



## Factors Affecting Central Corneal Thickness in Patients with Primary Glaucoma

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### Abstract

**Purpose:** To study the factors influencing central corneal thickness in patients diagnosed with primary glaucomas.

**Methods:** 230 eyes were included in this cross sectional study. Patient parameters were recorded using a prepared questionnaire and complete ocular examination including IOP and gonioscopy was done. CCT was measured using ultrasound pachymeter (Pacscan 300p – Sonomed).

**Results:** The mean CCT measured in this study was  $537.6 \pm 39.3 \mu\text{m}$ . Age was found to have a negative correlation with CCT, with  $r = -0.38$  ( $p < 0.001$ ). There was no significant correlation between gender and CCT. Diabetic patients were found to have higher CCT ( $555.72 \pm 33.81 \mu\text{m}$ ;  $p < 0.001$ ). The mean CCT in those with PACG was  $568.13 \pm 33.78 \mu\text{m}$ , which was significantly higher than that of patients with POAG ( $523.76 \pm 33.44 \mu\text{m}$ ), with a  $p$  value  $< 0.001$ . Myopes had a significantly lower CCT than hypermetropes (CCT =  $509.72 \pm 33.14 \mu\text{m}$ ,  $p < 0.001$ ). IOP by Goldmann applanation tonometry showed a significant positive correlation with CCT with  $r = 0.78$  and  $p < 0.001$ .

**Conclusion:** CCT is significantly affected by age, presence of diabetes mellitus, type of refractive error, type of primary glaucoma and intraocular pressure by Goldmannapplanation tonometer. There is no significant relation between gender and CCT.

**Keywords:** Central corneal thickness, intraocular pressure, Goldmann applanation tonometer, primary glaucoma.

### Introduction

Glaucoma is classically described as a chronic progressive optic neuropathy, caused by a group of ocular conditions which lead to damage of optic nerve with loss of visual function. Raised intraocular pressure (IOP) is an important risk factor for glaucoma.

Goldmann applanation tonometer (GAT) is currently the gold standard tonometer<sup>1</sup>, which

measures the force needed to flatten a standard area of the cornea. The mathematical calculation for Goldmann applanation tonometry is based on a presumed average central corneal thickness of 520  $\mu\text{m}$ .

Central corneal thickness (CCT) emerged as a risk factor for glaucoma in the Ocular Hypertension Treatment Study<sup>2</sup>, which showed that the effect of central corneal thickness may influence the

accuracy of applanation tonometry. Deviations from the average CCT are a source of error, with corneal edema underestimating the true IOP, whereas variations of CCT in normal corneas can lead to falsely higher pressure readings with thicker corneas and falsely lower ones with thinner corneas<sup>3</sup>.

This study aims at analysing the factors affecting central corneal thickness in patients with primary glaucoma.

**Materials and Methods**

This was a cross sectional study performed between January 2015 to January 2016, and enrolled patients visiting Glaucoma Clinic and outpatient department of our institution, after obtaining informed consent. 230 eyes of 130 patients were included. Exclusion criteria were history of previous intraocular surgery/refractive surgery, any corneal pathology, current corneal or conjunctival infection, astigmatism more than 3 diopters, and secondary glaucomas. Central corneal thickness was measured using ultrasound pachymeter (Pacscan 300p – Sonomed). Five consecutive ultrasound pachymetric measurements of CCT was obtained and a mean value was computed and recorded in micrometers. IOP was measured in all patients using a Goldmann applanation tonometer and recorded in mmHg. All measurements were performed under topical anaesthesia.

Statistical analysis was doing using Statistical Package for Social Sciences version 20 (SPSS Inc.). A P-value of less than 0.05 was considered to be statistically significant.

**Results**

The mean age of patients recruited in this study was 55.6 ±4.8 years. 60.4 % of total patients were female, compared to 39.6 % males. In this study group, 68.7 % of the eyes included had primary open angle glaucoma, whereas 31.3 % had primary angle closure glaucoma.

**Central Corneal Thickness**

The mean CCT measured in this study was 537.6 ± 39.3 µm, with the lowest value obtained being 432 µm and highest 632 µm.

**Factors affecting CCT**

1. Age

**Table 1:** Correlation of age with CCT

Correlation of Age with CCT	Pearson Correlation r	P
TOTAL (N=230)	-0.328	0.000

Age was found to have a negative correlation with CCT, with r = -0.38, p < 0.001; suggesting that central corneal thickness levels significantly declined in older patients.

2. Gender

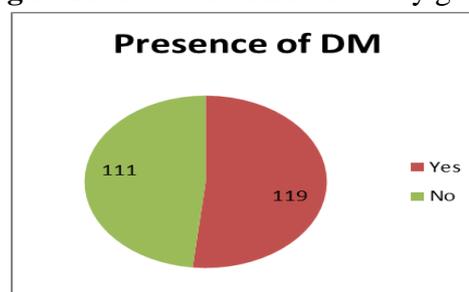
**Table 2:** Correlation of gender with CCT

Sex	CCT (µm)		T	P
	Mean	Sd		
Male	534.60	36.30	0.950	0.343
Female	539.64	41.18		

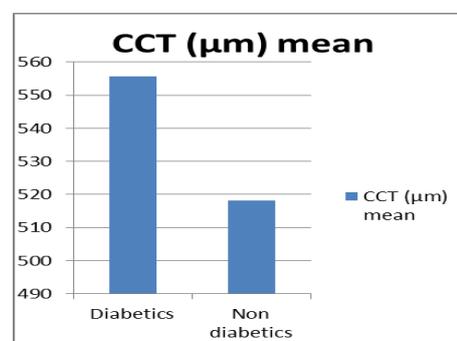
The mean CCT in males was 534.6 ± 36.30 µm, and that of female population was 539.64 ± 41.18 µm. The p value was 0.343, which shows that there was no significant difference.

3. Diabetes Mellitus

**Fig 1:** Distribution of DM in study group



**Fig 2:** Mean CCT in diabetic and non diabetic patients

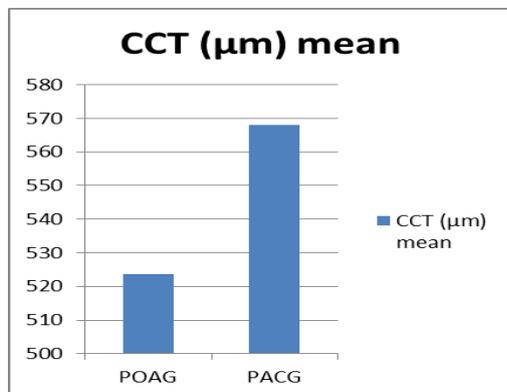


The mean CCT in diabetic patients was 555.72 ± 33.81 µm, and in those without diabetes was 518.27

± 35.49 μm. This difference was statistically significant, with p value < 0.001, showing that those with diabetes had a significantly thicker cornea.

4. Type of primary glaucoma

**Fig 3:** Mean CCT in patients with POAG and PACG



The mean CCT in those with PACG was 568.13 ± 33.78 μm, which was significantly higher than that of patients with POAG (523.76 ± 33.44 μm), with a p value < 0.001.

5. Type of refractive error

62.2% of patients had hypermetropia whereas 37.8 % patients had myopia.

**Table 3:** Mean CCT in patients with myopia and hypermetropia

Refractive Error	N	CCT (μm)		T	P
		Mean	Sd		
Myopia	87	509.72	33.14	10.079	<0.001
Hypermetropia	143	554.64	32.54		

The mean CCT in myopes was 509.72 ± 33.14μm, and that of hypermetropes was 554.64 ± 32.54μm. This difference was statistically significant with p value < 0.001, showing that those with myopia had lower CCT.

6. Intraocular pressure by GAT

**Table 4:** Correlation between CCT and IOP by GAT

Correlation Between CCT and GAT	Pearson Correlation r	P
Whole data (n=230)	.784	<0.001
In GAT ≤10 group (n=76)	.470	<0.001
In GAT 11-20 group (n=76)	.631	<0.001
GAT ≥21 group (n=78)	.450	<0.001

IOP by Goldmann applanation tonometry showed a significant positive correlation with CCT with r = 0.78 and p < 0.001.

Considering each subgroup on the basis of IOP range, IOP and CCT showed a significant positive correlation in all three groups; with highest correlation in the normal IOP range.

**Discussion**

This study was done to analyse the factors influencing central corneal thickness among patients diagnosed with primary glaucomas.

The mean CCT measured in this study was 537.6 ± 39.3 μm, with the lowest value obtained being 432 μm and highest 632 μm. This is similar to a study done in Indian population, which found the mean CCT to be 536 ± 19 μm<sup>4</sup>.

In this study, age showed a significant negative correlation with CCT. A similar result was reported in a study done on 1650 participants of Caucasian origin<sup>5</sup>, which concluded that CCT decreases over the lifetime, meaning that older people have thinner corneas. A study by Iyamu E et al<sup>6</sup> also concluded that the central corneal thickness was weakly correlated with age.

This study showed that there was no association of gender with CCT. A study done on 1650 participants of Caucasian origin<sup>61</sup>,concluded that CCT’s dependence on age is stronger in men and that young men tended to have higher CCT than women.

The present study showed a significant difference in CCT of diabetic and non diabetic patients, with mean CCT of 555.72 ± 33.81 μm in diabetic patients, and 518.27 ± 35.49 μm in those without diabetes. Similarly, a population-based study among Malays showed that diabetes and hyperglycemia are associated with significantly thicker central corneas, independent of age and IOP levels<sup>7</sup>. Several studies have documented abnormalities of corneal endothelial morphology and and increased CCT in persons with diabetes. Abnormal glucose metabolism may cause corneal endothelial dysfunction resulting in stromal hydration and swelling of the cornea. Thus, increase in CCT may be attributed to corneal endothelial damage.

This study showed a significantly higher CCT in PACG patients, compared to POAG patients. A

study done by Pang CE et al<sup>8</sup> concluded that PACG eyes had similar CCT as those with POAG or normal eyes in Chinese subjects. On the other hand, Shah et al<sup>9</sup> reported a higher CCT in PACG subjects compared to POAG. A study by Moghimiet al<sup>10</sup> also concluded that PACG eyes had thicker CCT as compared to POAG and normal healthy eyes in Iranian subjects.

The present study showed a significant correlation between type of refractive error and CCT. The mean CCT in myopes was  $509.72 \pm 33.14\mu\text{m}$ , and that of hypermetropes was  $554.64 \pm 32.54\mu\text{m}$ . This difference was statistically significant with p value  $< 0.001$ , showing that those with myopia had lower CCT.

Chang et al<sup>11</sup> investigated corneal thickness in Taiwanese patients. The mean corneal thickness in their study was  $536.29\mu\text{m}$  and was thinner in more myopic eyes. They concluded that a decrease in corneal thickness was a result of a change in the anterior segment as the eyeball elongated in myopic progression. A contradicting result was obtained in a study by Archana Prasad et al<sup>12</sup>, indicating that no correlation was found between refractive error and CCT ( $r^2 = 0.00645$ ).

The present study found a significantly positive correlation between IOP by GAT with CCT in all IOP ranges. IOP by Goldmann applanation tonometry showed a significant positive correlation with CCT with  $r = 0.78$  and  $p < 0.001$ .

### Conclusion

CCT is significantly affected by age, presence of diabetes mellitus, type of refractive error, type of primary glaucoma and intraocular pressure by Goldmann applanation tonometer. There is no significant relation between gender and CCT.

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