TITLE

CORRELATION BETWEEN CENTRAL CORNEAL THICKNESS, INTRAOCULAR PRESSURE, OPTIC DISC SIZE AND CUP-DISC RATIO IN NORMAL POPULATION

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ABSTRACT

- **BACKGROUND:** To study the central corneal thickness (CCT) and its correlation with age, gender, intraocular pressure (IOP), optic disc size and cup/disc (C/D) ratio in healthy subjects.

- **METHODS:**
  A cross-sectional prospective study was carried out at a tertiary eye care hospital, from August 2012 to July 2013. Subjects (n = 700) included healthy patients presenting for routine eye checkup or refractive error correction. Informed consent was obtained from all. The selection of eye was randomized to avoid bias. A complete ocular examination was done including visual acuity, refractive error, anterior and posterior segment examination, intraocular pressure examination with Goldman applanation tonometry, optic disc size and C/D ratio with Heidelberg retina tomography (HRT). Central corneal thickness (CCT) was measured by Optical Pachymeter.

- **RESULTS:** Sample included a total of 700 normal subjects (Males : 349, Females : 351). Mean central corneal thickness of the study was 520.9 ± 20.51 μ. Mean age of the study sample was 34.83 ± 11.14 years (20 years to 70 years). Subjects were divided decade wise for analysis (20-30 y=297, 31-40 y=225, 41-50 y=94, 51-60 y=72, 61-70 y=12). Mean central corneal thickness of the study group
was 520.9±20.51μ with average readings of males being 520.40±20.53μ and females 521.39±20.53μ. No significant difference of CCT was seen between males and females (P=0.52). Average CCT in different age groups (decade wise) was as follows: (20-30y – 520.18±20.64μ, 31-40y – 522.20±20.54μ, 41-50y – 519.28±20.69μ, 51-60y – 523±20.53μ, 61-70y – 514±20.77μ). No significant difference of CCT was seen with age (p=0.981). No significant difference of CCT was found with IOP (p=0.189). Heidelberg retinal tomography (HRT) was done in 413 out of 700 normal subjects for the measurements of optic disc size and C/D ratio. Mean optic disc size was 1.506±0.16 mm². No significant difference of CCT was found with optic disc size (p=0.724). No significant difference of CCT was found with C/D ratio (p=0.692).

- **CONCLUSION:** There was no significant correlation of CCT with age, gender and IOP in these normotensive subjects. There was also no significant correlation of CCT with optic disc size and C/D ratio in normal healthy subjects.

**Key words:** Central Corneal thickness, Intra Ocular Pressure, Optic disc size, Cup disc ratio
INTRODUCTION

Thin central corneal thickness (CCT) has been shown to be a powerful risk factor for the progression of ocular hypertension (OHT) and preperimetric glaucoma to primary open-angle glaucoma (POAG). Intraocular pressure (IOP) is a key element in the management of glaucoma (1) and it should, therefore, be measured using a reliable technique with high degree of accuracy. Though Goldman applanation tonometry (GAT) is the most widely used and current “gold standard” for IOP measurement, readings of IOP made with GAT are affected by central corneal thickness (CCT) (2). Goldman and Schmidtfelt that significant CCT variations occurred only rarely in the absence of corneal disease and thus assumed a "normal" CCT of 500 μ for their instrument (3). However, studies have shown that there is variation in the mean CCT among individuals with healthy eyes (2, 4), in patients with different types of glaucoma (5) and in presence of pseudo-exfoliation syndrome (2). Several studies have suggested 0.014–0.179 mmHg/0.01 mm increase in CCT. This small change could be clinically significant especially in individuals predisposed to glaucoma (6, 7). Moreover, failure to adjust IOP for CCT variation could lead to inappropriate targeting of IOP and setting targets very high for patients having thinner corneas and very low for those with thicker corneas. The cornea and optic disc both fill scleral “portholes” of the eye and due to the continuity of the cornea, sclera and optic disc.
lamina; there is a possibility that CCT may be extrapolated to characteristics of optic disc itself (8). This study was undertaken to measure the CCT and determine its correlation with age, gender, IOP, optic disc size and cup disc ratio in normal healthy subjects.

MATERIALS AND METHODS
A prospective study was carried out at a tertiary eye care hospital from August 2012 to July 2013. Subjects included in the study were healthy patients presenting for routine eye check up or refractive error correction. Informed consent was obtained from all. Data from one eye of each subject was taken. The eye selection was randomized to avoid bias. A complete ocular examination was done including visual acuity, refractive error, anterior and posterior segment examination, intraocular pressure with Goldman applanation tonometry, optic disc size and C/D ratio with Heidelberg retina tomography (HRT). Central corneal thickness (CCT) was measured by Optical Pachymeter.

Inclusion Criteria included age more than 20 years; visual acuity > 20/40; refractive error < ±4D and IOP < 20 mm Hg.

All subjects with history of ocular trauma, intraocular surgery, diabetes, positive family history of glaucoma, optic disc size < 1.3 mm or > 2 mm on HRT and with optic nerve pathologies were excluded from the study.

All prospective subjects completed a questionnaire to scrutinize their eligibility for the study. Visual acuity was tested by Snellen visual acuity chart. A slit lamp examination of the anterior eye was conducted. CCT was measured by Optical
Pachymeter. Average of three readings was recorded as the CCT. IOP was measured with GAT before pupillary dilation. Refraction of each eye was measured using an autorefractor (Canon R-F 10m Auto Refractometer). Direct ophthalmoscope was used for fundus examination with dilated pupils. Optic disc size and C/D ratio were measured with HRT. GraphPad Prism 6 trial version was used. Pearson's correlation coefficient was used to find out correlation of CCT with IOP, age, gender, optic disc size and C/D ratio.
RESULT

Table 1 – Age Group/ CCT

<table>
<thead>
<tr>
<th>Age group</th>
<th>Mean CCT (μ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 – 30</td>
<td>520.18±20.64</td>
</tr>
<tr>
<td>31-40</td>
<td>522.2±20.54</td>
</tr>
<tr>
<td>41-50</td>
<td>519.28±20.69</td>
</tr>
<tr>
<td>51-60</td>
<td>523±20.53</td>
</tr>
<tr>
<td>61-70</td>
<td>514±20.77</td>
</tr>
</tbody>
</table>

Chart 1 – Age Group/CCT
Table 2 – Gender/CCT

<table>
<thead>
<tr>
<th>Gender</th>
<th>Mean CCT(µ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>520.40±20.53</td>
</tr>
<tr>
<td>Female</td>
<td>521.39±20.53</td>
</tr>
</tbody>
</table>

Chart 2 – Gender/CCT
### Table 3 – Optic disc size / CCT

<table>
<thead>
<tr>
<th>Optic disc size</th>
<th>Mean CCT(µ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2 – 1.39</td>
<td>517.98±20.66</td>
</tr>
<tr>
<td>1.4 – 1.59</td>
<td>517.86±19.74</td>
</tr>
<tr>
<td>1.6 – 1.79</td>
<td>519.66±19.86</td>
</tr>
<tr>
<td>1.8 - 2</td>
<td>515.39±19.07</td>
</tr>
</tbody>
</table>

### Chart 3 – Optic disc size / CCT

[Bar chart showing optic disc size and CCT values]
Table 4 – IOP/CCT

<table>
<thead>
<tr>
<th>IOP</th>
<th>Mean CCT(µ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 – 13</td>
<td>522.13±20.44</td>
</tr>
<tr>
<td>13 – 16</td>
<td>519.9±20.55</td>
</tr>
<tr>
<td>16 – 18</td>
<td>521.78±20.53</td>
</tr>
<tr>
<td>18 – 20</td>
<td>524.36±20.54</td>
</tr>
</tbody>
</table>

Chart 4 – IOP/CCT
Table 5 – C/D ratio / CCT

<table>
<thead>
<tr>
<th>C/D ratio</th>
<th>Mean CCT(µ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3 – 0.4</td>
<td>516.45±19.84</td>
</tr>
<tr>
<td>0.41 – 0.5</td>
<td>519.17±19.76</td>
</tr>
<tr>
<td>0.51 – 0.6</td>
<td>516.43±20.52</td>
</tr>
<tr>
<td>&gt;0.6</td>
<td>520±18.79</td>
</tr>
</tbody>
</table>

Chart 5 – C/D ratio / CCT
Sample included a total of 700 normal subjects of which 349 were males and 351 females. Mean central corneal thickness of the study was 520.9±20.51 μ. Mean age of the study sample was 34.83 ± 11.14 years. Subjects were divided decade wise for analysis (20-30 y = 297, 31-40 y = 225, 41-50 y = 94, 51-60 y = 72, 61-70 y = 12). Mean central corneal thickness of the study group was 520.9±20.51μ with average readings of males being 520.40±20.53μ and females 521.39±20.53μ. No significant difference of CCT was seen between males and females (P=0.52)(Chart - 2). Average CCT in different age groups (decade wise) was as follows: (20-30y – 520.18±20.64μ, 31-40y – 522.20±20.54μ, 41-50y – 519.28±20.69μ, 51-60y – 523±20.53μ, 61-70y – 514±20.77μ). Weak negative correlation was found between CCT and age (r= -0.001) which was statistically insignificant (p=0.981). No significant difference of CCT was found with IOP (P=0.189). HRT was done in 414 out of 700 normal subjects for the measurements of optic disc size and C/D ratio. Mean optic disc size was 1.506±0.16 mm². Weak negative correlation was found between CCT and optic disc size (r= -0.017) which was statistically insignificant (p=0.724). No significant difference of CCT was found with C/D ratio (p=0.692). One way ANOVA test was used which gave no statistical difference between the age groups (p = 0.411) (Chart - 1). Patients were divided into four groups according to their optic disc size, C/D ratio and IOP (Charts 3, 4 and 5). One way ANOVA test was used for each of these parameters and there was no statistical difference between optic disc size groups (P= 0.838), C/D ratio groups (P = 0.576) and IOP groups (P= 0.485).
DISCUSSION

Ehlers et al (5) reported that the Goldman tonometer provided accurate readings only when the CCT was 0.52 mm; they calculated that applanation tonometry overestimated or underestimated IOP by approximately 5 mm Hg for every 0.070 mm of deviation in corneal thickness. More recently, Whitacre et al (7) reported that thin corneas may result in a 4 to 9 mm Hg underestimation of IOP and thick corneas may result in overestimation of the IOP by 6.8 mm Hg.

In a population-based study of Malay persons aged 40 to 80 years by Wu RY et al (9), CCT was found to be correlated with rim area and cup-to-disc ratio (tomography measurements) only in POAG patients, independent of axial length, IOP, disc area, and other confounding factors. No significant correlation between CCT and optic disc parameters was seen in subjects without glaucoma which was similar to this study.
Barbara Nemesure et al \textsuperscript{(10)} studied age-sex distribution of CCT among 1142 participants (2276 eyes) with a mean age of 64.3 years; 58% were women. Though an inverse relationship was found between CCT and age ($P<.001$), there were no significant differences in corneal thickness between men and women ($P>.05$) which was similar to this study.

Eghosasere Iyamu et al \textsuperscript{(11)} studied one hundred and thirty eyes from 130 subjects (mean age=47.8±16.8 years) including 77 males and 53 females. They found that CCT of normotensive Nigerian adults decreases with increasing age. There was no correlation between CCT and IOP in normotensive subjects. CCT was not significantly influenced by gender, corneal curvature and corneal diameter which also supports this study.

Dr. Apala Bhattacharya et al \textsuperscript{(12)} studied the relation between central corneal thickness and optic disc size in normal Subjects and patients with primary open angle glaucoma. In the control group there was a weak negative correlation ($r= -0.141$) which was statistically insignificant ($p=0.092$). In POAG patients the negative correlation ($r = -0.256$) was statistically significant ($p=0.0063$). The results of this study were also similar to our study.

Mean central corneal thickness (CCT) in this study was found to be 520.9±20.51 microns which was similar to Japanese population (517.5+/−29.8 micron)\textsuperscript{(13)}.

In a recent study, Pakravan et al. (2007)\textsuperscript{(8)} reported a significant negative correlation between CCT and optic disc size in a small hospital-based population.
The authors concluded that a thin CCT might be a marker for more deformable discs being more susceptible to the effects of increased IOP.

This study was undertaken to find out any possible relationship between CCT and optic disc size in normal subjects. Optic disc size influences the susceptibility to POAG. Higher chance of excavation of superior and inferior disc area is associated with increased disc size because of lack of connective tissue support in larger disc and exposes the disc to more axonal damage \cite{14,15,16}.

In this study average optic disc size was 1.506 mm$^2$ which was smaller than that found in Caucasians in other studies \cite{17,18}.

Studies which have found a relationship between CCT and ONH parameters did so only in ocular hypertensive and glaucomatous eyes \cite{1,4,19}. CCT also did not correlate with gender in the above mentioned studies. There was no correlation between CCT and IOP or age in this sample.

**CONCLUSION**

Mean central corneal thickness (CCT) was found to be 520.9±20.51 and it had no correlation with age, gender, IOP, optic disc size and C/D ratio in normal population.
REFERENCES


10. Barbara Nemesure, PhD; Suh-Yuh Wu, MA; Anselm Hennis, MRCP (UK), PhD; M. Cristina Leske, MD, MPH; for the Barbados Eye Study Group. Corneal Thickness and Intraocular Pressure in the Barbados Eye Studies Arch Ophthalmol. 2003; 121(2):240-244.

11. Eghosasere Iyamu, Ebi Osuobeni: Age, gender, corneal diameter, corneal curvature and central corneal thickness in Nigerians with normal intra ocular pressure.

12. Dr. Apala Bhattacharya, Dr. Gautam Bhaduri, Dr. Arun Kumar Bandyopadhyay, Dr. Alipta Bhattacharya: A Study on Central Corneal Thickness and Optic Disc Size in Normal Subjects and Patients with Primary Open Angle Glaucoma.

