ORIGINAL RESEARCH

Assessment of correlation between intraocular pressure and visual field loss in primary open angle glaucoma (POAG) and primary angle closure glaucoma (PACG)

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ABSTRACT
Background: The second most common cause of blindness in the world is glaucoma. The present study was conducted to assess correlation between intraocular pressure and visual field loss in primary open angle glaucoma (POAG) and primary angle closure glaucoma (PACG).
Materials & Methods:65 diagnosed cases of PACG of both genders underwent a detailed glaucoma evaluation which included IOP measurement with Goldmann applanation tonometer and visual field-testing using Humphrey Field Analysis (HFA) 24-2 pattern. Advanced Glaucoma Intervention Score (AGIS) was calculated from reliable visual field test result.
Results:20 males and 18 females had POAG and 15 males and 12 females had PACG. The difference was non- significant (P> 0.05). The mean age (years) was 57.4±4.2 and 56.3±5.6, IOP (mm Hg) was 31.0±3.1 and 31.2±2.5, CCT (mm) was 503.2±43.1 and 528.4±45.8, ACD (mm) was 2.5±1.1 and 2.6±1.4 and AL (mm) was 21.7±6.3 and 24.3±7.4 in PACG and POAG patients respectively. The difference was non- significant (P> 0.05). The Pearson correlation for linear regression for baseline IOP and AGIS score in MD (r- 0.6, p- 0.01) and AGIS (r- 0.81, p- 0.01) demonstrated correlation coefficient. No Pearson correlation for linear regression for baseline IOP and POAG (P> 0.05).
Conclusion: The degree of visual field impairment can be managed by regulating IOP alone in PACG, according to a substantial association shown between IOP and visual field loss. The current suggested pathophysiology of optic neuropathy, which involves numerous factors influencing in addition to IOP, is consistent with the lack of statistical significance in the link between pretreatment IOP and visual field reduction in POAG.
Keywords: optic neuropathy,primary open angle glaucoma (POAG) and primary angle closure glaucoma
Keywords: dry eye syndrome, diabetic retinopathy, TBUT

INTRODUCTION

The second most common cause of blindness in the world is glaucoma. It is estimated that 11.2 million persons over 40 in India suffer from glaucoma, of whom 6.48 million have POAG and 2.54 million have PACG. Glaucoma is an irreversible optic neuropathy that causes problems in the visual field.[1] If treatment is not received in a timely manner, it can lead to blindness. The IOP level is a significant risk factor. It is established by the drainage of aqueous humor, which is reliant on the anterior chamber's angle. Angle structures are open in POAG despite trabecular meshwork sclerosis, whereas they are occluded in PACG.[2]

Because of its minimal intra- and inter-observer variability, Goldmann Applanation Tonometry (GAT) has been regarded as the most accurate technique for measuring intraocular pressure.[3] As part of a comprehensive ocular examination, gonioscopy enables us to assess the anterior chamber angle and is essential for the diagnosis and treatment of glaucoma. Gonioscopy can identify eyes that are at risk of closing and identify irregularities in angle.[4]

According to a study, the degree of visual field loss in PACG was more strongly correlated with initial IOP, which was measured before to beginning therapy, than POAG.[5] This suggests that IOP may play a larger role in PACG than POAG as a causal factor for optic nerve injury. IOP was investigated in the current group since it is the most significant modifiable risk factor to stop the development of optic neuropathy and the ensuing loss of visual field.[6] In contrast to POAG, the disease pathology in PACG is probably totally dependent on intraocular pressure. Complementary approaches to glaucoma therapy are crucial to preventing visual degradation, even if IOP-lowering is a cornerstone of glaucoma therapy and a very effective "neuro-protectant" in and of itself.[7]

AIM & OBJECTIVES

The present study was conducted to assess correlation between intraocular pressure and visual field loss in primary open angle glaucoma (POAG) and primary angle closure glaucoma (PACG).

MATERIALS & METHODS

Study Design

Type: Cross-sectional observational study.

Objective: To evaluate and compare clinical and visual field parameters in newly diagnosed cases of Primary Angle Closure Glaucoma (PACG) and Primary Open Angle Glaucoma (POAG).

Study Population

Sample Size: 65 diagnosed cases of PACG.

Age: Participants aged above 40 years.

Gender: Both males and females.

Consent: All participants provided written informed consent.

Study Setting

Location: Department of Ophthalmology, Vardhman Mahavir Medical College & Safdarjung Hospital, New Delhi, India.

Duration: January 2020 to March 2021(One year and three months).

Ethical Considerations

The study was conducted following ethical guidelines, with all participants providing informed consent.

Inclusion Criteria

- Newly diagnosed cases of PACG and POAG above 40 years of age.
- Patients who attended the glaucoma clinic for complete ocular examination and visual field analysis.

Exclusion Criteria

- Secondary glaucomas.
- Acute congestive glaucoma.
- Patients on anti-glaucoma medications or topical steroids.
- History of ocular surgery or trauma in the affected eye.

Refractive error greater than ±5 diopters (myopia or hypermetropia).

Unreliable visual fields even after repeated testing.

Methodology

1. **Initial Evaluation**:

Patients with intraocular pressure (IOP) >21 mmHg in either eye were further evaluated.

Collected data: age, gender, ocular history, medical history, and family history of glaucoma.

2. **Ocular Examinations**:

Best Corrected Visual Acuity (BCVA): Assessed using Snellen's chart.

IOP Measurement: Using Goldmann Applanation Tonometer (GAT); calibration done weekly.

Color Vision: Assessed using Ishihara chart.

Slit Lamp Biomicroscopy: Performed for anterior segment evaluation.

Gonioscopy: Indentation gonioscopy using Posner lens under dim illumination; occludable angle defined as posterior pigmented trabecular meshwork visible in less than 90° without indentation.

Optic Nerve Head and RNFL Assessment: Using 90D lens; evaluated for glaucomatous changes like vertical cup-disc ratio >0.6, asymmetry >0.2, bayonetting, laminar dot sign, beta peripapillary atrophy, nasal shift of vessels, and baring of circumlinear vessels.

Visual Field Testing:

Instrument: Humphrey Field Analyzer (HFA) using Swedish Interactive Threshold Algorithm (SITA) standard 24-2 pattern.

Criteria for Reliability: Fixation loss <20%, false positives and negatives <33%.

Procedure:

Refractive correction applied during testing.

Pupil diameter ensured to be >2 mm; dilated if necessary.

Size III white stimulus used with foveal threshold test turned on.

Room lighting dimmed without direct light on the patient.

Patients allowed to blink and maintain fixation.

Unreliable tests were repeated.

Visual Field Analysis:

1. **Mean Deviation (MD)**: Reflects overall depression of the visual field; normal values between 0 to -2 dB.

2. **Pattern Standard Deviation (PSD)**: Indicates irregularities in the visual field; higher values suggest localized defects.
3. **Advanced Glaucoma Intervention Study (AGIS) Scoring**:Visual field divided into nasal, superior hemifield, and inferior hemifield areas.

Scoring based on the number and depth of depressed points.

Maximum score: 20 (nasal area: 2; each hemifield: 9).

Higher scores indicate more severe visual field loss.

4. **Additional Measurements**:

Anterior Chamber Depth (ACD) and **Axial Length (AL)**: Measured using ultrasound A-scan.

Central Corneal Thickness (CCT): Measured using pachymeter.

Outcome Measures

Primary Outcomes:

Correlation of baseline IOP with:

Mean Deviation (MD).

Pattern Standard Deviation (PSD).

AGIS score.

Statistical Analysis

Software Used: SPSS version 22.0.

Data Presentation: Baseline demographic and clinical data presented as mean ± standard deviation (SD).

Analytical Methods:

Linear regression analysis to assess correlation between baseline IOP with MD, PSD, and AGIS score.

Spearman correlation used due to non-normal distribution of values.

Significance Level: P-value < 0.05 considered statistically significant.

RESULTS

Table 1: Gender wise distribution of patients

Type	Male	Female	P value
POAG	20	18	0.41
PACG	15	12	

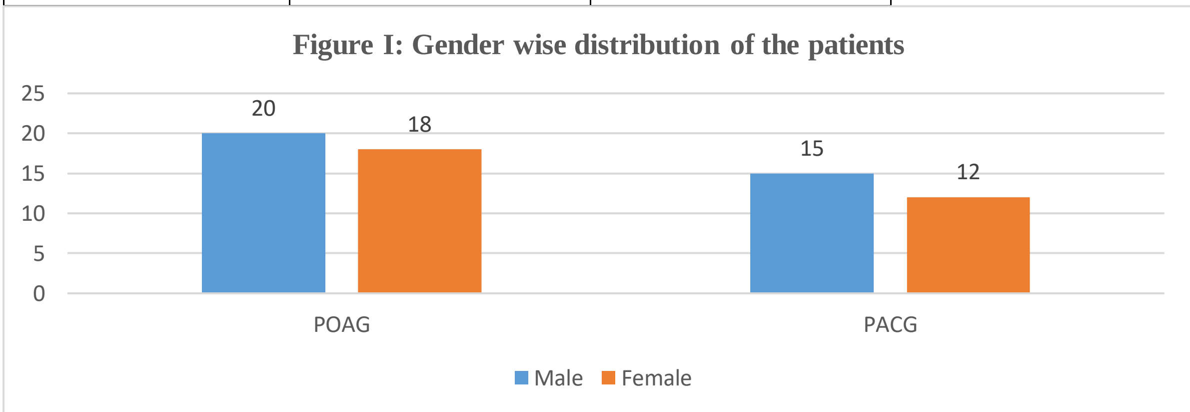

Table 1 and figure I, shows that 20 males and 18 females had POAG and 15 males and 12 females had PACG. The difference was non- significant (P> 0.05).

Table 2: Ocular biometrics assessment in PACG & POAG

Parameters	PACG	POAG	P value
Age (years)	57.4±4.2	56.3±5.6	0.59
IOP (mm Hg)	31.0±3.1	31.2±2.5	0.62
CCT (mm)	503.2±43.1	528.4±45.8	0.05
ACD (mm)	2.5±1.1	2.6±1.4	0.91
AL (mm)	21.7±6.3	24.3±7.4	0.03

The comparative analysis of ocular biometric parameters between patients with Primary Angle Closure Glaucoma (PACG) and Primary Open Angle Glaucoma (POAG) reveals both similarities and distinct differences that are crucial for understanding the pathophysiology and guiding the management of these conditions.

Table 2, shows that the mean age of patients in both groups is comparable, with PACG patients averaging 57.4 years and POAG patients 56.3

years. This similarity suggests that age, in this cohort, is not a distinguishing factor between the two glaucoma types.

In terms of intraocular pressure (IOP), both groups exhibit elevated levels, with PACG patients having a mean IOP of 31.0 mm Hg and POAG patients 31.2 mm Hg. The lack of significant difference in IOP indicates that elevated pressure is a common feature in both conditions, underscoring its role as a critical factor in glaucomatous damage regardless of the angle status.

Central corneal thickness (CCT) presents a notable difference; PACG patients have a thinner cornea (503.2 µm) compared to POAG patients (528.4 µm). This difference is statistically significant and clinically relevant, as thinner corneas can lead to underestimation of IOP measurements and may be associated with an increased risk of glaucoma progression. This finding aligns with previous studies indicating that CCT can influence IOP readings and glaucoma risk assessment.

The anterior chamber depth (ACD) is slightly shallower in PACG patients (2.5 mm) than in POAG patients (2.6 mm), though this difference is not statistically significant. However, a shallow anterior chamber is a known anatomical risk factor for angle closure, and even small differences can be clinically significant in susceptible individuals.

Axial length (AL) shows a significant disparity; PACG patients have a shorter axial length (21.7 mm) compared to POAG patients (24.3 mm). Shorter axial length is associated with hyperopic refractive errors and a predisposition to angle closure due to crowded anterior segment anatomy. This anatomical configuration contributes to the pathogenesis of PACG by facilitating pupillary block and angle crowding, leading to increased IOP and optic nerve damage. These findings are consistent with existing literature that identifies shorter axial length as a characteristic feature in PACG patients.

Table 3: Correlation of IOP with visual field scores in PACG

Parameters	Mean	r	P value
MD (dB)	-14.2	0.6	0.01
PSD (dB)	8.5	-0.1	0.39
AGIS	10.2	0.81	0.01
CCT (mm)	531.2	-0.24	0.72
ACD (mm)	2.3	0.015	0.14
AL (mm)	2.10	-0.018	0.52

The table 3 presents the correlation between intraocular pressure (IOP) and various visual field parameters in patients with Primary Angle Closure Glaucoma (PACG). Analyzing these correlations provides insights into how elevated IOP affects visual function and ocular anatomy in PACG.

The average Mean Deviation (MD) is -14.2 dB, indicating significant overall visual field loss among the PACG patients studied. A positive correlation coefficient (r = 0.6) with a P-value of 0.01 suggests a statistically significant relationship between higher IOP and greater visual field loss. This finding aligns with existing literature, emphasizing the critical role of IOP in the progression of visual field deterioration in PACG patients.

With a mean Pattern Standard Deviation (PSD) of 8.5 dB, the data reflects localized visual field defects. However, the correlation between IOP and PSD is weakly negative (r = -0.1) and not statistically significant (P = 0.39), indicating that IOP may not be a strong predictor of localized visual field changes in PACG.

The mean Advanced Glaucoma Intervention Study (AGIS) Score score is 10.2, reflecting moderate to severe visual field loss. A strong positive correlation (r = 0.81) with a P-value of 0.01 indicates a significant association between higher IOP and increased AGIS scores, reinforcing the impact of elevated IOP on the severity of visual field impairment in PACG.

The average Central Corneal Thickness (CCT) is 531.2 µm. The correlation between IOP and CCT is negative (r = -0.24) but not statistically significant (P = 0.72), suggesting that corneal thickness may not substantially influence IOP measurements or visual field outcomes in this patient group.

With a mean Anterior Chamber Depth (ACD) of 2.3 mm, the correlation with IOP is minimal (r = 0.015) and lacks statistical significance (P =

0.14), indicating that anterior chamber depth does not have a notable relationship with IOP levels in PACG patients.
The mean axial length is 2.10 mm, which appears to be an outlier and may warrant verification. The correlation between Axial Length (AL) and IOP is negligible (r = -0.018) and not statistically significant (P = 0.52), suggesting that axial length does not significantly affect IOP in this context.
Pearson correlation for linear regression for baseline IOP and AGIS score in MD (r- 0.6, p- 0.01) and AGIS (r- 0.81, p- 0.01) demonstrated correlation coefficient.

Table 4: Correlation of IOP with visual field scores in POAG

Parameters	Mean	r	P value
MD (dB)	-16.2	-0.04	0.92
PSD (dB)	8.5	0.07	0.35
AGIS	11.3	0.02	0.73
CCT (mm)	502.6	-0.05	0.12
ACD (mm)	2.7	0.14	0.83
AL (mm)	23.1	0.074	0.75

Table 4 shows that in patients with Primary Open Angle Glaucoma (POAG), the correlation between intraocular pressure (IOP) and visual field parameters appears to be weak and statistically insignificant. The mean deviation (MD) is -16.2 dB, indicating substantial visual field loss; however, the correlation coefficient (r) between IOP and MD is -0.04 with a P-value of 0.92, suggesting no significant association. Similarly, the pattern standard deviation (PSD) has a mean of 8.5 dB, with an r value of 0.07 and a P-value of 0.35, again showing no significant correlation. The Advanced Glaucoma Intervention Study (AGIS) score averages at 11.3, with an r value of 0.02 and a P-value of 0.73, further indicating a lack of significant correlation between IOP and visual field loss in POAG patients.
Regarding ocular biometric parameters, the central corneal thickness (CCT) averages 502.6 µm, with a correlation coefficient of -0.05 and a P-value of 0.12, suggesting no significant relationship with IOP. The anterior chamber depth (ACD) has a mean of 2.7 mm, with an r value of 0.14 and a P-value of 0.83, indicating no significant correlation. The axial length (AL) averages 23.1 mm, with an r value of 0.074 and a P-value of 0.75, also showing no significant association with IOP.
These findings suggest that in POAG, factors other than IOP may play a more significant role in visual field deterioration. This aligns with previous studies indicating that the correlation between pretreatment IOP and the extent of visual field loss is stronger in primary angle closure glaucoma (PACG) than in POAG.Therefore, comprehensive management of POAG may require addressing additional risk factors beyond IOP control.
Table 4 shows no pearson correlation for linear regression for baseline IOP and POAG (P> 0.05).

DISCUSSION

Glaucoma is one of the leading causes of blindness worldwide and open-angle glaucoma (OAG) is the most common form of glaucoma in the Western world. OAG is a neurodegenerative condition that is multifactorial in origin.[8] Increased intraocular pressure (IOP) remains an important primary and prognostic risk factor for OAG, but other IOP-independent risk factors may be involved in the pathogenesis and progression of OAG.[9,10] Consideration of other IOP-independent risk factors have led to speculation that optic nerve fiber sensitivity to damage and its tolerance to presenting IOP, even in a normal range, may be the major concept in the pathogenesis of OAG.[11] The present study was conducted to assess correlation between intraocular pressure and visual field loss in primary open angle glaucoma (POAG) and primary angle closure glaucoma (PACG).
We found that 20 males and 18 females had POAG and 15 males and 12 females had PACG. Gazzard G et al[12] compared the correlation between visual field loss and the pretreatment intraocular pressure (IOP) in primary angle closure glaucoma (PACG) and primary open angle glaucoma (POAG). In 74 patients (43 PACG, 31 POAG), pretreatment IOP was measured at presentation, before treatment was initiated. The severity of visual field loss was assessed by AGIS score, mean deviation (MD), pattern standard deviation (PSD), and corrected pattern standard deviation (CPSD). Glaucomatous optic neuropathy was assessed

from simultaneous stereo disc photographs. There was a stronger correlation between pretreatment IOP and the extent of visual field loss in PACG subjects than in those with POAG for both MD (PACG: Pearson correlation coefficient (r) = 0.43, p = 0.002; r^2 = 0.19), (POAG: r = 0.21, p = 0.13; r^2 = 0.04) and AGIS score (PACG: r = 0.41, p = 0.003; r^2 = 0.17), (POAG: r = 0.23, p = 0.19; r^2 = 0.05 respectively). No such associations were seen for pattern standard deviation (PSD) or corrected pattern standard deviation (CPSD) in either group (p> 0.29). Both horizontal and vertical cup-disc ratio was well correlated with severity of field loss but not with presenting IOP for either diagnosis.

We found that mean age (years) was 57.4±4.2 and 56.3±5.6, IOP (mm Hg) was 31.0±3.1 and 31.2±2.5, CCT (mm) was 503.2±43.1 and 528.4±45.8, ACD (mm) was 2.5±1.1 and 2.6±1.4 and AL (mm) was 21.7±6.3 and 24.3±7.4 in PACG and POAG patients respectively. Raji V et al.[13] studied the correlation between pretreatment IOP and extent of visual field loss in PACG and POAG. Newly diagnosed cases of PACG (25 patients-13 males, 12 females, mean age 58.72±10.07 years) and POAG (85 patients-45 males, 40 females, mean age 60.28±10.42 years) underwent a detailed glaucoma evaluation which included IOP measurement with Goldmann applanation tonometer and visual field testing using Humphrey Field Analysis (HFA) 24-2 pattern. Amongst the total 110 patients of this study, 25 patients were of PACG while POAG were in 85 patients. A significant correlation between pretreatment IOP and the extent of visual field loss in PACG was noted. There was no significant correlation in POAG. Linear regression analysis demonstrated a significant positive correlation between IOP and AGIS score in PACG r=0.805.

We found that Pearson correlation for linear regression for baseline IOP and AGIS score in MD (r- 0.6, p- 0.01) and AGIS (r- 0.81, p- 0.01) demonstrated correlation coefficient. We found no Pearson correlation for linear regression for baseline IOP and POAG (P> 0.05). Chauhan BC et al[14] found that median follow-up was 5.3 years, with 167 patients (64.7%) completing 5 years or more and 67 patients (26.0%) completing 7 years or more. Abnormal baseline anticardiolipin antibody levels (hazard ratio [HR], 3.86; 95% confidence interval [CI], 1.60-9.31), higher baseline age (HR per year, 1.04; 95% CI, 1.01-1.07), female sex (HR, 1.94; 95% CI, 1.09-3.46), and higher mean follow-up intraocular pressure (HR per 1 mm Hg, 1.19; 95% CI, 1.05-1.36) before progression were associated with progression.

LIMITATIONS OF THE STUDY

Sample Size: Relatively small sample size (65 patients) may limit the generalizability of the findings.

Study Design: Cross-sectional nature precludes assessment of disease progression over time.

Exclusion Criteria: Excluding patients with high refractive errors and unreliable visual fields may introduce selection bias.

Single-Centre Study: Conducted at a single institution, which may limit the applicability of results to other populations or settings.

CONCLUSION

Authors found that the degree of visual field impairment can be managed by regulating IOP alone in PACG, according to a substantial association shown between IOP and visual field loss. The current suggested pathophysiology of optic neuropathy, which involves numerous factors influencing in addition to IOP, is consistent with the lack of statistical significance in the link between pretreatment IOP and visual field reduction in POAG.

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