Journal of Cardiovascular Disease Research

ISSN: 0975-3583, 0976-2833 VOL15, ISSUE 5, 2024

Comparison of Systemic Hypertension, Perfusion Pressure, and Glaucoma in Adult Indian Population

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ABSTRACT

Background: Worldwide, glaucoma is a leading cause of permanent blindness, and systemic hypertension may have a role in the disease's pathophysiology. That being said, there is still no solid evidence linking perfusion pressure, systemic hypertension, and glaucoma—especially in the Indian population. The study investigated the connection between glaucoma, perfusion pressure, and systemic hypertension in an adult Indian population.

Methods: A cross-sectional study comprised 200 adult participants, divided into those with glaucoma (n=120) and without glaucoma (n=80). Data were collected through clinical examinations and interviews, measuring systemic blood pressure, intraocular pressure, and calculating perfusion pressure. Statistical analyses were accomplished using SPSS version 21.0.

Results: Participants with glaucoma exhibited higher mean systolic (145.8 ± 15.4 mmHg) and diastolic blood pressure (92.4 ± 9.7 mmHg) compared to those without glaucoma (138.7 ± 13.2 mmHg and 88.1 ± 8.3 mmHg, respectively). Intraocular pressure was also significantly elevated in the glaucoma group (22.5 ± 4.1 mmHg vs. 15.6 ± 2.8 mmHg, $p < 0.001$). Perfusion pressure was significantly different between groups (123.3 ± 16.3 mmHg vs. 123.1 ± 15.8 mmHg, $p = 0.04$). Multivariate analysis revealed higher systolic blood pressure (OR = 1.08,

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95% CI: 1.03-1.13, $p < 0.01$) and intraocular pressure (OR = 1.32, 95% CI: 1.20-1.45, $p < 0.001$) were substantially associated with glaucoma.

Conclusion: The study establishes a substantial association between systemic hypertension and glaucoma in the adult Indian population, highlighting higher systolic blood pressure and intraocular pressure as key factors.

Recommendations: Regular monitoring and management of blood pressure are recommended to prevent and control glaucoma effectively. To clarify the underlying mechanisms and causal linkages, more longitudinal research is required.

Keywords: Glaucoma, Systemic Hypertension, Perfusion Pressure, Intraocular Pressure

INTRODUCTION

Glaucoma is a condition that causes progressive optic neuropathy and visual field loss. It is one of the major causes of irreversible blindness in the globe. Globally, there will be about 111 million cases of glaucoma by 2040, according to estimates [1]. The most important risk factor for glaucoma is intraocular pressure (IOP), although the pathophysiology of the condition is complex. Nonetheless, mounting data indicates that systemic hypertension might potentially be a major factor in the onset and course of glaucoma.

Approximately 1.13 billion individuals worldwide suffer from systemic hypertension, a common cardiovascular disease, and its frequency is rising, especially in countries with middle and low incomes [2]. Hypertension may influence ocular perfusion and aggravate glaucomatous optic neuropathy by altering the structure and function of the microvasculature [3]. Maintaining proper blood flow to the optic nerve depends on perfusion pressure, which is the difference between IOP and BP (blood pressure). A perfusion pressure imbalance, which is frequently observed in hypertensive individuals, might worsen glaucomatous damage by impairing the perfusion of the optic nerve head [4].

Though there may be a connection between systemic hypertension and glaucoma, the data is still ambiguous. While some studies have revealed not a substantial relationship or even an inverse relationship, others have reported a favourable correlation between high BP and an increased risk of glaucoma [5]. These differences may result from differences in the population characteristics, blood pressure and IOP measurement techniques, and study design.

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Furthermore, the bulk of studies have been carried out on populations in the West, and there is little information from Asian nations, such as India, where the prevalence and features of glaucoma and hypertension may vary [6].

This study examined the association between glaucoma, perfusion pressure, and systemic hypertension in an adult Indian population.

METHODOLOGY

Study Design

A comparative, cross-sectional analysis.

Study Setting

The research took place in a tertiary care hospital in Bihar, India, known for its specialized ophthalmology department. The study spanned from March 2022 to September 2023.

Participants

A total of 200 adult participants were comprised for the study.

Inclusion and Exclusion Criteria

Inclusion criteria involved adults aged 18 and above who were diagnosed with systemic hypertension and glaucoma. Participants without a diagnosis of glaucoma but with systemic hypertension were also included for comparison. Exclusion criteria excluded individuals with any other systemic illnesses, those who had undergone ocular surgery, and participants with a history of ocular trauma.

Sample size

To calculate the sample size for this study, the following formula was used for estimating a proportion in a population:

$$n = \frac{Z^2 \times p \times (1-p)}{E^2}$$

Where:

- n = sample size

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- Z = Z-score corresponding to the desired level of confidence

- p = estimated proportion in the population

- E = margin of error

Bias

To minimize selection bias, participants were randomly selected from the hospital's outpatient department. Observer bias was reduced by ensuring that the clinicians assessing the participants were blinded to their systemic hypertension status.

Variables

The primary variables measured included systemic hypertension, perfusion pressure, and the presence of glaucoma. Secondary variables included age, gender, and duration of hypertension.

Data Collection

Data was collected through clinical examinations and patient interviews. A standardised sphygmomanometer was used to measure the intraocular pressure, and Goldmann applanation tonometry was used to assess the systemic blood pressure. The difference between intraocular pressure and systolic blood pressure (SBP) was used to compute perfusion pressure.

Procedure

Participants underwent a thorough ophthalmologic examination, including visual acuity tests, slit-lamp biomicroscopy, and fundus examination. Blood pressure readings were taken in a controlled environment to ensure accuracy. All data were recorded in a structured data sheet.

Statistical Analysis

SPSS version 21.0 was used to analyse the data. The individuals' clinical and demographic features were compiled using descriptive statistics. T-tests and chi-square tests were used in a comparative analysis to ascertain the connection between glaucoma, perfusion pressure, and systemic hypertension. We used multivariate logistic regression to account for possible confounders.

Ethical considerations

The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

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RESULT

Table 1: Participant Demographics

Characteristic	With Glaucoma (n=120)	Without Glaucoma (n=80)	Total (n=200)
Age (years)	56.2 ± 9.8	54.1 ± 11.2	55.3 ± 10.4
Gender (Male/Female)	60/60	40/40	100/100
Duration of Hypertension (years)	8.5 ± 5.2	7.3 ± 4.8	7.9 ± 5.0

The study included 200 participants, comprising 100 males and 100 females. The mean age was 55.3 years (± 10.4). The participants were allotted into 2 groups: those with glaucoma (n = 120) and those without glaucoma (n = 80). Table 1 provides a summary of the demographic and clinical features of the participants.

Table 2: Blood Pressure and Intraocular Pressure

Variable	With Glaucoma	Without Glaucoma	p-value
Systolic BP (mmHg)	145.8 ± 15.4	138.7 ± 13.2	<0.01
Diastolic BP (mmHg)	92.4 ± 9.7	88.1 ± 8.3	<0.01
Intraocular Pressure (mmHg)	22.5 ± 4.1	15.6 ± 2.8	<0.001

The mean SBP in participants with glaucoma was significantly higher than in those without glaucoma (145.8 ± 15.4 mmHg vs. 138.7 ± 13.2 mmHg, $p < 0.01$). Similarly, the mean DBP was also higher in the glaucoma group (92.4 ± 9.7 mmHg vs. 88.1 ± 8.3 mmHg, $p < 0.01$). The mean IOP was notably higher in participants with glaucoma (22.5 ± 4.1 mmHg) compared to those without glaucoma (15.6 ± 2.8 mmHg, $p < 0.001$).

Perfusion pressure was significantly different between the two groups. Participants with glaucoma had a lower mean perfusion pressure (123.3 ± 16.3 mmHg) compared to those without glaucoma (123.1 ± 15.8 mmHg, $p = 0.04$).

Table 3: Multivariate Analysis

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Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Systolic BP	1.08	1.03-1.13	<0.01
Diastolic BP	1.04	0.98-1.10	0.12
Intraocular Pressure	1.32	1.20-1.45	<0.001

A multivariate logistic regression analysis was accomplished to adjust for potential confounders, including age, gender, and duration of hypertension. The results indicated that higher systolic blood pressure (OR = 1.08, 95% CI: 1.03-1.13, $p < 0.01$) and higher intraocular pressure (OR = 1.32, 95% CI: 1.20-1.45, $p < 0.001$) were substantially related with the presence of glaucoma.

DISCUSSION

The study results reveal a significant correlation between systemic hypertension and glaucoma in the adult Indian population. Participants with glaucoma had higher mean systolic and diastolic blood pressure compared to those without glaucoma.

Additionally, intraocular pressure was notably elevated in the glaucoma group. Perfusion pressure was also considerably different among the two groups.

Multivariate logistic regression analysis confirmed that higher SBP and IOP were notably related with the presence of glaucoma, even after adjusting for age, gender, and duration of hypertension.

These findings suggest that systemic hypertension, particularly elevated systolic blood pressure, and higher intraocular pressure are key factors linked to the development of glaucoma. Consequently, careful monitoring and management of BP may play a crucial role in preventing and controlling glaucoma in this population.

The intricate connections between glaucoma, ocular perfusion pressure, and systemic hypertension have been the subject of recent research, with an emphasis on adult Indian populations. There were notable associations found when systemic hypertension, IOP, and mean ocular perfusion pressure (MOPP) were compared in patients with primary open-angle glaucoma (POAG), normal tension glaucoma (NTG), and the general population. The study discovered a modestly positive link between mean artery pressure (MAP) and IOP, but a fairly

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substantial correlation between MAP and MOPP. Furthermore, a negative connection was observed between MOPP and IOP [7].

In a longitudinal cohort study involving Malay and Indian adults, researchers investigated the impact of aging on IOP and associated risk factors. The study found that normal aging and reduced systemic BP were associated with decreased IOP. Conversely, participants who developed hypertension during the follow-up period experienced stable IOP levels. The study highlighted the importance of controlling hypertension to manage IOP and reduce glaucoma risk [8].

In a population-based sample, the relationships between MOPP and several systemic and ocular parameters were investigated. The results showed a substantial correlation between migraine and elevated IOP and reduced MOPP, which may worsen optic nerve head blood flow and raise the risk of glaucomatous damage. greater BMI, age, and hypertension were linked to greater MOPP, which may have a protective impact [9].

Research on NTG conducted in South India found that decreased diastolic perfusion pressure and hypertension were important risk factors for glaucoma. According to the study, there was a significant relationship between the degree of visual field abnormalities and optic disc cupping, and lower central corneal thickness (CCT) was linked to lower IOP [10].

CONCLUSION

This study establishes a substantial relationship between systemic hypertension and glaucoma in the adult Indian population. Higher systolic blood pressure and intraocular pressure are key factors linked to the development of glaucoma. These findings underscore the importance of regular monitoring and management of blood pressure to prevent and control glaucoma effectively.

Limitations: The limitations of this study include a small sample population who were included in this study. Furthermore, the lack of comparison group also poses a limitation for this study's findings.

Recommendation: Regular monitoring and management of blood pressure are recommended to prevent and control glaucoma effectively. To clarify the underlying mechanisms and causal linkages, more longitudinal research is required.

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Acknowledgement: We are thankful to the patients; without them the study could not have been done. We are thankful to the supporting staff of our hospital who were involved in patient care of the study group.

List of abbreviations:

BP - Blood Pressure

CI - Confidence Interval

CCT - Central Corneal Thickness

DBP - Diastolic Blood Pressure

IOP - Intraocular Pressure

MAP - Mean Arterial Pressure

MOPP - Mean Ocular Perfusion Pressure

NTG - Normal Tension Glaucoma

OR - Odds Ratio

POAG - Primary Open-Angle Glaucoma

SBP - Systolic Blood Pressure

Source of funding: No funding received.

Conflict of interest: The authors have no competing interests to declare.

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