

A Study of Corneal Endothelial Cell Count and Central Corneal Thickness in Patients with Primary Open-Angle Glaucoma

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Abstract

Background: To evaluate and compare corneal Endothelial cell density and Central corneal thickness (CCT) in patients of Primary open-angle glaucoma (POAG) with healthy Controls. **Material and Methods:** The prospective observational study was conducted on the patients attending the Eye OPD for one year, in which 50 diagnosed cases (100 eyes) of POAG and 50 age and sex matched healthy individuals (100 eyes) were evaluated. **Results:** In our study, the mean age in the POAG cases group was 55.96 ± 7.03 years compared to the mean age of 56.94 ± 7.33 years in the control group. Most patients were in the age group of 51-60 years in both groups. In our study, out of 50 cases, the prevalence of POAG was higher in male patients (54%) compared to females (46%). The mean endothelial cell density was 2287 ± 240.54 cells/mm² in the POAG cases group compared to the mean endothelial cell density of 2486.77 ± 206.8 cells/mm² in the control group. The difference in the endothelial cell count between the two groups was statistically significant (p value < 0.0001). The mean central corneal thickness was 514.65 ± 33.73 μ m in the POAG cases group compared to the mean central corneal thickness of 516.69 ± 22.86 μ m in the control group, and the difference was found to be statistically insignificant (p value = 0.545). **Conclusion:** According to the study's findings, individuals with POAG had less corneal endothelial cell density than those in the same age range who do not have glaucoma. Therefore, performing anterior segment procedures on such patients requires all care to prevent additional damage to corneal endothelial cells. The measurement of CCT is an important factor in evaluating and managing glaucoma, as the measurement of IOP by applanation tonometry is affected by central corneal thickness. High CCT leads to overestimation of IOP, and low CCT leads to underestimation of IOP readings. However, in our study, there was no significant difference in the average CCT between the POAG and the control group.

Keywords: CCT (central corneal thickness, IOP (intra-ocular pressure), POAG (primary open-angle glaucoma).

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INTRODUCTION

Glaucoma is increasingly recognized as a major cause of ocular morbidity worldwide (Park K).

Glaucoma is a collection of ocular disorders with a multifaceted aetiology. It is marked by the acquired degeneration of retinal ganglion cells, progressive optic neuropathy accompanied by morphological alterations in the optic nerve head, and irreversible visual field deficits. Elevated intraocular pressure is recognised as a principal risk factor.

Classification: (Shields Textbook of Glaucoma, 2011) The glaucomas have traditionally been classified into:

1. Primary Glaucoma: In this class of glaucomas, the initial events leading to the aqueous outflow obstruction and IOP elevation are confined to the anterior chamber angle or conventional outflow pathway. Primary glaucomas can further be divided into:
 2. Open-angle glaucoma.
 3. Angle closure glaucoma.
 4. Congenital glaucoma.

Secondary Glaucoma: occurs due to underlying predisposing ocular or systemic events.

POAG: is typically characterized by:

1. An open, normal appearing anterior chamber angle.

2. An increased IOP without any apparent ocular or systemic abnormality that might account for the elevated IOP.
3. Typical optic nerve head damage or Visual field defects. (Shields Textbook of Glaucoma, 2019).

Effects of POAG on corneal endothelial cell count: The corneal endothelium is essential for preserving corneal clarity by actively dehydrating the corneal stroma, which facilitates an organised arrangement of collagen fibrils and produces clear tissue. The average endothelial cell count is about 2000 to 3500 cells /mm² in young adults,^[2] or about 400,000 cells.^[3] These cells have a uniform thickness of 5 μ m and a width of 20 μ m and have a polygonal (mostly hexagonal) shape.^[4] There is a decrease in the endothelial cells at about 0.6% per year, and corneal oedema develops at a cell density of about 500 cells/mm², and

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the corneal transparency is impaired.^[5]

Other factors affecting endothelial cell count are increasing age, accidental or surgical trauma (during cataract extraction), diseases like Diabetes and Glaucoma.

The underlying multifactorial influences of elevated intraocular pressure (IOP), prolonged exposure to preservatives in glaucoma medications, surgical management, mechanical forces, and changes in the aqueous environment are all linked to glaucoma's detrimental effects on the corneal endothelium (Janson BJ et al., 2017). Open-angle glaucoma has been linked to decreased corneal endothelial cell density (Hong C et al., 1982).

Central corneal thickness in POAG: Central corneal thickness (CCT) is an important biometric measurement in several ocular conditions, such as corneal oedema, corneal dystrophies, corneal endothelial diseases, and glaucoma (Doughty MJ et al., 2000) [6]. The normal central corneal thickness is 0.51-0.52 mm (Krachmer JH, 2005), which may be affected by various ocular conditions.

The assessment of central corneal thickness (CCT) is crucial in the diagnosis and therapy of patients with primary open-angle glaucoma (POAG) since intraocular pressure (IOP) measurements obtained using applanation tonometry are influenced by CCT (Herndon LW et al., 1997). Research indicates that a change of around 100µm in corneal thickness results in alterations in intraocular pressure (IOP) by 6-7 mmHg (Ehler et al., 1975).

Research indicates that elevated central corneal thickness (CCT) results in an overestimation of intraocular pressure (IOP), while diminished CCT leads to an underestimation of IOP measurements (Doughty MJ 2000). Numerous studies conducted by the American Academy of Ophthalmology (Deuker DK et al., 2007) and the European Glaucoma Prevention Study (Miglior S et al., 2007) determined that those with thinner corneas have a heightened risk of getting glaucoma compared to those with normal corneal thickness.

Aims and Objectives:

1. To evaluate the Endothelial cell count in Primary Angle Glaucoma patients using the Specular microscope (TOPCON SP-1P).
2. To evaluate the Central corneal thickness (CCT) in patients of POAG using the Specular microscope (TOPCON SP-1P).

MATERIALS AND METHODS

The suggested Case-Control research was executed in the Department of Ophthalmology at Government Medical College, Jammu. It was a prospective observational study in which 50 diagnosed and investigated patients (100 eyes) of Primary Open Angle Glaucoma, who met the inclusion criteria, were enrolled. Their Central Corneal Thickness (CCT) and Endothelial Cell Count were measured and compared with 50 (100 eyes) age and sex matched healthy controls using Specular Microscope (TOPCON SP-1P).

The study was conducted in two groups:

Group I: 50 Patients, ≥ 40 years of age, diagnosed as Primary Open Angle Glaucoma.

Group II: 50 Healthy age-matched (± 5 years) individuals with normal eyes were taken as the Control group.

The Institutional Ethical Committee cleared the reference study. All the patients enrolled in the study gave informed written consent. The study was conducted on patients attending the Eye OPD, GMC Jammu, for over one year.

Inclusion Criteria:

1. All Patients, more than or equal to 40 years of age, of Primary Open Angle Glaucoma, attending the Eye OPD.
2. Patients of either sex

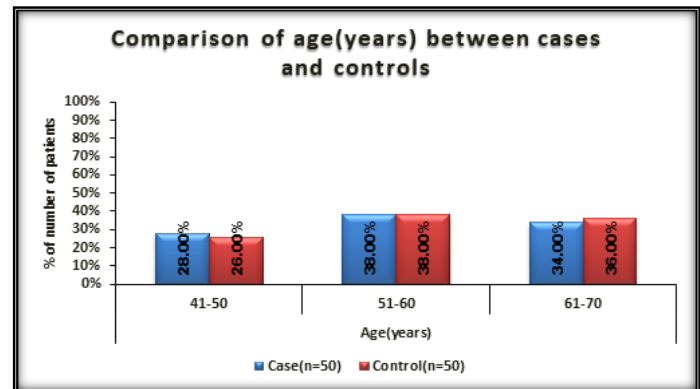
Exclusion Criteria:

Patients < 40 years of age, other types of Glaucoma, presence of any corneal pathology like corneal dystrophy or degeneration, ectasia, corneal infections, etc., previous ocular surgery or laser procedure, ocular trauma, contact lens wearers, systemic disease like diabetes mellitus.

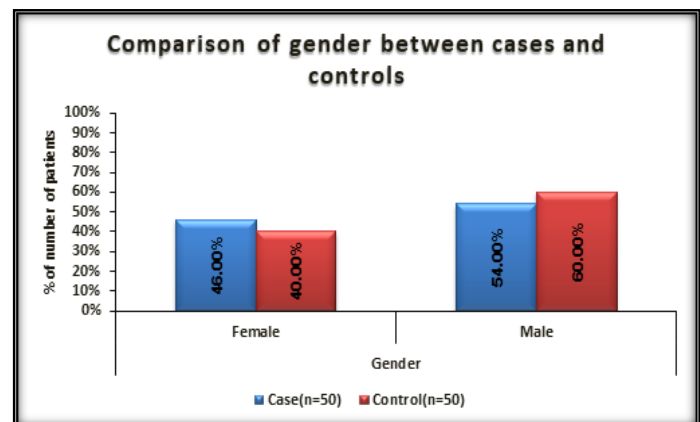
The study proceeded as follows:

1. A detailed clinical history and general physical examination of all the cases and the controls were done.
2. In both the cases and the control group, a thorough ocular examination, including recording Visual acuity (for near and distance) and BCVA, IOP (using NCT 20), Slit lamp examination, Fundus examination, gonioscopy, static perimetry (using Opto AP 100 perimeter), and Spherical microscopy (using noncontact specular microscope TOPCON SP-1P), was done.

RESULTS

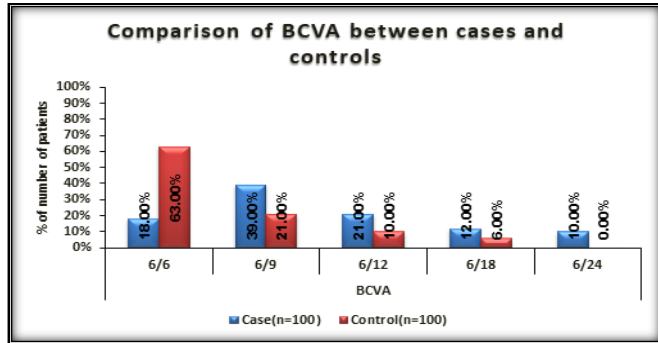


The mean age in POAG group was 55.96 ± 7.03 years compared to the mean age of 56.94 ± 7.33 years in the control group.

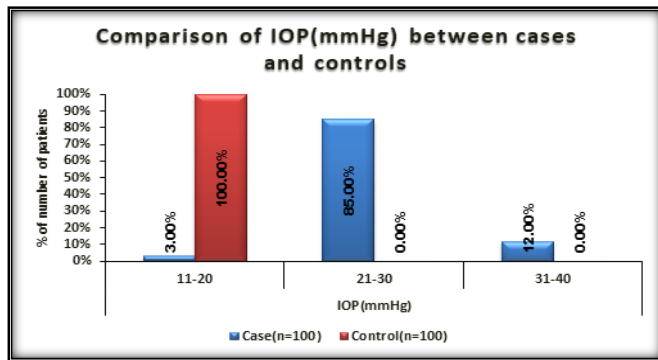


Out of the total 50 cases of POAG, 27(54%) were males and 23(46%) were females while out of the 50 controls, 30(60%) were males and 20(40%) were females.

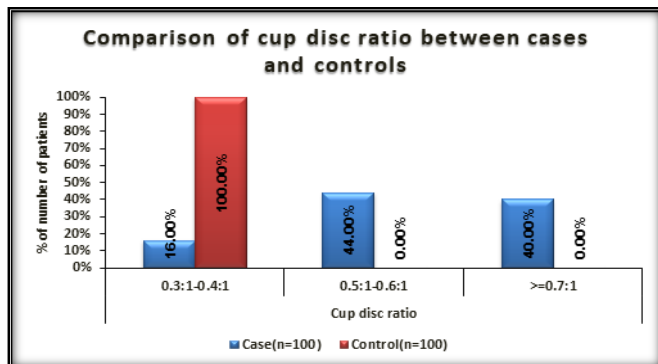
There was no statistically significant difference in demographic variables (age and sex) between the POAG patients and controls.



Best corrected visual acuity (BCVA) was found to be 6/9 (39%) in most of patients in POAG group while majority of subjects in the control group had a BCVA of 6/6 (63%). The difference in BCVA of two groups was statistically significant (p value<0.0001).



The mean IOP in the POAG cases group was found to be 25.83± 3.87 mm Hg while the mean IOP in the control group was 15.42 ± 2.3 mm Hg. There was statistically significant difference in the mean IOP between the two groups (p value <0.0001).



Among the POAG cases, the mean CD ratio was found as 0.61 ± 0.17 while the mean CD ratio among the controls was

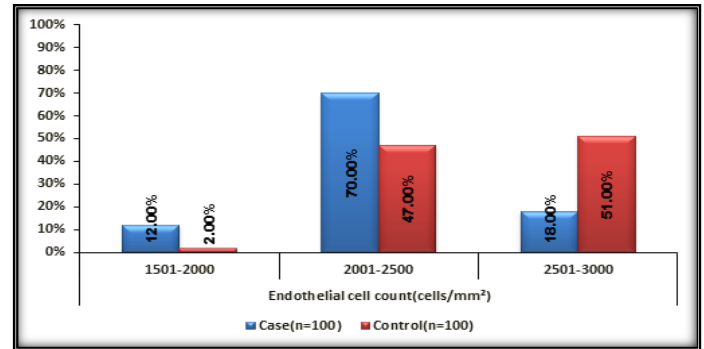
found as 0.3± 0. The difference in the mean CD ratio between the two groups was statistically significant (p value< 0.0001).

The Endothelial cell count (cells/mm²) and Central corneal thickness (µm) were measured using non-contact Specular microscope (TOPCON SP-1P).

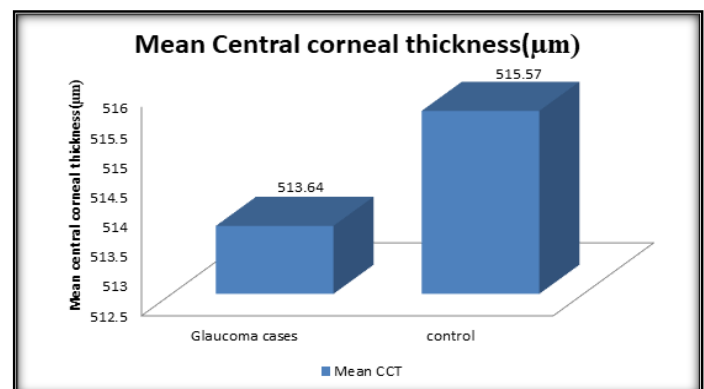
In this study, out of 50 cases of POAG (100 eyes), 12 (12%) eyes were having endothelial cell count of 1501-2000 cells/mm², 70 (70%) eyes were having endothelial cell count of 2001-2500 cells/mm² and 18 (18%) eyes were having endothelial cell count of 2501-3000 cells/mm².

Out of 50 controls (100 eyes), 2 (2%) eyes were having endothelial cell count of 1501-2000 cells/mm², 47 (47%) eyes were having endothelial cell count of 2001-2500 cells/mm² and 51 (51%) eyes were having endothelial cell count of 2501-3000 cells/mm².

The difference in endothelial cell count was statistically significant between the two groups (p value <0.0001).



Comparison of central corneal thickness (µm) between cases and controls.



The mean central corneal thickness (CCT) was $514.65 \pm 33.73 \mu\text{m}$ in the POAG cases group compared to the mean CCT of $516.69 \pm 22.86 \mu\text{m}$ in the control group and the

difference was found to be statistically insignificant (p value = 0.545).

Table 1: Comparison of Endothelial cell count between POAG Cases and Controls.

Endothelial cell count(cells/mm ²)	Case (n=100)	Control (n=100)	Total	P value	Test performed
1501-2000	12 (12%)	2 (2%)	14 (7%)	<.0001	Chi square test,27.447
2001-2500	70 (70%)	47 (47%)	117 (58.50%)		
2501-3000	18 (18%)	51 (51%)	69 (34.50%)		
Mean \pm SD	2287.88 \pm 240.54	2486.77 \pm 206.8	2387.32 \pm 244.95	<.0001	t test;6.27
Median(25th-75th percentile)	2298 (2158-2439.25)	2507 (2380.75-2614.25)	2408.5 (2252.25-2562)		
Range	1560-2783	1900-2989	1560-2989		

DISCUSSION

In our study, 50 patients (100 eyes) of POAG were enrolled and compared with 50 (100 eyes) age and sex matched controls. The mean age in the POAG case group was 55.96 ± 7.03 years compared to the mean age of 56.94 ± 7.33 years in the control group. Most patients were in the age group of 51-60 years in both the groups, i.e., 38% in the POAG case group and 38% in the controls. In our study, out of 50 cases, the prevalence of POAG was found to be higher in male (27) patients (54%) as compared to the female (23) patients (46%). No statistically significant variation in sex distribution was seen in instances with POAG (p -value = 0.545). Similar observations have been made in various studies conducted in the past. Palimkar A et al,^[9] (2008) conducted a study and found that the prevalence of POAG was 51.4 % in males, while in females it was 48.6%. In their study, Tham YC et al. (2014) observed that men had 36% more risk of developing POAG than women. In their study, Kapetanakis et al. (2016) found that males showed a 33% higher risk of POAG than females. In our study, the prevalence of POAG increased with the patient's age. The mean age in the POAG case group was 55.96 ± 7.03 years. Tuck MW et al (2009) found that the prevalence of POAG was 7% in the less than 55 age group, 44% in those aged 55-74 years, and 49% in older patients. The prevalence of POAG increased as the patient's age increased. Khandelwal RR et al. (2019) found the mean age of prevalence of POAG was 60.20 ± 10.71 years. The mean endothelial cell density in the POAG cases group was 2287 ± 240.54 cells/mm², while the control group had a mean endothelial cell density of 2486.77 ± 206.8 cells/mm². The disparity in endothelial cell count between the two groups was statistically significant (p value < 0.0001). Gagnon M et al. (1997),^[10] performed a comparative analysis of endothelial cell counts in glaucoma patients against healthy controls, with the same findings. The ocular endothelial cell count was markedly reduced in glaucoma patients (2154 ± 419 cells/mm²) compared to controls (2560 ± 360 cells/mm²). Sung Woo Cho et al. (2009),^[11] in their study compared the endothelial cell density in patients with POAG and NTG with the controls. They found that the mean endothelial cell densities in the POAG group were 2370 ± 392.3 cells/mm², in the NTG group were 2696.7 ± 303.9 cells/mm², and in the control group were 2723.6 ± 300.6 cells/mm². POAG had a significantly lower endothelial cell count (p value < 0.0001) than the other two

groups. In the POAG group, the average central corneal thickness was $514.65 \pm 33.73 \mu\text{m}$. In contrast, the control group exhibited a mean central corneal thickness of $516.69 \pm 22.86 \mu\text{m}$, with the difference statistically insignificant (p value = 0.545). Copt R et al. (1999),^[12] conducted a study. They observed no significant difference in the CCT between the eyes of patients of POAG ($543 \pm 35 \mu\text{m}$) and healthy controls ($552 \pm 35 \mu\text{m}$). H. Dave et al. (2004),^[13] in their study found no significant difference in CCT in patients of POAG ($559.5 \pm 43.5 \mu\text{m}$) and the control group ($555.9 \pm 34.6 \mu\text{m}$). Narayanaswamy A et al. (2013),^[14] conducted a study and observed that the mean CCT in the normal population was $540.31 \pm 33.79 \mu\text{m}$ as compared to the CCT of $529.8 \pm 30.8 \mu\text{m}$ in POAG patients. There was a statistically significant difference in CCT between the POAG and the control group (p -value = 0.003). This observation differed from our study.

CONCLUSION

The research found that people with primary open-angle glaucoma have reduced corneal endothelial cell density compared to age-matched individuals without glaucoma. The suggested explanations include direct damage from elevated intraocular pressure, congenital changes in the corneal endothelium in individuals with glaucoma, toxicity from glaucoma medications, or a combination of these factors. Consequently, it is essential to implement all necessary safeguards to save the corneal endothelial cells from further damage during any anterior segment procedures. The mean CCT exhibited no statistically significant difference between the POAG patients and the control group.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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