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Research Article

COMPARISON OF CENTRAL CORNEAL THICKNESS IN NORMAL TENSION GLAUCOMA AND PRIMARY OPEN ANGLE GLAUCOMA- A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Primary Open-Angle Glaucoma (POAG) and Normal Tension Glaucoma (NTG) are the two most prevalent subtypes of glaucoma, which is a leading cause of permanent blindness. The corneal thickness (CCT) significantly affects the measurement of IOP and development of glaucoma.

The goal of this study is to compare the thickness of the Ganglion Cell Complex (GCC) and CCT in patients with NTG and POAG.

Method: At Rohilkhand Medical College in Bareilly, 60 patients (30 POAG, 30 NTG) participated in a cross-sectional observational study.

Findings: Compared to NTG patients (15.77 ± 3.22 mmHg; 502.33 ± 13.91 µm), POAG patients had significantly higher IOP (29.93 ± 10.05 mmHg) and CCT (542.37 ± 28.79 µm). NTG had a higher GCC (80.67 ± 7.61 µm) than POAG (74.67 ± 7.41 µm).

In conclusion, NTG exhibits thinner corneas with comparatively maintained GCC, whereas POAG is linked to thicker corneas and thinner GCC. These variations demonstrate how crucial CCT is to the diagnosis and treatment of glaucoma.

INTRODUCTION

Glaucoma is a complex, multifactorial ocular disease characterized by progressive optic nerve damage and vision loss, frequently linked to elevated intraocular pressure (IOP). Is a leading cause of progressive irreversible blindness worldwide, and is by far one of the most significant factors contributing to irreversible bilateral blindness.

Primary open-angle glaucoma (POAG) is a category of glaucomas characterized by an open , normal-appearing anterior chamber angle and increased intraocular pressure (IOP), without any other underlying condition. The present estimated worldwide population of primary open-angle glaucoma is 68.56 million.

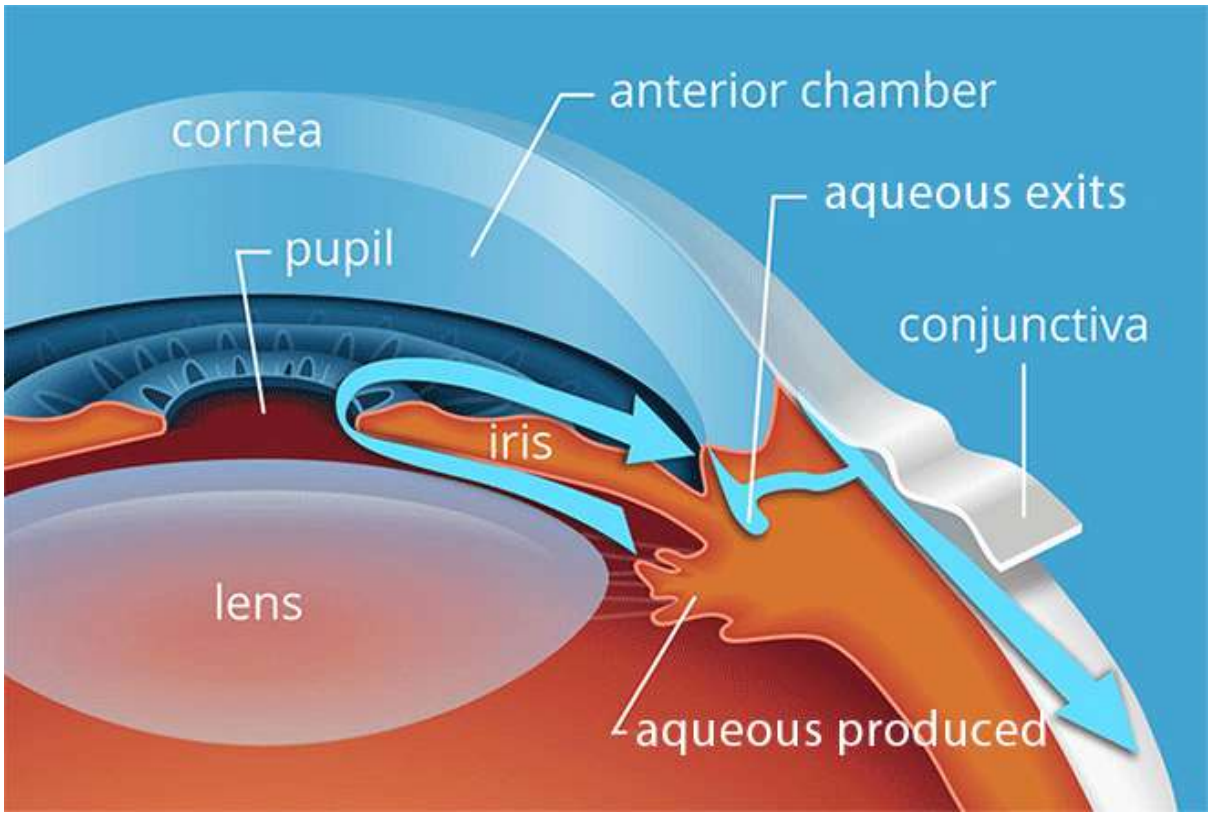


Figure 1: Aqueous production and drainage (Source-McManes A)

Normal-Tension Glaucoma presents with glaucomatous optic nerve damage and visual field loss despite intraocular pressure within the statistically normal range. The pathophysiology is still unknown, and it is debatable whether it is a spectrum of primary open-angle glaucoma (POAG) or avariety of conditions.

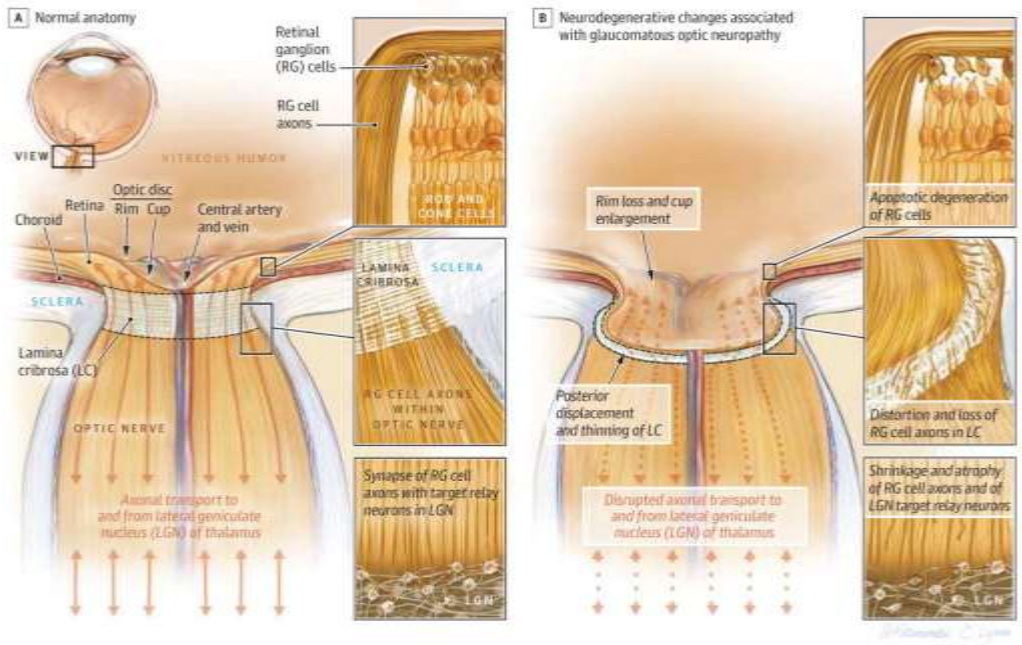


Figure 2:Pathophysiology of POAG (Source: Weinreb et ali. 2014)

The Central Corneal Thickness (CCT) is an important parameter in ophthalmology. It is responsible for the treatment of different eye disorders including glaucoma, keratoconus, contact lens use, corneal conditions, vision correction surgery, and corneal transplantation. It has emerged as a significant parameter in evaluating and managing glaucoma. Central Corneal Thickness also plays a crucial role in the accuracy of intraocular pressure measurement.

The central cornealthickness is commonly measured using Optical coherence tomography (OCT), Topographer (TOPO), Ultrasonic Pachymeter (US), Specular Microscope (MS), and Contactless Tonometer (TONO).

The normal range of central corneal thickness is 540 microns. Central corneal thickness was shown to decrease considerably with increasing disease severity in POAG.

The Ganglion Cell Complex (GCC) is an important structure in the retina that includes the nerve fiber layer (axons), ganglion cell layer (body), and inner plexiform layer (dendrites). Its thickness can provide valuable insights into the presence and progression of glaucoma.

Patients with POAG typically exhibit a significant reduction in GCC thickness as the disease progresses. This thinning is often correlated with the severity of visual field loss and intraocular pressure (IOP) levels.

In NTG, GCC thinning can also be observed, but the degree of thinning may not correlate as strongly with IOP levels since NTG occurs despite normal IOP. Studies have shown that GCC thickness in NTG patients can be similar to or even less than that in POAG patients at similar stages of visual field loss.

AIM AND OBJECTIVES

Aim

- To study the comparison of central corneal thickness in primary open-angle glaucoma and normal tension glaucoma

Objectives

- To correlate the central corneal thickness with a degree of raised IOP.
- To compare the thickness of Ganglion Cell Complex in patients with Primary open-angle glaucoma and Normal Tension Glaucoma.

MATERIAL AND METHODS

- Study was carried out among 60 patients, coming to Department of Ophthalmology; Rohilkhand medical college & hospital Bareilly, U.P.

Inclusion criteria:

- Patients who have given informed consent.
- Patients with Schaffer's grading 3 to 4 on gonioscopy
- Patients who are a case of NTG with IOP<21 mmHg and glaucomatous optic nerve head damage.
- POAG patients with untreated IOP of >21mmHg with glaucomatous optic nerve head damage.

Exclusion criteria:

- Patients with Schaffer's grading ≤2 on gonioscopy.
- Patients who have corneal pathologies.
- Patients of corneal edema due to causes other than glaucoma.
- Patients who have undergone previous intraocular surgeries.
- Patients diagnosed with secondary glaucoma.
- Chronic contact lens wearers.
- Patients who have undergone any ocular laser therapy.
- Patients who have comorbidities such as Hypertension, Diabetes mellitus.

METHODOLOGY

- After taking approval from the Institutional Ethics Committee, this study will be conducted by recruiting the patients, qualifying the inclusion as well as the exclusion criteria.
- **Group A- patients diagnosed with POAG (IOP>21mmHg with glaucomatous optic disc changes)**
- **Group B- patients diagnosed with NTG (with IOP≤21mmHg with glaucomatous optic disc changes)**
- All patients enrolled in this study was undergo the following:

1. History taking and Determination of best corrected visual acuity.
2. Slit lamp examination to assess the anterior segment and exclude any corneal pathology if present.
3. Non-Contact Tonometry (to measure the IOP), Gonioscopy (to assess the anterior chamber angles), Perimetry (to assess the visual field), and OCT (optical coherence tomography) for the assessment of Ganglion Cell Complex thickness.
4. Fundus examination using +90D lens with the slit lamp.

Ultrasonic pachymetry test was done to assess the thickness of central

cornea. **Sample size:** for this study is being calculated using Power and Sample Software[7]:

- Alpha- 0.05 (5%)
- Power8- 0.8 (80%)
- Mean difference (delta)- 3
- Standard Deviation(sigma)- 4
- The sample size calculated for each group is 30.
- Total sample sizeis 60.

OBSERVATIONS AND RESULTS

Table no.1: Distribution of age in both groups

Age in years	Group		Test Value [p value]
	POAG [N=30]	NTG [N=30]	
<= 40	2 (6.7)	1 (3.3)	2.873 [0.579]#
41-50	8 (26.7)	5 (16.7)	
51-60	10 (33.3)	11 (36.7)	
61-70	9 (30.0)	9 (30.0)	
>70	1 (3.3)	4 (13.3)	
Mean±SD (years)	55.8±8.9	58.6±9.2	-1.181 [0.243]*

Data representation= Frequency [percentage]; #= chi square test, *= independent t test

The table 1 shows the distribution of age in two groups: POAG and NTG. The average age of the POAG group is 55.8 years, while the NTG group has a mean age of 58.6 years. The difference between the two averages is not statistically significant (p = 0.243).

The table also shows the percentage of patients in each group in each age category. In the POAG group, the majority of participants fall within the age range of 51–60 years (33.3%), followed by 61–70 years (30.0%), 41–50 years (26.7%), ≤40 years (6.7%), and >70 years (3.3%). Similarly, in the NTG group, the highest proportion is in the 51–60 years range (36.7%), followed by 61–70 years (30.0%), 41–50 years (16.7%), >70 years (13.3%), and ≤40 years (3.3%).

The chi-square test was used to compare the distribution of age in the two groups. The chi-square test showed that there was_no statistically significant_difference between the two groups (p = 0.579).

Figure 3:Distribution of Age in both groups

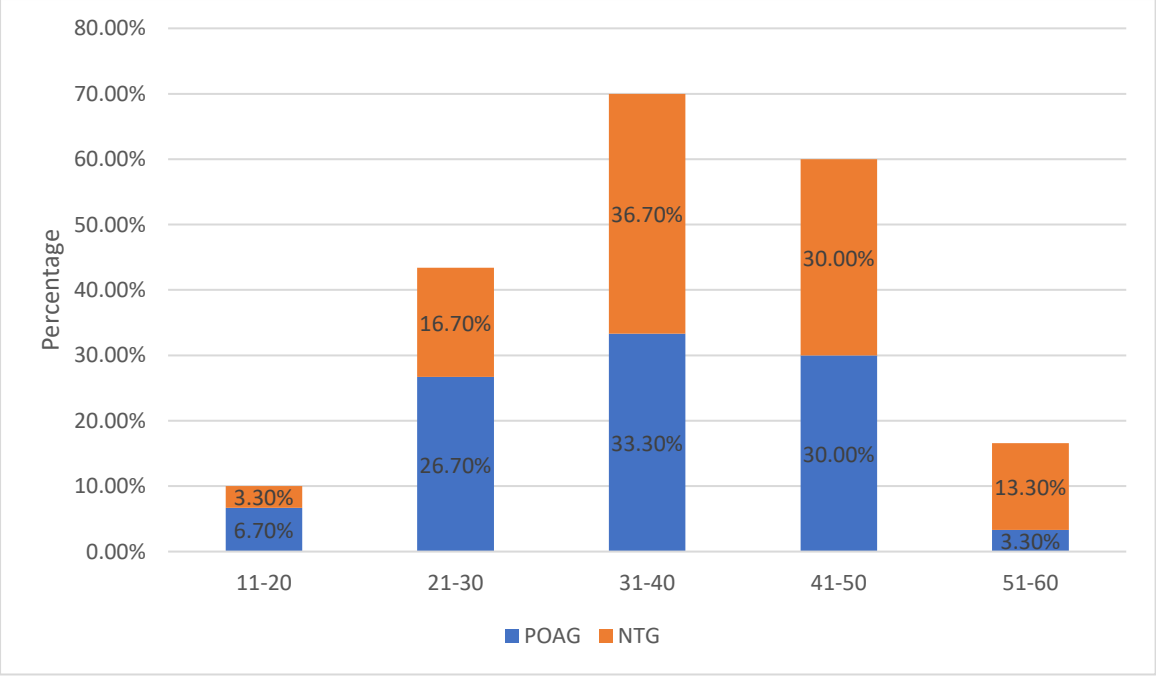


Table no. 2:Distribution of Gender in both groups

Gender	Group	Test Value [p

	POAG [N=30]	NTG [N=30]	value]
Male	21 (70.0)	19 (63.3)	0.300 [0.584]#
Female	9 (30.0)	11 (36.7)	

Data representation= Frequency [percentage]; #= chi square test

The table 2 displays the gender distribution across two groups, POAG and NTG. In the POAG group, males constitute 70% (21 out of 30), while females make up 30% (9 out of 30). Conversely, the NTG group comprises 63.3% males (19 out of 30) and 36.7% females (11 out of 30).

A chi-square test was conducted to assess if the observed gender difference between the two groups wasstatistically significant. The test yielded a p-value of 0.584, suggesting that the difference is not statistically significant.

Figure 4:Distribution of sex in both groups

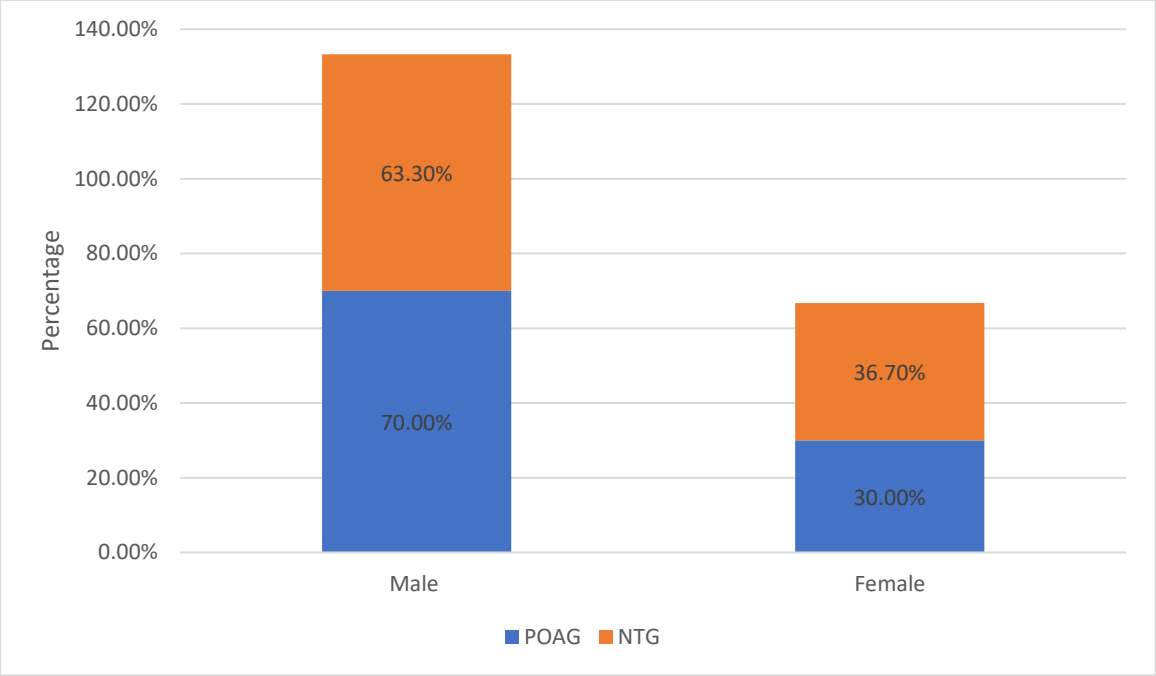


Table no.3: Comparison of IOP in both groups

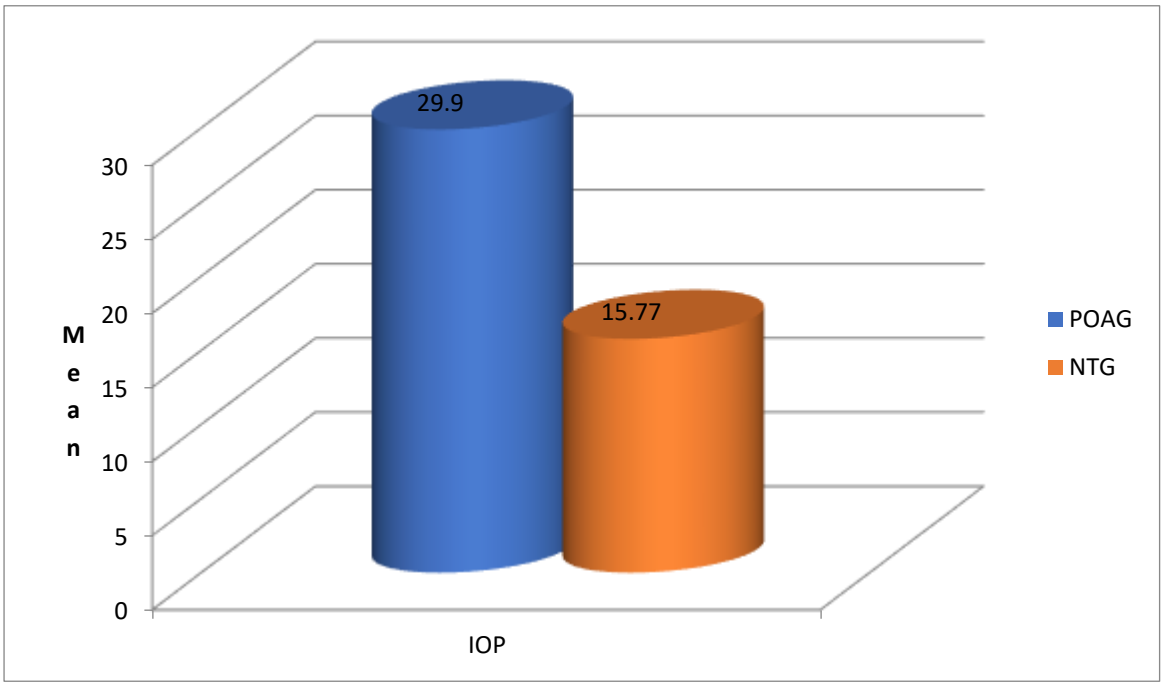
	Group	N	Mean	Std. Deviation	Minimum	Maximum	Test Value [p value]

IOP	**POAG**	30	29.93	10.1	18	54	7.351 [<0.001]*
	NTG	30	15.77	3.2	11	21	

*= independent t test; IOP= Intra ocular pressure

In the POAG_group, the mean_IOP is significantly higher at 29.93 ± 10.05 mmHg, with values ranging from 18 to 54 mmHg. In contrast, the NTG group has a markedly lower mean IOP of 15.77 ± 3.22 mmHg, with a range of 11 to 21 mmHg. The difference in IOP between the two groups is statistically significant, as indicated by the independent t-test result ($p < 0.001$). This demonstrates a clear distinction in IOP levels between patients_with POAG and those with NTG, with POAG patients exhibiting significantly elevated IOP [Table no 3].

Figure 5:Comparison of IOP in both groups



Comparison of CCT and GCC in both groups

These findings highlight significant differences in both CCT and GCC between the two groups, with POAG patients having thicker corneas and thinner ganglion cell layers compared to NTG patients.

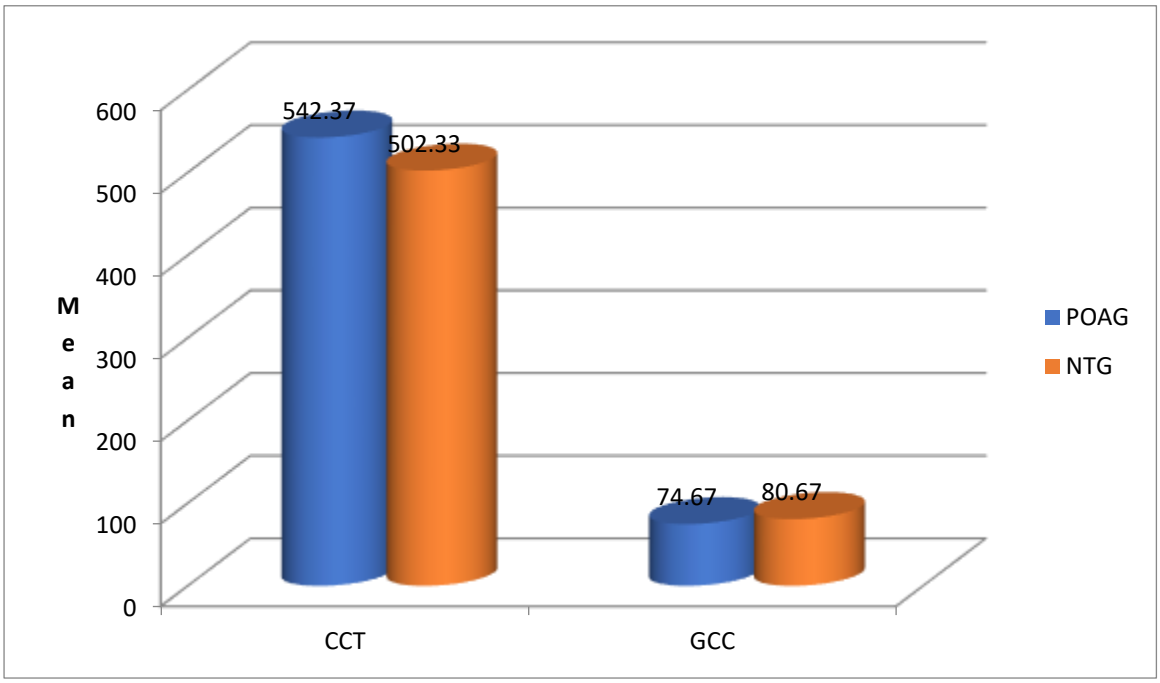


Table no. 4: Comparison of CCT and GCC in both groups

	Group	N	Mean	Std. Deviation	Minimum	Maximum	Test Value [p value]
CCT	POAG	30	542.37	28.786	487	588	**6.858 [<0.001]***
	NTG	30	502.33	13.912	470	521	
GCC	POAG	30	74.67	7.406	63	85	**-3.095 [0.003]***
	NTG	30	80.67	7.608	65	93	

*= independent t test; CCT= Central Corneal Thickness; GCC= Ganglion Cell Complex

For CCT, the mean value in the POAG group is significantly higher at 542.37 ± 28.79 µm, with a range of 487 to 588 µm, compared to the NTG group, which has a mean CCT of 502.33 ± 13.91 µm, ranging from 470 to 521 µm. The independent t-test indicates a statistically significant difference between the two groups ($p < 0.001$), with POAG patients having thicker corneas on average.

Regarding GCC, the mean value in the POAG group is 74.67 ± 7.41 µm, with a range of 63 to 85 µm, while the NTG group has a significantly higher mean GCC of 80.67 ± 7.61 µm, ranging from 65 to 93 µm. The independent_t-test also shows a statistically significant_difference (p = 0.003), with NTG patients exhibiting greater GCC thickness than POAG patients.

These findings highlight significant differences in both CCT and GCC between the two groups, with POAG patients having thicker corneas and thinner ganglion cell layers compared to NTG patients.

Figure 6: Comparison of CCT and GCC in both groups

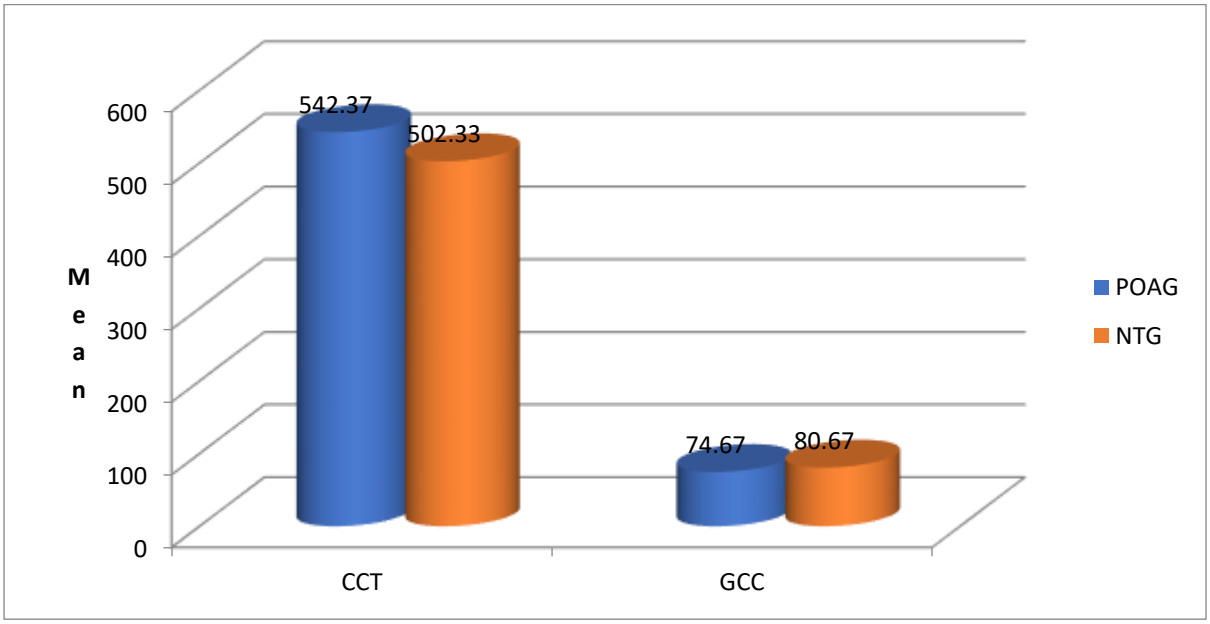


Table no. 5: Comparisons of IOP, CCT and GCC

Comparison	Difference between	

	Means	
IOP	14.17	***
CCT	40.03	***
GCC	-6.00	***

IOP= Intra ocular pressure; CCT= Central Corneal Thickness; GCC= Ganglion Cell Complex

The mean IOP POAG group is higher by 14.17mmHg compared to the NTG group, indicating a substantial elevation in IOP among POAG patients. Similarly, the mean CCT in the POAG group exceeds that of the NTG group by 40.03 µm, reflecting thicker corneas in POAG patients. Conversely, the mean GCC in the POAG group is lower by 6.00 µm compared to the NTG group, signifying greater thinning of the ganglion cell layer in POAG patients.These statistically significant differences ($p < 0.05$) emphasize the distinct characteristics of IOP, CCT, andGCC between the two study groups, underscoring the physiological variations associated with POAG and NTG.

Table no. 6: Correlation of IOP with CCT and GCC

		IOP	**CCT**	**GCC**
IOP	**Pearson Correlation (r value)**	1	0.528**	-.165
	P value		0.000	.207
	N	60	60	60
CCT	**Pearson Correlation (r value)**	0.528**	1	-0.331**
	P value	0.000		0.010
	N	60	60	60
**. Correlation is significant at the 0.01 level (2-tailed).				

Pearson correlation test

A strong positive correlation ($r = 0.528$, $p < 0.001$) exists between IOP and CCT, indicating that as CCT increases, IOP tends to increase as well. This suggests that corneal thickness can influence IOP measurements.

On the other hand, a weak negative correlation ($r = -0.165$, $p = 0.207$) is observed between IOP and GCC. This implies that there is no significant linear relationship between IOP and GCC.

Figure 7: **Correlation of IOP with CCT**

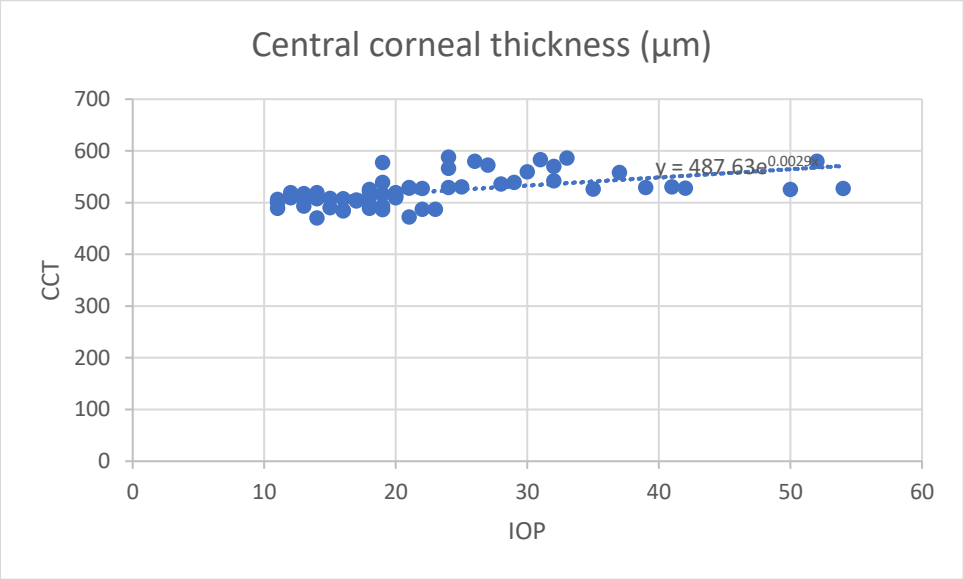
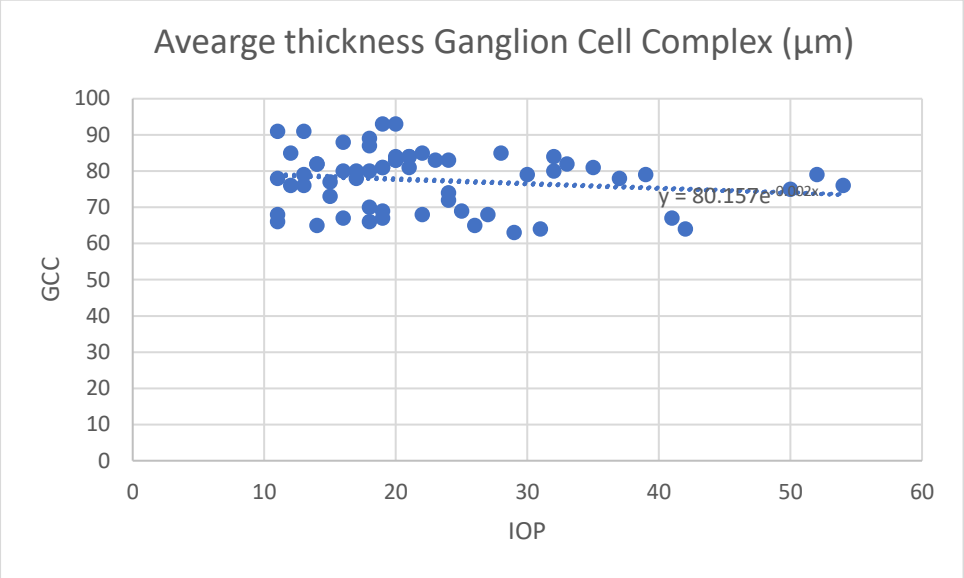


Figure 8:**Correlation of IOP with GCC**



SUMMARY

Recent studies suggest that Central Corneal Thickness may influence intraocular pressure readings and be an independent risk factor in the development and progression of glaucoma. The macular GCC is expected to target the cells directly affected by glaucoma in the area of their highest concentration. However, studies also have reported differences in macular GCC parameters between NTG and POAG. Present study was aimed to study the comparison of central corneal thickness in normal tension glaucoma and primary open angle glaucoma. This observational study was carried out in Department of Ophthalmology Rohilkhand Medical college and Hospital, Bareilly, U.P for 1 year time frame. All the diagnosed cases of Primary Open Angle Glaucoma (POAG), Normal Tension Glaucoma (NTG) attending at the department of ophthalmology; fulfilling the inclusion criteria.

Significantly higher IOP in the POAG group compared to the NTG group ($p<0.05$).

Significantly thicker CCT in the POAG group compared to the NTG group ($p<0.05$).

Significantly thinner GCC in the POAG group compared to the NTG group ($p<0.05$).

A strong positive correlation between IOP and CCT ($p<0.001$).

CONCLUSION

These findings underscore the distinct physiological features of POAG and NTG. The higher IOP and thicker CCT in POAG highlight the importance of accurate IOP measurements and consideration of corneal biomechanical factors in glaucoma diagnosis and management. OCT has proved to be a useful tool in the early diagnosis of glaucoma to prevent blindness. This study demonstrates significant differences in CCT and GCC between POAG and NTG patients. POAG patients exhibited thicker corneas and thinner GCC compared to NTG patients. These findings highlight the importance of considering corneal biomechanics in glaucoma diagnosis and management. Accurate measurement and consideration of CCT are crucial for proper IOP assessment and glaucoma treatment decisions. Further research is warranted to investigate the underlying mechanisms contributing to GCC thinning in POAG and its potential impact on visual function.

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