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Prevalence of Glaucoma in Patients with Cardiovascular Disease

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Abstract

Background: Glaucoma is a progressive optic neuropathy and one of the major causes of irreversible blindness worldwide. Cardiovascular diseases such as hypertension, coronary artery disease, myocardial infarction, and diabetes mellitus may contribute to glaucoma through vascular dysregulation, impaired ocular perfusion, and microvascular damage. Early identification of glaucoma in patients with cardiovascular disease is important to prevent permanent visual loss.

Materials and Methods: This hospital-based cross-sectional observational study was conducted at the Departments of Cardiology, General Medicine, and Ophthalmology, All India Institute of Medical Sciences (AIIMS), Bathinda, Punjab, over a period of 10 months. A total of 500 patients aged more than 25 years with diagnosed cardiovascular disease were included using consecutive sampling. After obtaining written informed consent, all participants underwent detailed clinical evaluation and comprehensive ophthalmic examination including visual acuity testing, slit-lamp examination, applanation tonometry, gonioscopy, fundus examination, and Optical Coherence Tomography (OCT). Data were analyzed using SPSS software. Chi-square test was applied, and a p-value <0.05 was considered statistically significant.

Results: Among the 500 participants, 17.0% had confirmed Primary Open-Angle Glaucoma (POAG), while 21.0% were categorized as glaucoma suspects. The majority of participants belonged to the 41–60 years age group (49.0%), and males constituted 57.0% of the study population. Hypertension was present in 61.0%, and diabetes mellitus in 42.0% of participants. A statistically significant association was observed between hypertension and glaucoma (χ^2 = 12.84, p <0.001). Increased age was also associated with higher glaucoma prevalence.

Conclusion: Glaucoma was found to be considerably prevalent among patients with cardiovascular disease, especially among elderly individuals with hypertension and diabetes mellitus. Patients with cardiovascular disease represent a high-risk group and should undergo routine ophthalmic screening for early diagnosis and prevention of irreversible blindness.

Keywords: Glaucoma, Cardiovascular disease, Prevalence, Hypertension, Diabetes mellitus, Primary Open-Angle Glaucoma, Intraocular pressure, OCT.

Introduction

Glaucoma is a group of progressive optic neuropathies characterized by optic nerve head damage, retinal ganglion cell loss, and corresponding visual field defects. It is one of the leading causes of irreversible blindness worldwide and often remains asymptomatic until advanced stages. Recent estimates suggest that more than 76 million people were affected by glaucoma in 2020, and this number is expected to increase

with population aging and longer life expectancy [1]. Early diagnosis and timely treatment are therefore essential to prevent permanent visual loss.

Primary Open-Angle Glaucoma (POAG) is the most common type of glaucoma globally, while Primary Angle-Closure Glaucoma (PACG) contributes significantly to blindness in Asian countries. Elevated intraocular pressure (IOP) is the most important modifiable risk factor; however, glaucoma may also occur in patients with normal IOP, indicating the role of vascular, genetic, and neurodegenerative mechanisms in disease development [2].

Cardiovascular disease (CVD) is another major global health concern and includes hypertension, coronary artery disease, myocardial infarction, stroke, heart failure, and valvular heart disease. It remains the leading cause of mortality worldwide and contributes significantly to morbidity and healthcare burden [3]. Common risk factors such as aging, diabetes mellitus, obesity, smoking, and sedentary lifestyle are frequently shared by both glaucoma and cardiovascular disease. Several studies suggest that glaucoma and cardiovascular disease may be linked through vascular dysregulation, endothelial dysfunction, impaired ocular perfusion pressure, and atherosclerotic changes. Chronic hypertension may damage blood vessels supplying the optic nerve, while excessive blood pressure lowering or nocturnal hypotension may reduce optic nerve perfusion and accelerate glaucomatous damage [4].

Diabetes mellitus, commonly associated with cardiovascular disease, may further increase glaucoma risk through oxidative stress, microvascular injury, and chronic inflammation. Dyslipidemia and systemic vascular disease may also contribute to reduced blood flow to ocular tissues [5]. Certain cardiovascular medications such as beta-blockers, calcium channel blockers, ACE inhibitors, angiotensin receptor blockers, and diuretics may influence intraocular pressure or ocular blood flow. However, available evidence regarding their protective or harmful effects on glaucoma remains inconsistent [6]. In developing countries, many glaucoma cases remain undiagnosed because of poor awareness and delayed presentation. Patients attending cardiology and general medicine clinics often belong to older age groups with multiple systemic risk factors, making them an ideal population for opportunistic glaucoma screening [7]. Hence, the present study was undertaken to determine the prevalence of glaucoma in patients with cardiovascular disease, to assess the types and presentation of glaucoma, and to evaluate the association of cardiovascular risk factors and medications with glaucoma.

Materials & Methods

Study Design, Setting

This hospital-based cross-sectional observational study was conducted over a period of 10 months in the Departments of Cardiology, General Medicine, and Ophthalmology at the All India Institute of Medical Sciences (AIIMS), Bathinda, Punjab, India. The study aimed to determine the prevalence of glaucoma among patients with cardiovascular disease and to evaluate its association with clinical and systemic risk factors.

Sample Size

A total of 500 eligible participants were recruited using consecutive sampling. The sample size was calculated using the standard formula for prevalence studies based on the expected prevalence of glaucoma among patients with cardiovascular disease, with an appropriate confidence level and precision.

Study Population

The study included adult patients aged >25 years with a confirmed diagnosis of cardiovascular disease attending the outpatient departments during the study period. Cardiovascular diseases included hypertension, coronary artery disease, myocardial infarction, cardiomyopathy, valvular heart disease, and stroke. Eligible participants underwent a comprehensive ophthalmic evaluation to identify glaucomatous

changes.

Inclusion Criteria: Patients aged >25 years with a confirmed diagnosis of cardiovascular disease who provided written informed consent were included in the study.

Exclusion Criteria: Patients with congenital or secondary glaucoma, significant ocular pathology interfering with glaucoma assessment, critically ill patients unable to undergo ophthalmic evaluation, and individuals unwilling to participate were excluded.

Study Tool

Data were collected using a prevalidated structured case record form comprising demographic characteristics, cardiovascular disease profile, duration of illness, treatment history, medication use, family history, and associated systemic comorbidities. Ophthalmic evaluation included best-corrected visual acuity assessment using the Snellen chart, slit-lamp biomicroscopy, intraocular pressure measurement by Goldmann applanation tonometry, gonioscopy, automated standard automated perimetry, dilated fundus examination of the optic nerve head, and Optical Coherence Tomography (OCT) for retinal nerve fiber layer analysis. Glaucoma was diagnosed based on a combination of structural and functional optic nerve changes in accordance with standard ophthalmic diagnostic criteria.

Data Collection

After obtaining written informed consent, demographic and clinical information was recorded using the study proforma. All ophthalmic examinations were performed by experienced ophthalmologists using standardized protocols to ensure uniformity of assessment. The primary outcome measure was the prevalence of glaucoma among patients with cardiovascular disease. Secondary outcome measures included the distribution of glaucoma subtypes and their association with demographic characteristics, cardiovascular disease profile, and other systemic risk factors.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using the Statistical Package for the Social Sciences (SPSS) software version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. The prevalence of glaucoma was estimated with corresponding confidence intervals. Associations between categorical variables were assessed using the Chi-square test. Variables demonstrating statistical significance in univariate analysis were further evaluated using multivariable logistic regression to identify independent predictors of glaucoma. Odds ratios with 95% confidence intervals were calculated where appropriate. A two-tailed p-value <0.05 was considered statistically significant.

Ethical Considerations

The study protocol was approved by the Institutional Ethics Committee of AIIMS Bathinda before commencement of the study. All participants provided written informed consent prior to enrolment. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Participant confidentiality and data privacy were maintained throughout the study, and all collected information was anonymized and used exclusively for research purposes.

Results

A total of 500 patients with cardiovascular disease were included in the study. The major findings are presented below.

Table 1. Age Distribution of Study Participants

Age Group (Years)	Frequency (n)	Percentage (%)
25–40	95	19.0
41–60	245	49.0
>60	160	32.0
Total	500	100

The majority of participants were in the 41–60 years age group (49.0%), followed by those aged above 60 years (32.0%), while younger adults aged 25–40 years constituted 19.0% of the study population.

Table 2. Gender Distribution of Study Participants

Gender	Frequency (n)	Percentage (%)
Male	285	57.0
Female	215	43.0
Total	500	100

Among the total participants, 57.0% were males and 43.0% were females, showing a male predominance. This may reflect the higher burden of cardiovascular disease among males due to lifestyle factors such as smoking, stress, and sedentary habits. It may also indicate greater healthcare utilization among male patients in tertiary care settings.

Table 3. Distribution of Hypertension

Hypertension	Frequency (n)	Percentage (%)
Yes	305	61.0
No	195	39.0
Total	500	100

Hypertension was present in 305 participants (61.0%), whereas 39.0% did not have hypertension. This demonstrates that hypertension was the most common cardiovascular comorbidity in the study population. Chronic hypertension can cause vascular remodeling, endothelial dysfunction, and impaired ocular perfusion, which may increase the risk of glaucomatous optic nerve damage. Therefore, hypertensive patients should be considered a high-risk group for glaucoma screening.

Table 4. Distribution of Diabetes Mellitus

Diabetes Mellitus	Frequency (n)	Percentage (%)
Yes	210	42.0
No	290	58.0
Total	500	100

Diabetes mellitus was observed in 210 participants (42.0%), while 58.0% were non-diabetic. This indicates a substantial prevalence of metabolic disease among cardiovascular patients. Diabetes is known to cause microvascular damage, oxidative stress, and impaired retinal circulation, which may predispose individuals to glaucoma.

Table 5. Final Diagnosis of Glaucoma

Diagnosis	Frequency (n)	Percentage (%)
No Glaucoma	310	62.0
Glaucoma Suspect	105	21.0
POAG	85	17.0
Total	500	100

Out of 500 participants, 310 (62.0%) had no evidence of glaucoma, 105 (21.0%) were categorized as glaucoma suspects, and 85 (17.0%) had confirmed Primary Open-Angle Glaucoma (POAG). The presence of confirmed glaucoma in nearly one-fifth of the study population indicates a considerable disease burden among patients with cardiovascular disease

Table 6. Association Between Hypertension and Glaucoma

Hypertension	Glaucoma Present	Glaucoma Absent	χ^2 value	p-value
Yes	68	237	12.84	<0.001
No	17	178		

A statistically highly significant association was found between hypertension and glaucoma ($\chi^2 = 12.84$, $p < 0.001$). Among hypertensive participants, glaucoma prevalence was considerably higher than in non-hypertensive individuals.

Discussion

The present hospital-based cross-sectional study was conducted to determine the prevalence of glaucoma in patients with cardiovascular disease and to assess the relationship between systemic risk factors and glaucoma. In the present study, confirmed Primary Open-Angle Glaucoma (POAG) was identified in 17.0% of participants, while 21.0% were categorized as glaucoma suspects. This finding indicates a substantial burden of glaucoma among patients with cardiovascular disease. Similar observations were reported by Wang et al. (2022), who found increased glaucoma prevalence among patients with systemic diseases, particularly those with vascular comorbidities [8]. Age distribution in the present study showed that the majority of participants belonged to the 41–60 years age group (49.0%), followed by those aged above 60 years (32.0%). Increasing age is a recognized risk factor for both cardiovascular disease and glaucoma. Age-related degeneration of retinal ganglion cells, vascular insufficiency, and reduced autoregulatory mechanisms may contribute to glaucomatous optic neuropathy. Tham et al. (2021) also reported that glaucoma prevalence rises progressively with advancing age worldwide [9].

Male participants constituted 57.0% of the study population, whereas females accounted for 43.0%. This male predominance may reflect the higher prevalence of cardiovascular disease among men due to greater exposure to smoking, occupational stress, and lifestyle-related risk factors. However, gender itself may not independently influence glaucoma occurrence, and both sexes remain susceptible to disease.
Hypertension was the most common cardiovascular comorbidity in the present study, affecting 61.0% of participants. Furthermore, a statistically significant association was found between hypertension and glaucoma ($\chi^2 = 12.84$, $p < 0.001$). This finding supports the vascular theory of glaucoma pathogenesis. Chronic hypertension may lead to endothelial dysfunction, vascular remodeling, increased arterial stiffness, and impaired ocular perfusion. Similar findings were reported by Choi et al. (2023), who demonstrated a significant association between glaucoma and cardiovascular disease, particularly hypertension [10]. Quaranta et al. (2024) also highlighted the importance of cardiovascular risk factors in glaucoma development [11].

Diabetes mellitus was present in 42.0% of participants in the present study, indicating a considerable burden of metabolic disease among cardiovascular patients. Diabetes may contribute to glaucoma through microangiopathy, oxidative stress, and impaired retinal circulation. Similar associations between diabetes and glaucoma have been reported in previous epidemiological studies [8]. The present study found that 17.0% of participants had confirmed POAG, while 21.0% were glaucoma suspects. POAG was the predominant type of glaucoma observed. This is consistent with the findings of Weinreb et al. (2020), who described POAG as the most common form of glaucoma worldwide and emphasized its chronic progressive nature [12].

The statistically significant association between hypertension and glaucoma observed in the present study ($p < 0.001$) suggests that patients with cardiovascular disease form a high-risk group requiring regular ophthalmic screening. Impaired ocular perfusion pressure due to systemic hypertension or excessive antihypertensive therapy may accelerate optic nerve damage. Fu et al. (2025) also reported that antihypertensive drugs may influence glaucoma risk through changes in blood pressure and ocular circulation [13]. Overall, the findings of the present study demonstrate that glaucoma is considerably prevalent among patients with cardiovascular disease, particularly among older individuals with

hypertension and diabetes mellitus. Early detection through routine ophthalmic evaluation in cardiology and general medicine clinics may help identify glaucoma at an earlier stage and prevent irreversible visual loss.

Strengths

This study provides a comprehensive evaluation of glaucoma among patients with cardiovascular disease using standardized ophthalmic investigations, including Goldmann applanation tonometry, automated perimetry, and Optical Coherence Tomography (OCT). The inclusion of a relatively large sample from a tertiary care center enhances the reliability of the study findings.

Limitations

The cross-sectional study design limits the ability to establish a causal relationship between cardiovascular disease and glaucoma. As this was a single-center hospital-based study, the findings may not be generalizable to the wider population.

Conclusion

Glaucoma was found to be considerably prevalent among patients with cardiovascular disease, especially among elderly individuals with hypertension and diabetes mellitus. Patients with cardiovascular disease represent a high-risk group and should undergo routine ophthalmic screening for early diagnosis and prevention of irreversible blindness.

Conflict of Interest: No
Source of Funding: No

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