

# Study the Correlation between the Central Corneal Thickness and Open Angle Glaucoma

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**Abstract:** Primary open angle glaucoma (POAG) is a characteristic acquired atrophy of the optic nerve and loss of retinal ganglion cells and their axons developing in the presence of open anterior chamber angles and manifesting characteristic visual field abnormalities. A thin cornea is a risk factor for conversion from ocular hypertension to open angle glaucoma. Thin corneas may be a marker for increased susceptibility of the optic nerve due to less support tissue in the optic nerve making it more liable to pressure-induced and/or vascular damage. In this study we have found the correlation between the central corneal thickness and open angle glaucoma. **Aim of the study:** To study the correlation between the central corneal thickness and open angle glaucoma. **Objectives of the study:** To analyze and compare the central corneal thickness in patients of open angle glaucoma. To study the association of central corneal thickness with open angle glaucoma severity. To study the effect of central corneal thickness in diagnosis and management of open angle glaucoma. **Materials and methods:** a study of 50 eyes having primary open angle glaucoma were studied at G.T. Sheth Eye hospital, Rajkot and its correlation with central corneal thickness was found. **Results:** The mean cup to disc ratio is  $0.726 \pm 0.119$  SD. The mean central corneal thickness is  $513.68 \mu\text{m} \pm 32.506$  SD. The correlation coefficient  $r$  is  $-0.53821$   $p$  value (0.000). This correlation is significant at the 0.01 level (2 tailed). The mean intraocular pressure is  $19.84 \text{ mm Hg} \pm 3.3280$  SD. The correlation coefficient  $r$  between intraocular pressure and central corneal thickness is  $0.04516$ ,  $p$  value (0.755). This is not statistically significant. The mean MD of the patients observed in this study is  $10.646 \text{ dB} \pm 6.4937$  SD. The correlation coefficient  $r$  observed between the central corneal thickness and mean deviation of perimetric data is  $-0.311$ ,  $p$  value (0.028). This correlation is statistically significant at the 0.05 level (2-tailed). **Conclusion:** Glaucoma patients with thin central corneal thickness are found at an advanced stage of the disease. A statistically significant correlation is found between the central corneal thickness and visual field parameters.

**Keywords:** open angle glaucoma, central corneal thickness, intraocular pressure

## 1. Introduction

Glaucoma is the disturbance of the structural or functional integrity of the optic nerve that can usually be arrested or diminished by adequate lowering of IOP.<sup>1</sup>

Primary open angle glaucoma (POAG) is a multifactorial optic neuropathy with a characteristic acquired atrophy of the optic nerve and loss of retinal ganglion cells and their axons developing in the presence of open anterior chamber angles and manifesting characteristic visual field abnormalities. In majority of cases, the intraocular pressure is elevated above the statistically 'normal' range reflecting a reduced aqueous humor outflow facility.<sup>2</sup>

There are 11.2 million persons aged 40 years and older with glaucoma in India. Primary open angle glaucoma is estimated to affect 6.48 million persons.<sup>3</sup>

A thin cornea is a risk factor for conversion from ocular hypertension to open angle glaucoma. Thin cornea will cause Goldmann applanation tonometer to underestimate the intraocular pressure. Thin corneas may be a marker for increased susceptibility of the optic nerve. Perhaps, people with thin corneas have less support tissue in the optic nerve making it more liable to pressure-induced and/or vascular damage.<sup>4</sup>

Thus in open angle glaucoma patients by recording the intraocular pressure by goldmann applanation tonometer, fundus examination, gonioscopy, visual field analysis by perimetry and central corneal thickness measurements by

ocular coherence tomography a correlation can be studied between the central corneal thickness and open angle glaucoma.

## 2. Aim and Objectives of the Study

- 1) To analyze and compare the central corneal thickness in patients of open angle glaucoma.
- 2) To study the association of central corneal thickness with open angle glaucoma severity.
- 3) To study the effect of central corneal thickness in diagnosis and management of open angle glaucoma.

## 3. Material and Methods

This is the study carried on patients coming to the out patient department of ophthalmology, P.D.U. Medical college, Rajkot and being diagnosed as having open angle glaucoma. Fifty eyes are being evaluated in the current study.

### Inclusion Criteria

- 1) Patients diagnosed as having open angle glaucoma.

### Exclusion Criteria

- 1) Age <40 years.
- 2) Evidence of other anterior segment pathologies including corneal opacities, keratoconus, corneal degenerations, corneal dystrophies, active corneal infection.
- 3) Previous corneal surgeries.
- 4) Corneal edema.
- 5) Corneal Astigmatism >2 D.

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- 6) Optic nerve or retinal disease.
  - 7) Angle closure glaucoma and secondary glaucoma.
- Informed valid consent will be obtained from the patients.
  - Patients to be chosen according to the inclusion and exclusion criteria.
  - Detailed history to be recorded regarding complaints of diminution of vision .
  - The duration and progression of vision loss.
  - Associated symptoms if any like headache ,coloured haloes, pain and redness if present are noted to rule out chances of angle closure glaucoma.
  - History of frequent changes of glasses are to be noted.
  - Past history of any corneal refractive surgery is to be evaluated.

**Ocular examination**

- Visual acuity (unaided) is to be taken.
- Best corrected visual acuity is to be measured.
- Slit lamp examination is carried for the status of anterior segment.
- Intraocular pressure measurement is being done by applanation tonometry.
- Applanation tonometry is the gold standard for carrying out intraocular pressure measurement.
- Gonioscopy evaluation of the angle of anterior chamber is done using 3 mirror goldmann lens.
- The angle can be classified into open and closed depending on the degree of structures seen.
- Patients having open angle of the anterior chamber are being included in the study.
- Further evaluation of the associated visual field defects is done by perimetric examination.
- Octopus 900 is being used for carrying out perimetry.
- Dilated fundus examination is done using direct ophthalmoscopy and the changes including disc and nerve fibre layer changes are being noted.
- Central corneal thickness is then measured using zeiss ocular coherence tomography machine using anterior segment analysis either using anterior segment cube or anterior segment raster 5 line photographs.
- Correlation is then carried out between primary open angle glaucoma and central corneal thickness.

**4. Result and Analysis**

We have done study of the correlation between the central corneal thickness and open angle glaucoma of 50 eyes of patients at G. T. Sheth Ophthalmic Hospital, P. D. U. Govt. Medical College, Rajkot.

**Table 1:** Distribution of central corneal thickness in various groups and its cup disc ratio

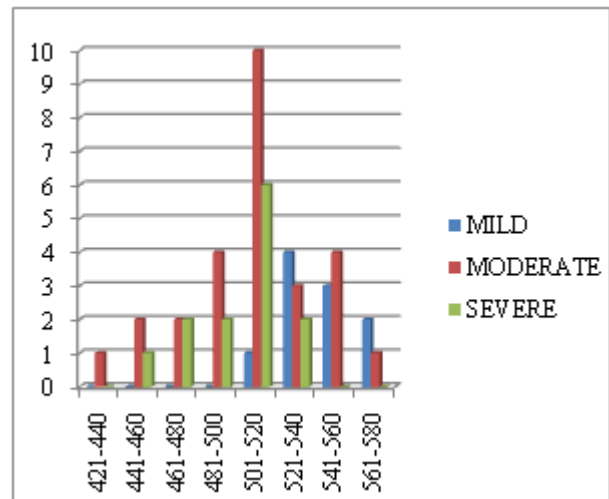
CCT GROUPS	Number of eyes	CD RATIO (no. of eyes)		Percentage	
		0.3-0.6	0.7-1	0.3-0.6	0.7-1
<500	14	0	14	0	100
500-519	15	2	13	13.33	86.66
520-539	9	5	4	55.55	44.44
540-559	8	3	5	37.5	62.5
560-579	4	4	0	100	0

Table 1 shows that 14 eyes have central corneal thickness < 500 µm having cup to disc ratio in the range of 0.7 to 1 and patients having central corneal thickness >560 µm cup to disc ratio between 0.3 to 0.6.

**Table 2:** Comparison between different age groups

Comparison Between Age Groups			
Age Groups	No. of Eyes	Mean CCT µm	Mean CD Ratio
41-44	6	530.66	0.68
45-54	22	506.13	0.76
55-65	16	521	0.66
ABOVE 65	6	504.83	0.78

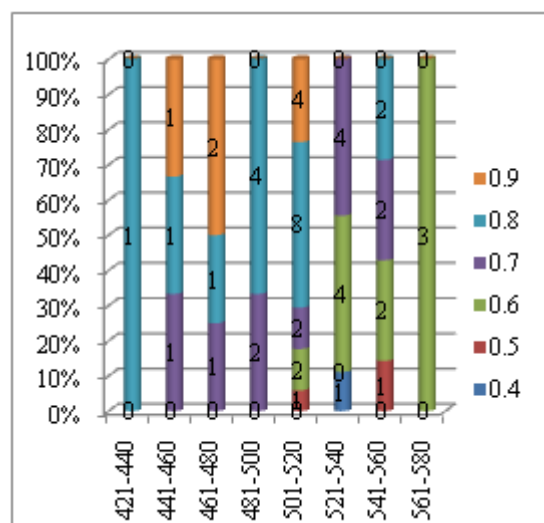
**Distribution according to severity of visual field defect and its relation to central corneal thickness**



**Figure 1**

Figure 1 shows that eyes with thick corneas have mild to moderate visual field defects as compared to thin corneas which have severe visual field defects.

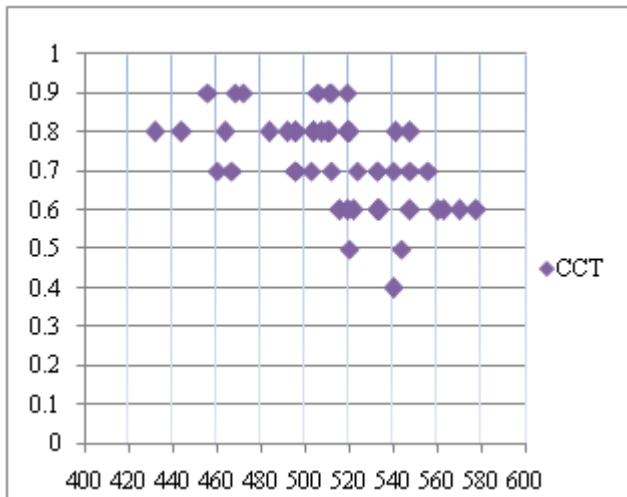
**Distribution according to cup to disc ratio and its relation to central corneal thickness**



**Figure 2**

Figure 2 shows that thin corneas are associated with increased cup to disc ratio.

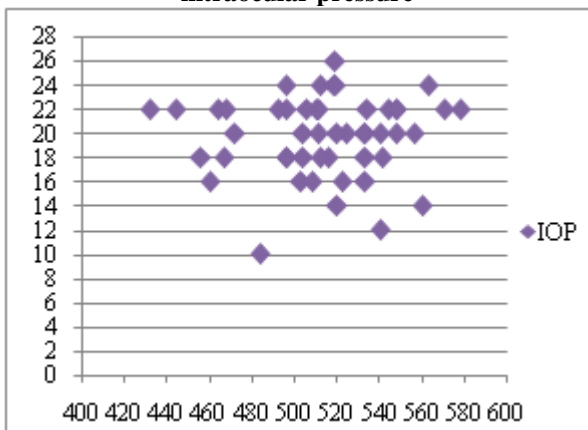
**Correlation between central corneal thickness and cup to disc ratio.**



**Figure 3**

- The mean cup to disc ratio in this study is  $0.726 \pm 0.119$  SD. The mean central corneal thickness is  $513.68 \mu\text{m} \pm 32.506$  SD.
- The correlation coefficient  $r$  is  $-0.53821$   $p$  value (0.000). This correlation is significant at the 0.01 level (2 tailed). There is a negative correlation between central corneal thickness and cup to disc ratio i.e.patients with higher cup to disc ratio have thin corneas

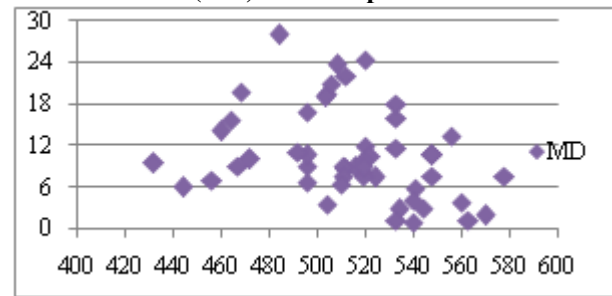
**Correlation between central corneal thickness and intraocular pressure**



**Figure 4**

In this study, the mean intraocular pressure is  $19.84 \text{ mm Hg} \pm 3.3280$  SD. The correlation coefficient  $r$  between intraocular pressure and central corneal thickness is  $0.04516$ ,  $p$  value (0.755). There is a positive correlation suggesting that in thin corneas intraocular pressure measured is lower as compared to thick corneas. Though this correlation is not statistically significant.

**Correlation between central corneal thickness and mean deviation (MD) from the perimetric data**



**Figure 5**

- The mean MD of the patients observed in this study is  $10.646 \text{ dB} \pm 6.4937$  SD.
- The correlation coefficient  $r$  observed between the central corneal thickness and mean deviation of perimetric data is  $-0.311$ ,  $p$  value (0.028).
- There is negative correlation suggesting that thin corneas have more visual field defects as compared to thick corneas.
- This correlation is statistically significant at the 0.05 level (2-tailed).

**5. Discussion**

Correlation of central corneal thickness and open angle glaucoma in various studies<sup>(5-12)</sup>

In study of **Mokbel TH**, there was statistically significant correlation between thin CCT and optic disc area ( $r = -0.251$ ,  $P = 0.031$ ), neuroretinal rim area ( $r = 0.036$ ,  $P = 0.016$ ), vertical cup: disc ratio ( $r = 0.043$ ,  $P = 0.014$ ), and horizontal cup: disc ratio ( $r = 0.031$ ,  $P = 0.021$ ). Regarding the visual field there was a statistically significant correlation between thin CCT and mean deviation visual field ( $r = -0.065$ ,  $P = 0.003$ ).

In study of **Wangsupadilok B**, there were significant correlations between CCT and MD ( $r = 0.532$ ,  $p < 0.001$ ), cup-to-disc ratio ( $r = -0.478$ ,  $p = 0.001$ ).

In study of **Zeynep Ozturker**, thin CCT was significantly correlated with higher cup area, neuroretinal rim area loss, horizontal C:D ratio, vertical C:D ratio, rim volume and cup volume ( $p = 0.003$ ,  $p = 0.022$ ,  $p = 0.001$ ,  $p = 0.002$ ,  $p = 0.001$ ,  $p = 0.016$  respectively).

In study of **Mariya Memon**, majority of patients with thin cornea ( $<500-519\mu\text{m}$ ) presented with advanced stage of disease i.e advanced cup disc ratio as compared to patient with thick corneas ( $>540\mu\text{m}$ ) which was statistically significant ( $p=0.031$ ). 88% of the patients with CCT  $<500 \mu\text{m}$  and 80% of the patients with CCT  $<520 \mu\text{m}$  presented with advanced cupping.

In study of **Wenzhong Lin**, the CCT tended to decrease as the degree of visual field defect worsened, The CCT was significantly thinner in the severe visual field defect group than in the early visual field defect group ( $P = 0.0012$ ; Fisher's PLSD). There were more eyes with severe visual field defect distributed in the thin CCT group than in the

thick or moderate CCT groups, and there were fewer eyes with early visual field defect in the thin CCT group than in the thick CCT group.

In study of **Gunvant P**, eyes with POAG had significant negative correlation between the 'cup to disc area ratio' HRT parameter and CCT ( $r = -0.370$ ,  $p = 0.002$ ) indicating that eyes with thinner than average CCT values had a greater 'cup to disc area ratio'.

In study of **Jost B. Jonas**, central corneal thickness correlated negatively with mean visual field defect ( $P = 0.001$ ). In study of **Leon W. Herndon**, an increase in CCT was associated with an improved mean deviation of visual field ( $P < .001$ ), a decrease in vertical ( $P < .001$ ) and horizontal ( $P = .003$ ) cup-disc ratios. Significant predictors of mean deviation of visual field were CCT ( $P = 0.006$ ). For an increase of 10  $\mu\text{m}$  of CCT, the mean deviation of visual field improved by 0.34. Significant predictors of vertical cup-disc ratio were CCT ( $P < .001$ ). For an increase of 10  $\mu\text{m}$  of CCT, the vertical cup-disc ratio decreased by 0.008. Significant predictors of horizontal cup-disc ratio were CCT ( $P = 0.003$ ). For an increase of 10  $\mu\text{m}$  of CCT, horizontal cup-disc ratio decreased by 0.007.

In the **Current study**, eyes having central corneal thickness < 500  $\mu\text{m}$  have cup to disc ratio in the range of 0.7 to 1. Patients having central corneal thickness > 560  $\mu\text{m}$  have cup to disc ratio between 0.3 to 0.6.

There is a negative correlation between central corneal thickness and cup to disc ratio i.e. patients with higher cup to disc ratio have thin corneas.

The correlation coefficient  $r$  is -0.53821  $p$  value (0.000). This correlation is significant at the 0.01 level (2 tailed).

The correlation coefficient  $r$  between intraocular pressure and central corneal thickness is 0.04516,  $p$  value (0.755).

There is a positive correlation suggesting that in thin corneas intraocular pressure measured is lower as compared to thick corneas.

Though this correlation is not statistically significant.

The correlation coefficient  $r$  observed between the central corneal thickness and mean deviation of perimetric data is -0.311,  $p$  value (0.028).

There is negative correlation suggesting that thin corneas have more visual field defects as compared to thick corneas. This correlation is statistically significant at the 0.05 level (2-tailed).

## 6. Conclusion

In patients with primary open angle glaucoma those with thinner central corneal thickness are likely to develop greater glaucomatous optic nerve and visual field damages than those with a thicker central corneal thickness.

1) Glaucoma patients with thin central corneal thickness are found at an advanced stage of the disease.

- 2) A statistically significant correlation is found between the central corneal thickness and visual field parameters.
- 3) Measuring of the central corneal thickness may aid in identification of glaucoma patients at high risk for progression.

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