A STUDY OF CENTRAL CORNEAL THICKNESS IN NORMAL GHANAIANS

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SUMMARY

Objectives:

- To determine central corneal thickness (CCT) in normal eyes
- To compare CCT between different age groups, and gender
- To review the literature and to find out if there is any relation between CCT and intraocular pressure

Method: This was an observational study carried out at the Korle-Bu Teaching Hospital in Ghana. The subjects comprised 169 indigenous Ghanaians in whom there was no evidence of glaucoma, corneal or anterior segment disease, contact lens wear or previous eye surgery. The thickness of the central cornea was measured by means of ultrasound pachymetry.

Results: The mean CCT in all the subjects (aged 20-72years) was 533.3μ, 527.7μ-538.9μ (95%CI) OD; and 534.8μ, 529.0μ-540.6μ (95% CI) OS. The mean CCT was 521.14μ with a SD of 38.76 in subjects aged 30 years and above (n=86). There was no significant difference between the right and left eyes (t = 0.11, p=0.91). The mean for the right eye in the 20-29 year age group (538μ) was significantly higher than that for the age groups 30-39, 520μ; 40-49, 523μ; ≥50 age group, 515μ (all p values<0.05). There was no significant difference between male and female CCT (t = 0.39, p=0.7001). A scatter diagram showed a very weak relation between CCT and IOP <21mm Hg (trendline equation $y= 0.67x^2 + 17.223x +619.93$, $R^2=0.1556$).

Conclusions: Younger subjects (under 30 years) had thicker central corneas than the older subjects. Older subjects (over 30 years) had thinner CCT than the average of 534μ for that age group in the literature. There was no gender difference in CCT, while the correlation between CCT and IOP within 21mmHg was very weak.

Key words: central corneal thickness, pachymetry, cornea, glaucoma

INTRODUCTION

There has been growing interest in the use of pachymetry to assess the human cornea. Interpretation of what is abnormal requires knowledge of the normal range. In addition, much clinical interest is being given to the potential relationship of central corneal thickness (CCT) with intraocular pressure (IOP) measurement by applanation tonometry. Intraocular pressure is a major risk factor in developing glaucoma, an important cause of blindness in Ghana and the West African sub-region in general.[1,2,3] Knowledge of the distribution of corneal thickness in clinically normal eyes in indigenous African subjects is therefore important. Values based on the CCT, at least, can easily be measured with a pachymeter to help in clinical decision making and research into related eye disorders. Our aim was to determine central corneal thickness (CCT) in normal eyes, compare CCT between different age groups and gender, review the literature, and find out if there is any relation between CCT and intraocular pressure.

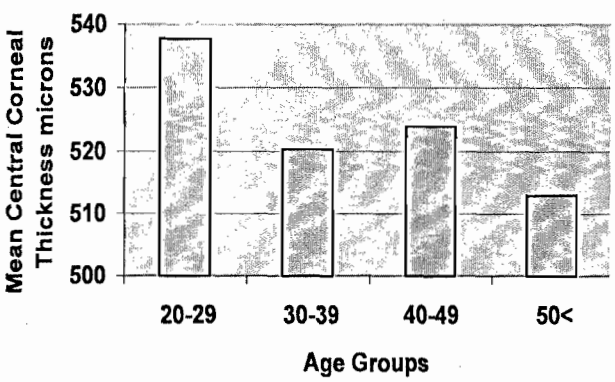

Figure 1. Mean central corneal thickness by age group

Hypothesis: there is no difference in CCT between our subjects and the average CCT of 534μ recorded in the literature.

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METHOD

Subjects were selected at random (lottery method) – 200 subjects were selected from two hostels for health care personnel; and an additional 50 outpatients (aged over 20 years) from our ear, nose and throat clinic at the Korle-Bu Teaching Hospital in Accra, Ghana. The study was explained to the subjects and those who gave verbal consent were examined. A general eye examination including optic disc evaluation and refraction (where refractive error was not known by subject) was carried out by the principal investigator. The eligibility criteria for inclusion for CCT measurement and analysis were: no previous eye surgery, no contact lens wear, normal cornea, IOP less than 22mmHg, normal optic discs and normal anterior segments. The second investigator measured the CCT by means of ultrasonic pachymeter (Pachette 2) DGH Technology Inc. Five measurements were taken for each eye. The mean of the 5 values and the lowest value were recorded for each eye. The lowest CCT reading was considered the best value taken since the probe direction would be the most perpendicular to the cornea. The third investigator measured the intraocular pressures by applanation tonometry.

RESULTS

The response rate (i.e., selected subjects who responded to the invitation for recruitment) from the hostels was 70% (n = 143), and from the ENT clinic 90% (n = 45) making a total of 188 subjects presenting for examination. The total number of subjects who satisfied the criteria for inclusion for analysis was 169: 97 women and 72 men (130 hostel, 39 ENT clinic). Their ages ranged from 20 to 72 years, with a mean age of 34.09 and SD 12.14. The summary of the CCT values is presented in table 1. There was no significant difference between average values and lowest CCT values (OD, t = 1.09, p=0.2745; OS, t=1.33, p=0.1838 in the same eye). Further analysis was done using minimum CCT values. There was no significant difference between the OD and OS minimum CCT values (t = 0.11, p=0.9136).

Table 1. Central cornea thickness: Total population

CCT μ	OD Average of 5 values	OD Lowest value	OS Average of 5 values	OS Lowest value
Mean	533.3	528.9	534.8	529.3
95% CI	527.7-538.9	523.2-534.5	529.0-540.6	523.5- 535.1
Median	534.0	533.0	533.0	532.0
Mode	501.0	550.0	500.0	566.0
SD	37.0	37.3	38.0	37.9
Range	437-638	435-632	426-638	419-632

OD, right eye; OS, left eye.

Gender

Among women sampled, the least CCT measurement for the right eye was 527.9μ; for the men it was 530.1μ. There was no significant difference between men and women (t = 0.39, p=0.7001). The least CCT measurement for the left eye was 527.3μ for women and 532.0μ for men. There was no significant difference between men and women (t = 0.81, P=0.4214).

Age

The CCT values for different age groups are presented in table 2. The test for overall differences across age groups is statistically significant (F = 3.48, p = 0.0173). The tests of multiple comparison by Student-Newman-Keuls (SNK) show that the mean of the least measurements for the OD in the 20-29 years age group was significantly greater than that for the 30-39 years age group, the 40-49 years age group, and the >=50 years age group (all p values<0.05). The test for overall difference across age groups is also statistically significant (F = 4.03, p = 0.0085).

Table 2. Mean CCT by age

Age group	OD minimum (mean)	OS minimum (mean)
20-29 (538 μ)	537.6	539.2
30-39 (520 μ)	520.1	519.6
40-49 (523 μ)	523.9	521.6
≥50 (515 μ)	513.1	515.7

Age >30 year group

For the age range 30-72 years (n = 86, mean age 43.8 years, SD 9.6), the CCT range for the right eye was 435-611μ with a mean of 520.4μ, and SD 38.3. Values obtained for OS were 419-612μ with a mean of 519.7μ and SD 37.9. The null hypothesis is rejected for both eyes (p values<0.05) when tested against the average CCT of 534μ quoted in a major review article.[4] The CCT in persons 30 years and above are thinner than the average in the literature for that age group. This age group has a higher risk for simple glaucoma than the younger group and is therefore the group for which screening for glaucoma is performed.

One eye of each subject in the >30 age group was randomly selected and pooled. The mean CCT of the least measurements was 521.14μ with a SD of 38.76. The frequency distribution is displayed in figure 2. A scatter diagram of CCT and IOP showed very weak correlation for IOP <21 (figure 3, trendline eqation ; $y = 0.67x^2 + 17.223x + 619.93$, $R^2 = 0.1556$).

Most of the subjects did not have a refractive error (n = 132). Spherical equivalents of refractive errors present in the rest were myopia (n = 18,< -3.5DS, n = 1, -7), hypermetropia (n = 18, <+1.25DS).

DISCUSSION

Several methods can be used to obtain reliable measurements of corneal thickness. The most commonly used approach is ultrasonic pachymetry. Over the past few years, new instruments have been developed to measure corneal thickness. Some are Orbscan II corneal topography system, scanning-slit topography, SP-2000P specular microscope. Disparities existing between instruments can result from their distinct methodologies. Therefore, one must view differences in CCT measurement with respect to type of instrument used.

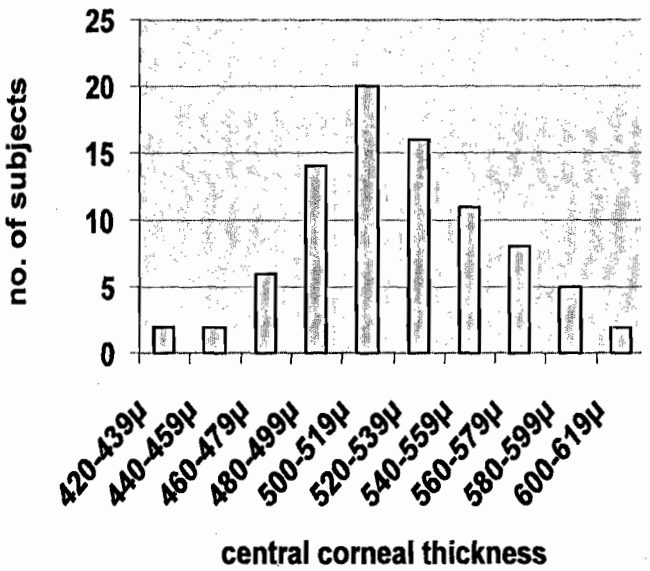

Figure 2. Frequency distribution of central corneal thickness in subjects over 30 years old

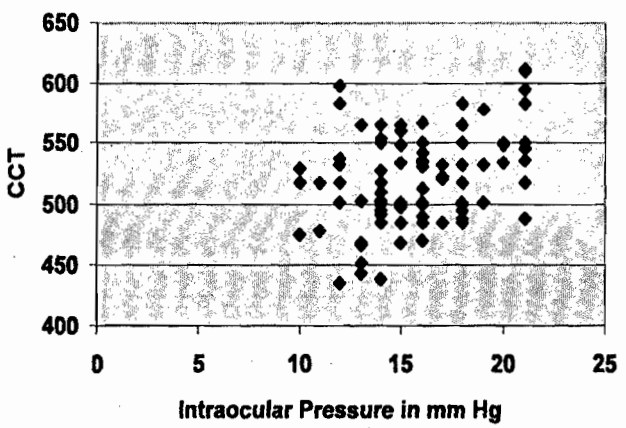

Figure 3. Scatter diagram of CCT and IOP in subjects over 30 years old

From this study the mean CCT values in normal subjects aged 20-72 years was 533.3μ, 527.7μ-538.9μ (95%CI) OD; and 534.8μ, 529.0μ-540.6μ (95% CI) OS. Comparing CCT between ages by decades, the central cornea was thicker in the third decade of life, but there were no significant differences in the fourth to eighth decades. Some studies have noted thicker CCT in newborn babies than adults.[5,6] A gradual decrease in corneal thickness has also been detected with increasing age in some non-European races: the Eskimos[7] and the Japanese[8,9] A major review article concludes that overall evidence from published data suggest that in majority of Caucasians there is no substantial change in CCT beyond the infant years.[4] One study in 108 subjects aged 17- 75 found no significant differences in corneal thickness with increasing age,[10] however, the authors indicated that the small sample size was a limitation to their study with a high probability of Type 2 error.

No gender difference was noted in our study as found in other studies.[7,9,12,13] There was also no difference in CCT values between the left and right eyes as has also been found in some studies.[5,14]

Our study group has on average relatively thinner CCT corneas. Doughty et al. concluded in a major review article that although the issue of racial difference does not seem to have been addressed adequately in the literature, a case can be made that there is a difference, especially when older eyes are compared, as CCT thickness tends to decrease with age in non-whites but not in whites.[4] To our knowledge, this is the first attempt at determining normal values of CCT in an indigenous African population. African-American and Caucasian populations are so intermixed that when a finding is made it is difficult to tell for sure that it came from the African part of the individual's ancestry. However, it was noted in a study comparing Caucasians and African-Americans that African-American patients have thinner corneas[14] and that this may influence the IOP measurement and its interpretation in the management of glaucoma. Numerous studies have demonstrated the importance of corneal thickness in the determination of readings with the Goldmann applanation tonometer.[15,16,17,18] The Goldmann applanation tonometer is theoretically only accurate for CCT at 520 μm.[15] Ehlers et al. calculated the instrument to be accurate at a central corneal thickness (CCT) of 520 μm, with a cornea 70 μm thicker resulting in intraocular pressure readings that were 5mmHg higher, and a cornea 70 μm thinner resulting in a reading that was 5 mmHg lower.[17] Whitacre et al. showed that the extremes of underestimation and overestimation span a range of almost 16 mmHg, indicating that measuring CCT may well have important implications with regard to IOP measurement.[18] Despite the fact that the corneas in people over 30 years (the usual age group for glaucoma screening in our population) were thinner, the mean of the least values was close to 520μm and therefore Goldmann applanation tonometer should be theoretically accurate. At 2 standard deviations (SD, 38) from the mean, an over or underestimation of about 5mmHg of IOP again, is theoretically possible. However

we did not find any correlation between CCT and the normal range of IOP in our study group. We shall carry out another study with glaucoma patients with high IOP >21 to determine the impact of CCT on glaucoma.

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