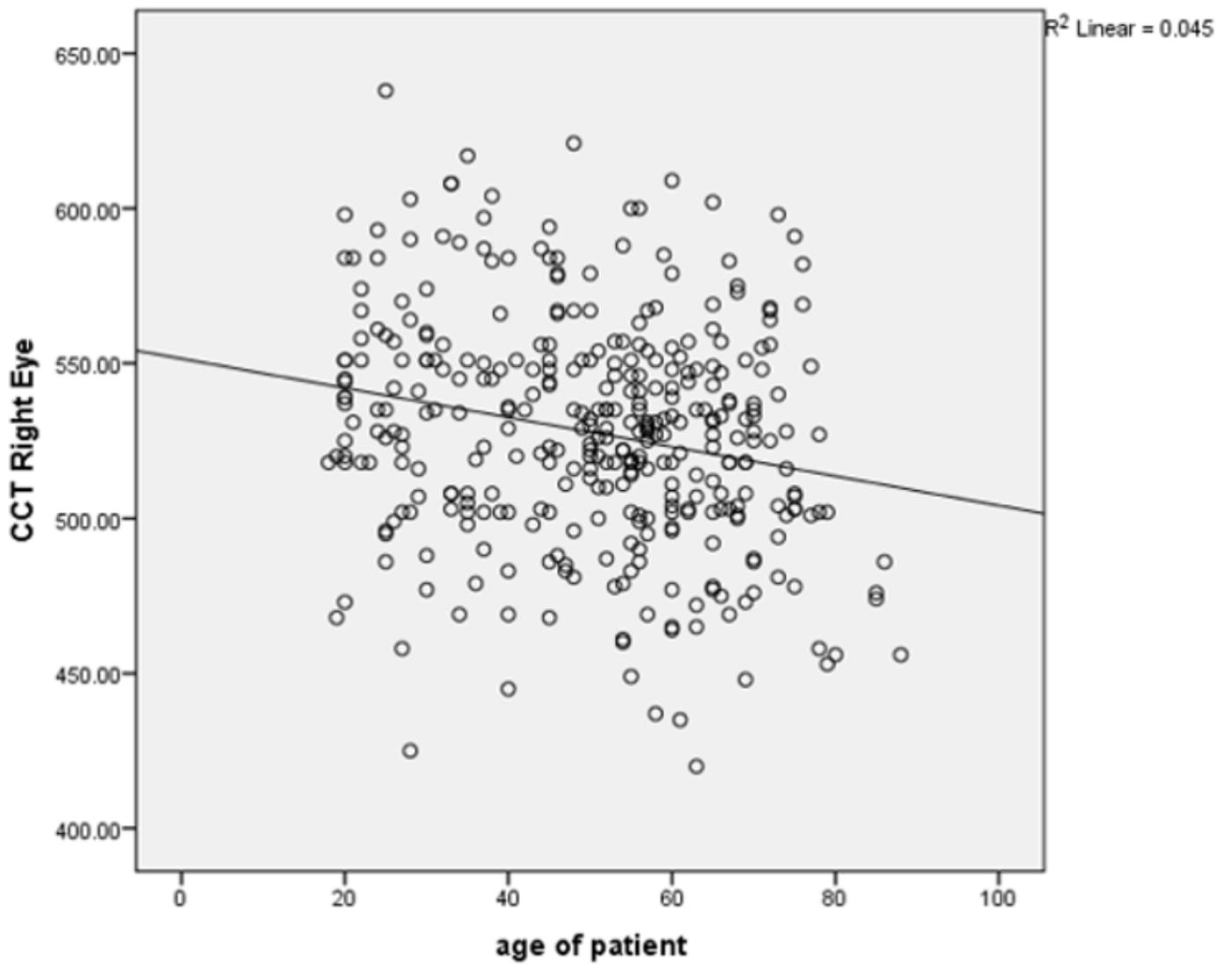


Figure 2

Relationship between age and central corneal thickness [Right eye]

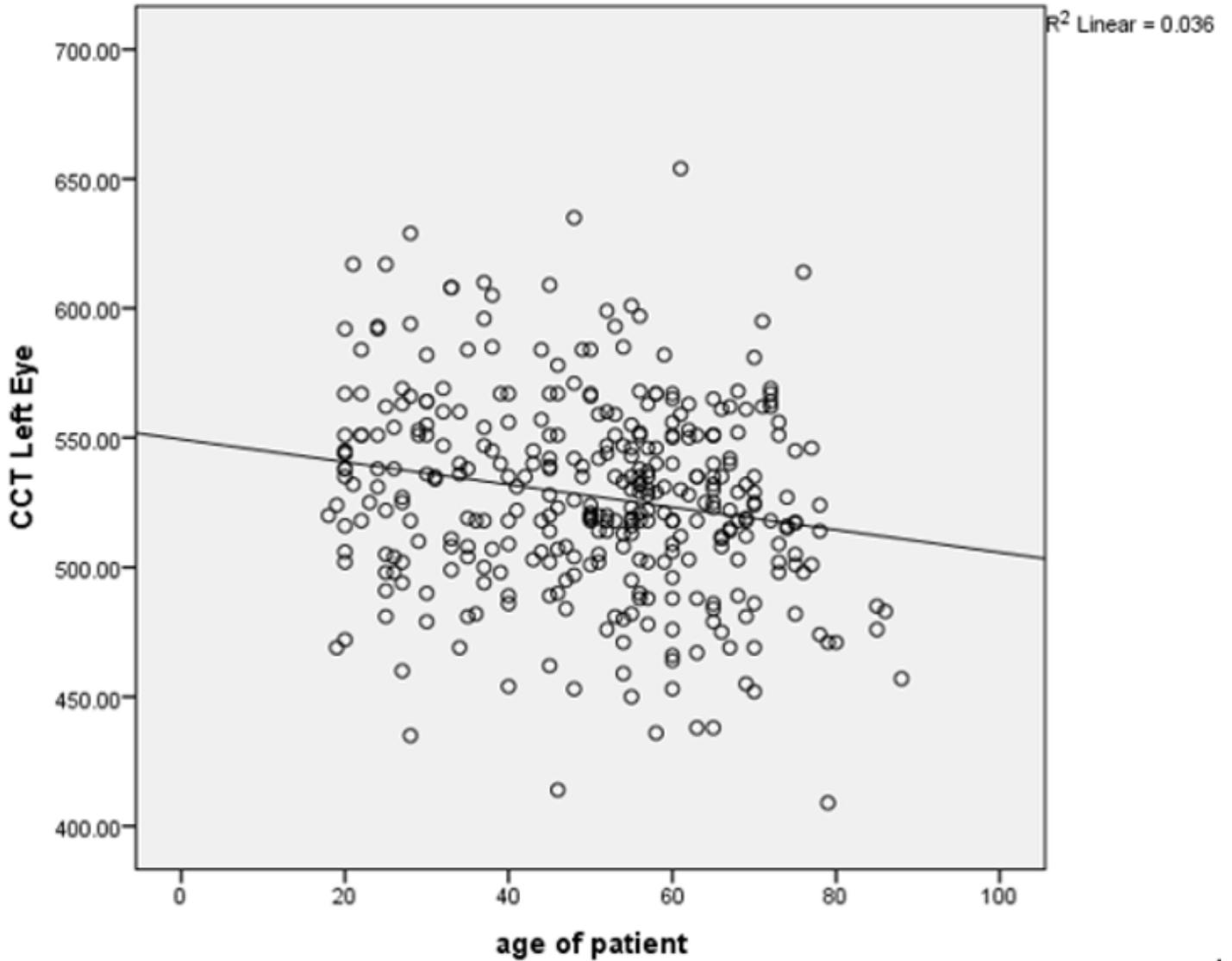


Figure 3

Relationship between age and central corneal thickness [Left eye]

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