Correlation of Intraocular Pressure and Visual Field Defects among Patients Diagnosed with Primary Open Angle Glaucoma in a Tertiary Care Center

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ABSTRACT

Introduction: Primary open angle glaucoma is the most common subtype of glaucoma prevalent in Asian countries. Asymptomatic disease nature and lack of awareness have created difficulties in diagnosis and treatment. Significant visual field defects are mostly seen in cases with elevated IOP. Our study aims to correlate between intraocular pressure with visual field patterns in primary open angle glaucoma. .

Methods: A descriptive correlational study of newly diagnosed patients with Primary Open Angle Glaucoma was conducted in the glaucoma clinic of Shree Birendra Hospital (SBH) from November 2021 to January 2022. Ethical clearance was obtained from the Institutional Review Board of the Nepalese Army Institute of Medical Science. Ninety-four eyes of 47 patients were taken for the study. Data collected after getting informed consent was transferred in an excel sheet and analyzed using SPSS version 25.

Results: Superior arcuate scotoma was the most common visual field defect seen in 18 (19.1%) eyes. The mean IOP in mild POAG was 24.29 mm Hg (range 21-30); 26.40mmHg (range 22-31) in moderate POAG and 29.70 mmHg (range 22-36) in severe POAG. A significant relation was demonstrated between elevated IOP at presentation and higher negative values of MD ($p<0.001$).

Conclusions: The severity of primary open angle glaucoma is significantly associated with intraocular pressure in previously untreated patients.

Key Words: Goldmann applanation tonometer; Intraocular pressure; Primary open angle glaucoma; Visual field defect

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INTRODUCTION

Glaucoma is a common ocular condition that causes damage to the optic nerve resulting in vision loss and eventually blindness. It is the second leading cause of irreversible blindness after cataract. A national survey of Nepal done in 1981 ranked glaucoma in the third position for total blindness after cataract and corneal blindness.[1] It is estimated that in 2040, glaucoma will affect 111.8 million people globally.[2] Different studies show different patterns of visual field loss that are partly explained by various pathologies involved, including pressure-dependent and pressure-independent factors. Glaucoma includes two entities- intraocular pressure higher than normal range; Primary Open Angle Glaucoma (POAG) and intraocular pressure within normal range; Normal Tension Glaucoma (NTG). Since visual field loss is irreversible, early diagnosis and treatment prevent further damage to the ganglion cell loss.

The major risk factor for POAG is the elevated IOP, thus lowering IOP by 20-30% from the baseline becomes the aim of glaucoma treatment.[3] Standard automated white in white perimetry with Swedish interactive threshold algorithm test is most commonly used for the assessment of visual field that corresponds to the glaucomatous structural damage. Visual field defects in perimetry are seen only after damage of 40% of retinal ganglion cells.[4] Careful examination and interpretation of the visual field help in the diagnosis of glaucoma. The irreversible damage to the retinal nerve fiber layer compromises the patient quality of life in many ways thus the research is still ongoing emphasizing the pathogenesis of glaucoma.

In our country, there is lack of study in regards to the relation between pretreatment IOP and visual field loss. This study was conducted with the aim of finding the correlation between pretreatment IOP and visual field loss in POAG at presentation.

METHODS

This was a descriptive correlational study of newly diagnosed patients with POAG, conducted in the glaucoma clinic of Shree Birendra Hospital, Chhauni, Kathmandu, Nepal from November 2021 to January 2022. Ethical clearance was obtained from the Institutional Review Board of the Nepalese Army Institute of Medical Science (NAIHS). The sample size was calculated using the formula (n) = [(Zα+Zβ)/C]2 + 3. Where for simplicity, C is just a notion, whose value is, C= 0.5 * ln [(1+r)/(1-r)]. Assuming among POAG, the correlation of IOP with mean deviation (r) be 0.3. With a 95% confidence level and 80% power, the minimum sample size for the study was 85. With a 10% non-response rate, the total sample size is 94 eyes. Patients with secondary glaucoma, angle closure glaucoma, congenital or developmental glaucoma, media opacities obscuring posterior segment examination, and uncooperative patients were excluded from the study. Ninety-four eyes of 47 patients were taken for the study and these patients had never received medical, laser, or surgical treatment for glaucoma prior to the study. Thorough ophthalmologic examination was done including visual acuity, slit lamp examination, an average of three IOP measurements by Goldmann Applanation Tonometry (GAT), gonioscopy with Sussman four mirror goniolens and optic nerve assessment using +90 Diopter lens. POAG was defined as glaucomatous optic nerve damage with corresponding visual field defect, at least one recorded IOP > 21 mm Hg and open angle on gonioscopy. At least two Humphrey Visual Field assessments two weeks apart were performed for each patient using 24-2 Swedish Interactive Threshold Algorithm (SITA)- standard program after adequate refractive error correction when needed. The test was considered reliable if false positive and false negative results were less than 33% and fixation losses is less than 20%. Central visual field 10-2 was performed when indicated. Glaucomatous visual field defect and its severity were diagnosed based on Hodapp-Parrish-Anderson criteria.[5]

I. Glaucoma Hemifield Test (GHT) - Outside Normal Limits

II. The Corrected Pattern Standard Deviation (CPSD) P < 5%

III. Three contiguous, non-edge points on the pattern deviation plot each one of which with a probability of seeing in <5% and at least one with a probability of seeing in < 1% and all points was on the same side of the horizontal meridian.

Severity of POAG was defined as mild, moderate and severe in following manner.[5,6]

Mild POAG: vertical cup disc ratio (CDR) < 0.65 or mild visual field defect not within 10º of fixation, Mean Deviation (MD) < -6db on HVF 24-2

Moderate POAG: vertical cup disc ratio (CDR) <

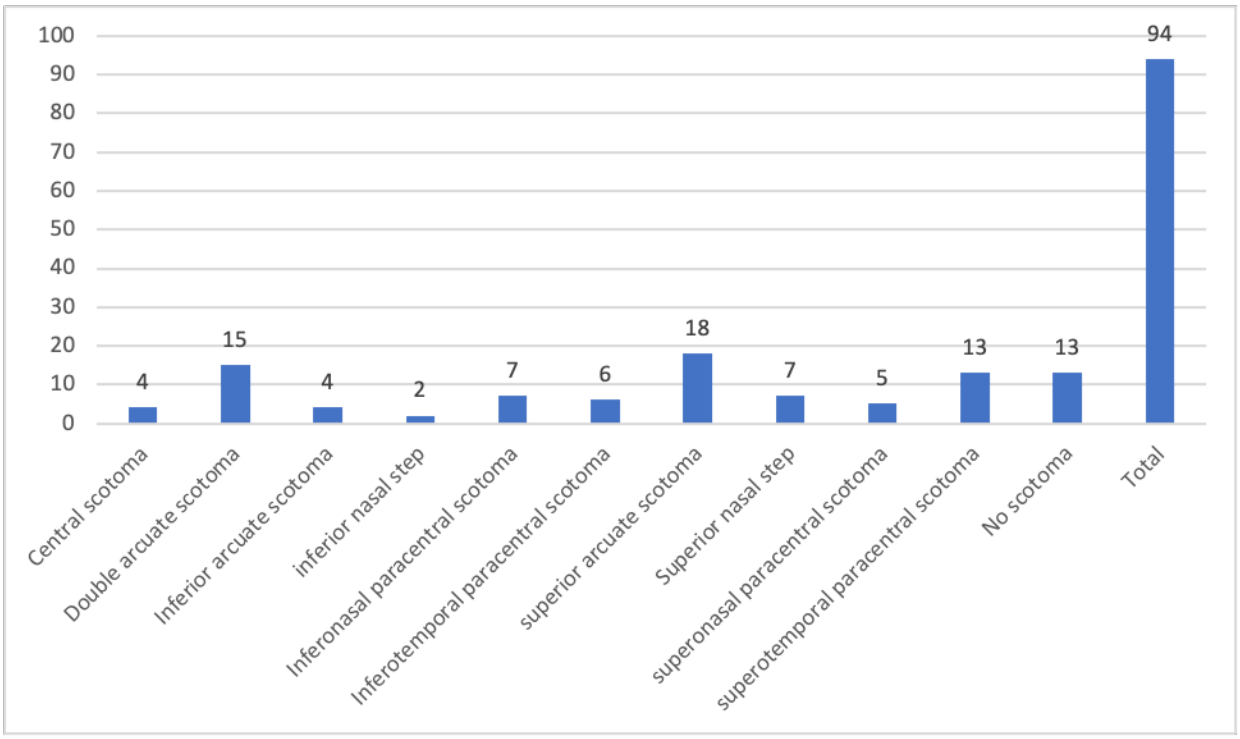

Figure 1. Bar diagram showing distribution of visual field defect in newly diagnosed POAG

0.65 or mild visual field defect not within 10º of fixation, MD between -6 db to -12 db on HVF 24-2

Severe POAG: vertical cup disc ratio (CDR) < 0.7 or mild visual field defect not within 10º of fixation, MD > -12 db on HVF 24-2

Data was collected after getting written informed consent from patients by using standard proforma and later on transferred in an excel sheet. Statistical analysis was performed using SPSS version 25. For comparing normally distributed Intra Ocular Pressure with POAG gradings, the ANOVA test was used, and for post hoc test, Bonferroni correction was done. For casual effect between IOP (Untreated) and visual field (Mean deviation), simple regression analysis was performed. P value < 0.05 was considered statistically significant.

RESULTS

A total of 47 patients (94 eyes) with newly diagnosed and previously untreated cases of POAG were included in the study comprising 27 (57.4%) males and 20 (42.6%) females with a mean (SD) age of 52.2 (9.5) years.

Superior arcuate scotoma was most common visual field defect seen in 18 (19.1%) eyes followed by double arcuate 15 (16%), superotemporal paracentral scotoma 13 (13.8%), inferonasal paracentral scotoma 7 (7.4%), superior nasal step 7 (7.4%), inferotemporal paracentral scotoma 6 (6.4%), superonasal paracentral scotoma 5 (5.3%), inferior arcuate scotoma 4 (4.3%) and least in inferior nasal step 2 (2.1%) whereas 13 (13.8%) had no scotoma (Figure 1).

In our study 56 (59.6%) eyes had mild POAG (MD of < - 6 dB) with no cases having double arcuate scotoma whereas 1 (16.0%) eye with moderate POAG (MD of - 6 to – 12 dB) had 1 double arcuate scotoma and 23 (24.5%) eyes with severe POAG (MD of >-12dB) had 14 double arcuate scotoma (Figure 2).

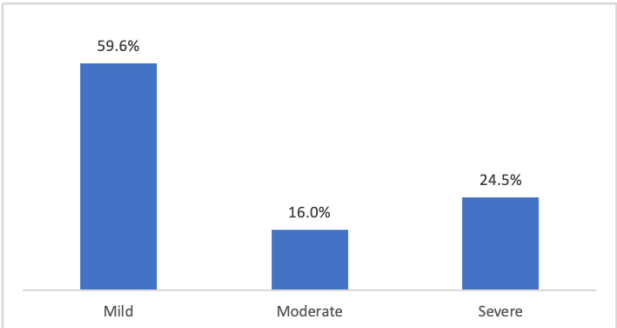

Figure 2. Bar diagram showing percentage of the severity of POAG in the study population (n = 94)

Table 1. IOP and severity of POAG

Grading	IOP mmHg					p value
	Count	Mean	SD	Minimum	Maximum	
Mild	56	24.29	1.83	21	30	< 0.001
Moderate	15	26.40	2.47	22	31	
Severe	23	29.70	3.47	22	36	
Total	94	25.95	3.30	21	36	

Bonferroni correction: Mild vs Moderate p = 0.01, Mild Versus Severe p < 0.001, Moderate vs Severe p < 0.001.

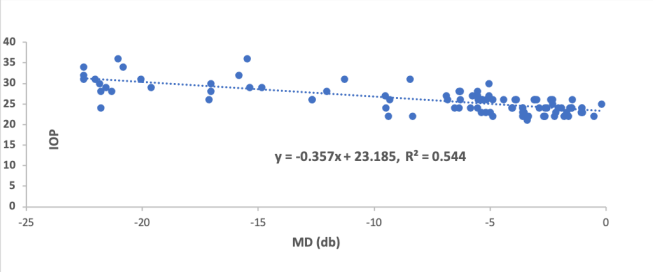

Figure 3. Scattergram showing simple regression analysis of the relation between IOP (untreated) and visual field (mean deviation)

The mean IOP was 25.95 mm Hg ranging from 21 - 36 mmHg. The mean IOP in mild POAG was 24.29 mm Hg (Range 21 - 30); 26.40 mm Hg (Range 22 - 31) in moderate POAG and 29.70 mm Hg (Range 22-36) in severe POAG (Table 1).

Figure 3 demonstrates a significant strong negative correlation (r = - 0.74) between elevated IOP at presentation and values of MD ($p < 0.001$). In one unit increase in MD (in db), IOP decreases by 0.357.

Ten (17.9%) eyes with mild POAG had a common presentation of superotemporal paracentral scotoma, followed by 5 (33.3%) eyes with superior arcuate scotoma and 14 (60.9%) eyes with double arcuate scotoma in moderate and severe POAG respectively. None of the cases had disc hemorrhage.

DISCUSSION

The burden of glaucoma is increasing day by day as studies done in Nepal show higher incidence of POAG in Nepalese population such as the study by Thapa et al in Nepal showed glaucoma prevalence of 1.9% with primary open angle glaucoma 1.24%; 0.39% of primary angle closure glaucoma and 0.15% of secondary glaucoma.[7] POAG is an IOP-dependent entity and comprises the largest proportion of the patient worldwide. Although the African population is known to have the highest prevalence of POAG, Asians account for almost half of the worlds' glaucoma population. This shows that race and ethnicity are associated with POAG. Thus, early diagnosis of POAG is possible only after careful examination and its correlation with the investigations. POAG has become a great challenge in diagnosing and treatment as it remains asymptomatic in the initial stages, and when the symptoms are seen it is usually in advanced stages. Medical, laser and surgical therapy are commonly practiced treatments to limit vision loss by glaucoma and enhance lifestyle in many ways.

Extensive studies have been done to show the correlation between IOP and glaucoma. Average IOP of 14 - 17 mmHg has been reported in a normal population but this changes in different races.[8] Elevated IOP, optic nerve changes, old age, African race, family history of glaucoma, and comorbidities such as hypertension, diabetes and thyroid disease are considered major risk factors for POAG.[9-11] Nowadays, the concept of setting Target IOP is getting popular where IOP is lowered to a certain level for different stages of glaucoma using absolute cut-off values, percentage reduction or formulas to halt the disease progression.[12,13] This helps to reduce further damage and better functioning of the damaged, malfunctioning, anatomically and physiologically altered ganglion cells.[8] Eye treatment should be directed toward preserving a good visual function maintaining the patient's quality of life for years. Patients with elevated IOP need special attention and follow-up for the treatment.

Studies of glaucoma have shown weaker correlation between pretreatment IOP and visual field defects at presentation.[14,15] Our result demonstrated that pretreatment IOP measurement is higher in severe POAG compared to the mild POAG with mean IOP of 29.70 mm Hg and 24.29 mm Hg, respectively and is significant ($p < 0.001$). But no significant association was seen in a study between pretreatment IOP at presentation and visual field mean deviation by Gazzard et al.[16] However, earlier studies have shown a protective effect of lowering IOP is associated with decreasing the progression of visual field defect.[17-19] Few studies have shown that lowering IOP is not always effective in glaucoma progression.[20,21]

We categorized POAG as mild, moderate and severe based on optic nerve head changes and HVF

parameters. Glaucomatous visual field defect is generally seen in periphery but can occur as central visual field loss initially in some cases.[22,23] Glaucomatous visual field defect was seen commonly in the superior hemifield compared to the inferior, especially in the nasal step region.[24] Our study revealed POAG is common in men compared to women with superior arcuate scotoma as the most common visual field defect. According to the severity, superotemporal paracentral scotoma, superior arcuate scotoma and double arcuate scotoma were the common visual field defects seen in mild, moderate and severe POAG, respectively. Studies have shown paracentral scotoma in superior hemifield as a common visual field defect in early POAG whereas, superior arcuate defect and double arcuate defect in moderate and severe stages respectively.[25] Similarly, another study has shown paracentral scotoma and nasal step as a common visual field defect in POAG.[26] Study by Yousefi et al[27] showed pronounced visual field defect in superior than in inferior hemifield.

Studies have also shown higher IOP with generalized visual field defect in primary angle closure glaucoma than in POAG.[16,28] Localized pattern of visual field defect in POAG may be due to non-pressure dependent mechanism and lesser IOP fluctuation[29] but due to different pathophysiology. This reveals the fact that not only elevated IOP, but also the prolonged duration of raised IOP plays a role in the severity of glaucomatous damage.[30] Whereas, our results demonstrated pretreatment average IOP increases as the severity of POAG increases. Thus, the cases with higher IOP can be correlated with the significant visual field defect and should be treated without any delay to prevent visual disability due to disease progression.

Diagnosis of POAG is usually made late when gross visual field loss has already occurred. Asymptomatic disease nature except in advanced stage, lack of awareness of the disease and its impact on vision are the major issues in the Nepalese population creating difficulties in treatment in most cases. Thorough eye examination, diagnostic tools and technologies enable us to detect disease early, which may not be feasible in all parts of our country. Identifying the possible risk factors, providing knowledge about glaucoma and the importance of vision in society aids to arrest the rate of disease progression. Reducing the baseline IOP by medication or by surgery is the mainstay of treatment for POAG. The limitation of our study is a single-centered study with a small number of populations taken for a short duration of time. Additionally, the central corneal thickness was not taken into consideration too.

CONCLUSIONS

Intraocular pressure of previously untreated patients is significantly associated with increased severity of primary open angle glaucoma. The most common visual field defect seen was superior arcuate scotoma.

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