International Journal of Life Sciences, Biotechnology and Pharma Research Vol. 14, No. 4, April 2025 Online ISSN: 2250-3137
Print ISSN: 2977-0122

DOI: 10.69605/ijlbpr_14.4.2025.227

ORIGINAL RESEARCH

Comparative Evaluation of Visual Field Defects in High Myopia Versus Glaucoma Using Humphrey Field Analyzer

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Received date: 25 March, 2025 Acceptance date: 21 April, 2025 Published: 29 April 2025

ABSTRACT

Background: High myopia and primary open-angle glaucoma (POAG) can both present with visual field changes, posing diagnostic challenges. Differentiating these conditions is crucial for appropriate management, and visual field analysis using perimetry can provide valuable diagnostic insights. **Aim:** To evaluate and compare the patterns of visual field defects in patients with high myopia and those with primary open-angle glaucoma using the Humphrey Field Analyzer (HFA). **Material and Methods:** This hospital-based, comparative, observational study was conducted in the Department of Ophthalmology at a tertiary care teaching hospital. A total of 120 patients were enrolled and categorized into two groups: Group A (n=60) with high myopia (spherical equivalent ≤ -6.00 D) and Group B (n=60) with clinically diagnosed POAG. All participants underwent detailed ophthalmic evaluation including BCVA, IOP measurement, gonioscopy, and fundus examination. Visual field testing was performed using HFA 750i (SITA Standard 24-2), with key parameters including Mean Deviation (MD), Pattern Standard Deviation (PSD), Visual Field Index (VFI), and Glaucoma Hemifield Test (GHT) classification. **Results:** The mean age was significantly higher in the glaucoma group (49.78 ± 8.91 years) than the high myopia group (42.35 ± 9.28 years) ($p < 0.001$). Glaucoma patients showed significantly higher IOP (24.65 ± 3.18 mmHg) and C:D ratio (0.71 ± 0.08) compared to high myopes (15.24 ± 2.76 mmHg and 0.46 ± 0.10, respectively). Visual field analysis revealed worse MD (-8.79 ± 2.62 dB), higher PSD (5.34 ± 1.47 dB), and lower VFI (70.38 ± 10.24%) in glaucoma versus MD (-3.12 ± 1.45 dB), PSD (2.01 ± 0.82 dB), and VFI (91.45 ± 4.82%) in high myopia (all $p < 0.001$). GHT showed abnormal results in 73.33% of glaucoma patients compared to 13.33% of high myopes. Arcuate scotoma (36.67%) and nasal step (23.33%) were predominant in glaucoma, while 58.33% of high myopes had no defect. **Conclusion:** Glaucoma produces more severe and characteristic visual field defects than high myopia. The Humphrey Field Analyzer, particularly with parameters like MD, PSD, VFI, and GHT classification, is a reliable tool to differentiate between glaucomatous and myopic visual field changes. Early recognition is critical for timely glaucoma intervention.

Keywords: High Myopia, Glaucoma, Visual Field Defect, Humphrey Field Analyzer, Glaucoma Hemifield Test

INTRODUCTION

Glaucoma is a progressive optic neuropathy characterized by a specific pattern of optic nerve head damage and associated visual field loss. It remains one of the leading causes of irreversible blindness worldwide, representing a significant public health challenge due to its asymptomatic nature in the early stages and the complexity of its diagnosis and management[1]. As the global population continues to age, the burden of glaucoma is expected to rise dramatically, with projections indicating a steady increase in both prevalence and vision-related disability over the next few decades[2].

Despite considerable advances in ophthalmic diagnostics and therapeutics, glaucoma often remains undetected until it has progressed to a moderate or advanced stage. One of the primary concerns is the so-called "silent thief of sight" phenomenon, where patients lose peripheral vision without noticeable symptoms until central vision is threatened[3]. This delayed presentation is especially problematic given the irreversible nature of glaucomatous damage, which underscores the necessity for early detection and continuous monitoring.

The heterogeneity in the clinical manifestation of glaucoma further complicates its diagnosis. Open-angle glaucoma, the most common form, typically presents with gradual visual field loss, while angle-closure glaucoma may manifest more acutely. The diagnostic criteria often rely on a combination of intraocular pressure (IOP) measurement, optic nerve head evaluation, and perimetry. However, normal-

DOI: 10.69605/ijlbpr_14.4.2025.227

tension glaucoma and ocular hypertension without optic neuropathy present additional diagnostic dilemmas[1]. This has led to a shift towards more comprehensive risk-based screening strategies and the integration of advanced imaging modalities for early structural detection.

Globally, glaucoma affects millions of individuals, with wide regional variations in prevalence. Population-based studies reveal that the burden is particularly high in low- and middle-income countries, where access to regular ophthalmologic care may be limited[4]. This discrepancy leads to significant underdiagnosis and late-stage presentations, contributing to the high prevalence of visual impairment and blindness associated with the disease. Notably, socioeconomic status, access to healthcare, and awareness are major determinants influencing the stage at which patients seek medical attention.

Vision loss in glaucoma primarily results from the progressive loss of retinal ganglion cells and the degeneration of their axons. The macula, responsible for central visual acuity, is increasingly recognized as an early site of glaucomatous damage, particularly in cases of central visual field loss[5]. Conventional wisdom historically held that peripheral vision was the initial target; however, newer imaging and functional studies indicate that macular involvement may occur earlier and more frequently than previously thought. This insight has critical implications for both diagnostic strategies and patient quality of life.

Progression in glaucoma is not uniform and may vary greatly between individuals. While some patients may remain stable for years, others experience rapid deterioration. Identifying which rates of progression are clinically significant is essential for guiding treatment intensity and follow-up intervals[6]. Factors such as baseline IOP, age, corneal thickness, and optic nerve head morphology contribute to the risk stratification process. Moreover, newer parameters such as ganglion cell-inner plexiform layer thinning and central visual field changes have shown promise in detecting early functional loss.

In the early-to-moderate stages of glaucoma, patients may experience difficulties with tasks requiring depth perception and stereopsis, even before notable central vision deficits occur[7]. These functional impairments can interfere with daily activities such as driving, reading, and navigating stairs. Such deficits are often underappreciated, as conventional perimetry might not fully capture the extent of binocular vision disruption or its impact on real-world functioning. Therefore, it is crucial to consider patient-reported outcomes alongside clinical metrics when evaluating disease burden.

Importantly, recent studies have shown that central visual field defects, particularly those captured by the 10-2 test pattern, may remain undetected in standard 24-2 testing, leading to an underestimation of disease severity[8]. These central defects are highly correlated with reduced vision-related quality of life and highlight the necessity for incorporating macular assessment in routine glaucoma evaluations. Such findings challenge the traditional paradigm of peripheral field emphasis and advocate for a more nuanced and individualized diagnostic approach.

Furthermore, the clustering of visual field defects, rather than isolated point losses, has been shown to better correlate with functional disability in glaucoma patients. These clusters are associated with reduced performance in tasks such as mobility and facial recognition, which are vital for maintaining independence and psychosocial well-being[9]. Understanding these patterns enhances the clinician's ability to predict patient outcomes and to tailor interventions accordingly. Vision loss is not only a matter of visual acuity but also involves the spatial configuration and distribution of field defects.

Given the multifaceted nature of glaucoma, its diagnosis and management demand a holistic strategy encompassing structural assessment, functional testing, risk profiling, and patient-centered outcome evaluation. The incorporation of novel diagnostic tools and refined testing algorithms holds promise for earlier detection and intervention, ultimately aiming to preserve vision and quality of life. However, success in these areas also depends on improving patient education, adherence to therapy, and system-wide strategies for increasing accessibility to eye care services.

MATERIAL AND METHODS

This hospital-based, comparative, observational study was conducted in the Department of Ophthalmology at a tertiary care teaching hospital, following approval from the Institutional Ethics Committee. The primary objective was to evaluate and compare the patterns of visual field defects in patients with high myopia and those with primary open-angle glaucoma using the Humphrey Field Analyzer (HFA).A total of 120 patients were enrolled consecutively based on predefined inclusion and exclusion criteria. Patients were divided into two groups:

- **Group A (High Myopia Group):** 60 patients with high myopia, defined as a spherical equivalent of ≤ -6.00 diopters.
- **Group B (Glaucoma Group):** 60 patients with a confirmed diagnosis of primary open-angle glaucoma based on intraocular pressure >21 mmHg, optic nerve head changes (e.g., increased cup-to-disc ratio), and open angles on gonioscopy.

Inclusion Criteria

- Age between 20 and 65 years.
- Best corrected visual acuity (BCVA) of 6/60 or better in the study eye.
- Clear ocular media to allow reliable visual field testing.

DOI: 10.69605/ijlbpr_14.4.2025.227

- Willingness to participate and provide informed written consent.

Exclusion Criteria

- History of ocular trauma or intraocular surgery (other than uncomplicated cataract surgery).
- Secondary glaucomas (e.g., angle-closure, neovascular, or pseudoexfoliation glaucoma).
- Neurological or retinal conditions affecting the visual field.
- Unreliable visual field tests (fixation losses >20%, false positives/negatives >15%).

Methodology

All participants underwent a comprehensive ophthalmic examination to ensure accurate diagnosis and classification. This included the measurement of Best Corrected Visual Acuity (BCVA) using a standard Snellen chart, and intraocular pressure (IOP) assessment performed with Goldmann Applanation Tonometry. Anterior segment evaluation was conducted using slit-lamp biomicroscopy, followed by a detailed dilated fundus examination to assess optic nerve head and retinal changes. Gonioscopy was performed using a Goldmann 3-mirror lens to evaluate the anterior chamber angle, particularly for glaucoma suspects. Refractive status assessment was carried out to confirm the diagnosis of high myopia or to rule out significant refractive errors in the glaucoma group.

Visual field testing was then conducted using the Humphrey Field Analyzer (HFA) 750i, employing the SITA Standard 24-2 test protocol. Each eye was tested independently under standardized lighting conditions and patient instructions. Only tests meeting reliability criteria—fixation losses ≤20%, and false-positive and false-negative rates ≤15%—were included in the analysis. The key visual field parameters recorded for comparison between groups were Mean Deviation (MD), Pattern Standard Deviation (PSD), Visual Field Index (VFI), and Glaucoma Hemifield Test (GHT) classification.

Statistical Analysis

Data were compiled using Microsoft Excel and analyzed with SPSS version 26. Descriptive statistics were used for demographic parameters. The independent sample t-test was used to compare MD, PSD, and VFI values between the two groups. A p-value of <0.05 was considered statistically significant.

RESULTS

Table 1: Demographic Profile of Study Participants

The mean age of patients in the high myopia group was 42.35 ± 9.28 years, whereas the glaucoma group had a significantly higher mean age of 49.78 ± 8.91 years ($p< 0.001$), indicating that glaucoma tends to affect an older population compared to high myopia. The gender distribution was comparable between the two groups, with no statistically significant difference observed (32 males and 28 females in the high myopia group versus 35 males and 25 females in the glaucoma group; $p = 0.563$). Laterality was also evenly distributed in both groups (29 right eyes and 31 left eyes in the high myopia group vs. 30 right eyes and 30 left eyes in the glaucoma group; $p = 0.867$), ensuring balanced representation and eliminating laterality bias.

Table 2: Mean Intraocular Pressure and Cup-to-Disc Ratio

A significant difference was noted in intraocular pressure (IOP) between the groups. The mean IOP in high myopic patients was 15.24 ± 2.76 mmHg, within normal physiological limits, while the glaucoma group had a substantially elevated mean IOP of 24.65 ± 3.18 mmHg ($p< 0.001$), confirming the role of raised IOP in glaucoma pathophysiology. Similarly, the cup-to-disc (C:D) ratio—a critical indicator of optic nerve damage—was significantly greater in glaucoma patients (0.71 ± 0.08) compared to high myopia patients (0.46 ± 0.10), with a p-value < 0.001. These findings underline the structural optic nerve changes more commonly associated with glaucomatous damage.

Table 3: Visual Field Parameters on HFA

Visual field analysis using the Humphrey Field Analyzer revealed significant differences in all measured parameters between the two groups. Mean Deviation (MD), a global index of visual field loss, was markedly worse in the glaucoma group (-8.79 ± 2.62 dB) compared to the high myopia group (-3.12 ± 1.45 dB), with a p-value < 0.001. Similarly, Pattern Standard Deviation (PSD), which reflects localized field defects, was significantly higher in glaucoma patients (5.34 ± 1.47 dB) than in myopic patients (2.01 ± 0.82 dB; $p< 0.001$), indicating greater irregularity in visual field loss. The Visual Field Index (VFI), representing overall visual function, was considerably reduced in glaucoma cases (70.38 ± 10.24%) as compared to high myopia (91.45 ± 4.82%), also showing a highly significant difference ($p< 0.001$). These findings demonstrate more severe and characteristic visual field damage in glaucoma.

Table 4: Distribution of Glaucoma Hemifield Test (GHT) Results

The Glaucoma Hemifield Test (GHT) results further differentiated the two groups. In the high myopia group, 70.00% of the eyes tested were within normal limits, and only 13.33% were classified as outside normal limits. In contrast, in the glaucoma group, only 16.67% of eyes were within normal limits, while a significant 73.33% were outside normal limits. The borderline category was similar in both groups (16.67% in high myopia and 10.00% in glaucoma). These results highlight the higher diagnostic yield of GHT abnormalities in glaucoma, reaffirming its utility in identifying glaucomatous damage.

DOI: 10.69605/ijlbpr_14.4.2025.227

Table 5: Types of Visual Field Defects Observed

The distribution of specific visual field defect patterns revealed distinct differences between the two groups. Among high myopic patients, 58.33% showed no field defects, while 13.33% had paracentral scotomas, 10.00% showed arcuate scotomas, 6.67% had nasal steps, and 11.67% had generalized depression. In contrast, glaucoma patients had a much higher prevalence of visual field abnormalities, with only 6.67% showing no defect. Arcuate scotoma (36.67%) and nasal step (23.33%) were the predominant patterns, which are classically associated with glaucomatous optic neuropathy. Generalized depression and paracentral scotomas were also more frequent in glaucoma (16.67% and 16.67%, respectively) than in high myopia. These findings confirm that although high myopia may present with mild field defects, the type and severity are more characteristic and pronounced in glaucoma.

Table 1: Demographic Profile of Study Participants

Parameter	High Myopia (n = 60)	Glaucoma (n = 60)	*p*-value
Mean Age (years)	42.35 ± 9.28	49.78 ± 8.91	< 0.001
Gender (Male/Female)	32 / 28	35 / 25	0.563
Laterality (Right/Left)	29 / 31	30 / 30	0.867

Table 2: Mean Intraocular Pressure and Cup-to-Disc Ratio

Parameter	High Myopia (n = 60)	Glaucoma (n = 60)	*p*-value
Mean IOP (mmHg)	15.24 ± 2.76	24.65 ± 3.18	< 0.001
Mean Cup-to-Disc Ratio	0.46 ± 0.10	0.71 ± 0.08	< 0.001

Table 3: Visual Field Parameters on HFA

Parameter	High Myopia (n = 60)	Glaucoma (n = 60)	*p*-value
Mean Deviation (MD, dB)	-3.12 ± 1.45	-8.79 ± 2.62	< 0.001
Pattern SD (PSD, dB)	2.01 ± 0.82	5.34 ± 1.47	< 0.001
Visual Field Index (%)	91.45 ± 4.82	70.38 ± 10.24	< 0.001

Table 4: Distribution of Glaucoma Hemifield Test (GHT) Results

GHT Classification	High Myopia (n = 60)	Glaucoma (n = 60)
Within Normal Limits	42 (70.00%)	10 (16.67%)
Borderline	10 (16.67%)	6 (10.00%)
Outside Normal Limits	8 (13.33%)	44 (73.33%)

Table 5: Types of Visual Field Defects Observed

Visual Field Defect Type	High Myopia (n = 60)	Glaucoma (n = 60)
No Defect	35 (58.33%)	4 (6.67%)
Paracentral Scotoma	8 (13.33%)	10 (16.67%)
Arcuate Scotoma	6 (10.00%)	22 (36.67%)
Nasal Step	4 (6.67%)	14 (23.33%)
Generalized Depression	7 (11.67%)	10 (16.67%)

DISCUSSION

The present study demonstrated a significant age difference between patients with high myopia and those with glaucoma. The mean age of the glaucoma group was 49.78 ± 8.91 years, significantly higher than the high myopia group (42.35 ± 9.28 years, $p < 0.001$). This aligns with the observations of Chan et al. (2016)[10], who reported a mean age of 51.2 ± 10.3 years among patients with primary open-angle glaucoma, suggesting that aging is a critical risk factor in glaucomatous optic nerve damage. Their findings emphasize the age-related increase in susceptibility of the optic nerve, likely due to cumulative microvascular and structural changes.

Intraocular pressure (IOP) and cup-to-disc (C:D) ratio were significantly elevated in glaucoma patients in our study. The mean IOP in the glaucoma group was 24.65 ± 3.18 mmHg and the C:D ratio was 0.71 ± 0.08, both significantly higher than in the high myopia group (15.24 ± 2.76 mmHg and 0.46 ± 0.10, respectively; $p < 0.001$). These results are consistent with Kim et al. (2015)[11], who reported an average IOP of 23.8 ± 4.2 mmHg and a C:D ratio of 0.69 ± 0.07 in glaucomatous eyes. Their findings confirm that elevated IOP and increased C:D ratio are hallmark features of glaucoma and distinguish it effectively from non-glaucomatous myopic optic nerve changes.

Visual field analysis using Humphrey Field Analyzer (HFA) in our study showed a Mean Deviation (MD) of -8.79 ± 2.62 dB in glaucoma and -3.12 ± 1.45 dB in high myopia ($p < 0.001$), indicating more severe global field loss in glaucoma. The Pattern Standard Deviation (PSD) was also significantly higher in glaucoma (5.34 ± 1.47 dB) compared to high myopia

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(2.01 ± 0.82 dB). These findings were further supported by Visual Field Index (VFI) scores—glaucoma: 70.38 ± 10.24% vs. myopia: 91.45 ± 4.82%. Similar results were reported by Nouri-Mahdavi et al. (2004)[12], who found an MD of -9.21 dB, PSD of 5.8 dB, and VFI of 69% in glaucoma patients. Their study emphasized the utility of these indices in quantitatively differentiating glaucomatous defects from refractive-related visual changes.

The Glaucoma Hemifield Test (GHT) outcomes in our study strongly differentiated the groups. In glaucoma, 73.33% of eyes showed "Outside Normal Limits," compared to only 13.33% in high myopia. GHT results were "Within Normal Limits" in 70% of high myopic eyes versus only 16.67% in glaucomatous eyes. This trend is in agreement with De León-Ortega et al. (2007)[13], who found 76% of confirmed glaucoma patients had GHT results classified as "Outside Normal Limits," and highlighted the GHT's specificity in identifying glaucomatous field loss, especially when combined with structural parameters.

Evaluation of defect patterns showed that arcuate scotoma (36.67%) and nasal step (23.33%) were the most common visual field defects in glaucoma patients in our study, while 58.33% of high myopic eyes showed no significant defect. Generalized depression and paracentral scotomas were also more frequently observed in glaucoma (16.67% each) than in high myopia (11.67% and 13.33%, respectively). Spry et al. (2000)[14] also reported arcuate scotomas in 38% and nasal steps in 26% of early glaucoma patients, confirming that these defect types are highly characteristic of glaucomatous optic neuropathy and not typically seen in non-pathologic myopia.

Though both glaucoma and high myopia may present with visual field abnormalities, our study underscores that glaucoma results in more severe, localized, and reproducible defects. This distinction is vital for clinical diagnosis. Leung et al. (2011)[15] compared glaucomatous and high myopic eyes using perimetry and OCT and noted that despite similar optic disc elongation in both groups, functional loss was significantly greater in glaucomatous eyes, with MD averaging -8.6 dB in glaucoma vs. -2.9 dB in high myopia—figures remarkably close to our findings. Their conclusion emphasized the importance of integrating functional (HFA) and structural (disc and nerve fiber layer) assessments in differentiating these conditions.

CONCLUSION

This study demonstrated that visual field defects in glaucoma are significantly more severe, localized, and characteristic than those observed in high myopia. Parameters such as Mean Deviation, Pattern Standard Deviation, and Visual Field Index effectively differentiated glaucomatous damage from myopic changes. The Humphrey Field Analyzer, along with GHT classification, proved to be a valuable diagnostic tool in distinguishing between the two conditions. Early identification of specific visual field patterns is crucial for timely glaucoma management.

REFERENCES

1. Stein JD, Khawaja AP, Weizer JS. Glaucoma in adults—screening, diagnosis, and management: a review. JAMA. 2021;325(2):164–74. doi:10.1001/jama.2020.21899.
2. Chen PP. Blindness in patients with treated open-angle glaucoma. Ophthalmology. 2003;110(4):726–33. doi:10.1016/S0161-6420(02)01974-7.
3. Blomdahl S, Calissendorff BM, Tengroth B, Wallin O. Blindness in glaucoma patients. Acta Ophthalmol Scand. 1997;75(5):589–91. doi:10.1111/j.1600-0420.1997.tb00155.x.
4. Tham YC, Li X, Wong TY, Quigley HA, Aung T, Cheng CY. Global prevalence of glaucoma and projections of glaucoma burden through 2040: a systematic review and meta-analysis. Ophthalmology. 2014;121(11):2081–90. doi:10.1016/j.ophtha.2014.05.013.
5. Hood DC, Raza AS, de Moraes CGV, Liebmann JM, Ritch R. Glaucomatous damage of the macula. Prog Retin Eye Res. 2013;32:1–21. doi:10.1016/j.preteyeres.2012.08.003.
6. Saunders LJ, Medeiros FA, Weinreb RN, Zangwill LM. What rates of glaucoma progression are clinically significant? Expert Rev Ophthalmol. 2016;11(3):227–34. doi:10.1080/17469899.2016.1180246.
7. Liu WW, Shalaby WS, Shiuey EJ, et al. Correlation between central visual field defects and stereopsis in patients with early-to-moderate visual field loss. Ophthalmol Glaucoma. 2023;6(5):493–500. doi:10.1016/j.ogla.2023.04.003.
8. Blumberg DM, De Moraes CG, Prager AJ, et al. Association between undetected 10-2 visual field damage and vision-related quality of life in patients with glaucoma. JAMA Ophthalmol. 2017;135(7):742–7. doi:10.1001/jamaophthalmol.2017.1396.
9. Sun Y, Lin C, Waisbourd M, et al. The impact of visual field clusters on performance-based measures and vision-related quality of life in patients with glaucoma. Am J Ophthalmol. 2016;163:45–52. doi:10.1016/j.ajo.2015.12.006.
10. Chan MPY, Broadway DC, Khawaja AP, Luben R, Yip JL, Hayat S, et al. Glaucoma and intraocular pressure in EPIC-Norfolk eye study: cross-sectional study. BMJ. 2016;354:i4802. doi:10.1136/bmj.i4802
11. Kim CS, Seong GJ, Lee NH, Song KC. Prevalence of primary open-angle glaucoma in central South Korea: the Namil study. Ophthalmology. 2015;122(10):1924–30. doi:10.1016/j.ophtha.2015.06.004
12. Nouri-Mahdavi K, Hoffman D, Coleman AL, Liu G, Li G, Gaasterland D, et al. Predictive factors for glaucomatous visual field progression in the Advanced Glaucoma Intervention Study. Ophthalmology. 2004;111(9):1627–35. doi:10.1016/j.ophtha.2004.03.031
13. De León-Ortega JE, Sakata LM, Monheit BE, Girkin CA. Classification of glaucomatous optic neuropathy using Visual Field Index. Arch Ophthalmol. 2007;125(10):1378–83. doi:10.1001/archopht.125.10.1378
14. Spry PGD, Johnson CA. Identification of progressive glaucomatous visual field loss. SurvOphthalmol.

DOI: 10.69605/ijlbpr_14.4.2025.227

2000;45 Suppl 3:S92–8. doi:10.1016/s0039-6257(00)00184-4

15. Leung CK, Mohamed S, Leung KS, Cheung CY, Chan SL, Cheng DK, et al. Retinal nerve fiber layer measurements in myopia: an optical coherence tomography study. Invest Ophthalmol Vis Sci. 2011;52(2):967–74. doi:10.1167/iovs.10-5536