Section: Ophthalmology

Original Research Article

COMPARISON OF INTRAOCULAR PRESSURE AMONG INDIVIDUALS WITH SYSTEMIC HYPERTENSION AND THOSE WITH NORMAL BLOOD PRESSURE: A CASE-CONTROL STUDY

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Received : 29/03/2025
Received in revised form : 12/05/2025
Accepted : 01/06/2025

Keywords:
Intraocular pressure, Systemic hypertension, Glaucoma, Blood pressure control, Ocular hypertension.

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DOI: 10.47009/jamp.2025.7.3.178

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2025; 7 (3); 927-931

ABSTRACT

Background: Intraocular pressure (IOP) is a major modifiable risk factor for the development of glaucomatous optic neuropathy. Systemic hypertension may influence IOP through increased aqueous production and episcleral venous pressure. This study compares IOP among individuals with systemic hypertension and normotensive individuals. This study to evaluate and compare intraocular pressure in individuals with systemic hypertension and those with normal blood pressure, and to assess the influence of blood pressure control on IOP levels. **Materials and Methods:** This was a hospital-based case-control study conducted at the Department of Ophthalmology, MediCiti Institute of Medical Sciences, Medchal, from January 2023 to January 2024. A total of 200 patients were included, comprising 100 hypertensives and 100 normotensives. IOP was measured using Goldmann applanation tonometry. Blood pressure was recorded using a sphygmomanometer. Statistical analysis was done using Student's t-test, and a p-value < 0.05 was considered significant. **Result:** The mean IOP was 16.67 ± 7.09 mmHg among hypertensive individuals and 15.44 ± 6.72 mmHg among normotensive controls ($p = 0.5949$), showing no significant difference. However, within the hypertensive group, patients with uncontrolled blood pressure had significantly higher IOP (20.72 ± 8.84 mmHg) compared to those with controlled blood pressure (15.32 ± 5.86 mmHg; $p = 0.0076$). **Conclusion:** Although no significant difference in IOP was observed between hypertensives and normotensives, uncontrolled blood pressure was associated with significantly elevated IOP. Regular ophthalmic evaluation is recommended in hypertensive individuals, especially those with poorly controlled blood pressure, to prevent the risk of glaucoma.

INTRODUCTION

Glaucoma is a chronic, progressive optic neuropathy and remains one of the leading causes of irreversible blindness globally. Among the various risk factors, elevated intraocular pressure (IOP) is the most significant modifiable contributor to the onset and progression of primary open-angle glaucoma (POAG).[1] Although the pathogenesis of glaucoma is multifactorial, elevated IOP plays a pivotal role in optic nerve damage and subsequent visual field loss.
IOP is regulated by the balance between aqueous humour production and outflow. Several systemic factors, including age, blood glucose levels, and notably, systemic blood pressure, are known to influence this balance. In individuals with systemic hypertension, increased capillary pressure in the ciliary body may enhance aqueous humour production, while elevated episcleral venous pressure can impede outflow—both mechanisms contributing to elevated IOP.[2,3]
The relationship between systemic hypertension and IOP has been explored in numerous epidemiological studies. The Beaver Dam Eye Study demonstrated a longitudinal association between systemic blood pressure and increased IOP,[2] while Tiambeng et al. showed that acute reduction in systemic blood pressure could influence IOP levels in hypertensive patients.[3] Moreover, Dikopf et al. highlighted the role of systemic diseases in contributing to long-term IOP variability, even in nonglaucomatous eyes.[4]
In the Indian context, Deb et al. found a significant association between hypertension, ocular perfusion pressure, and the risk of glaucoma in adults,

ISSN (O): 2687-5365; ISSN (P): 2753-6556

underscoring the need for population-specific evaluations.[5] However, the influence of blood pressure control—particularly the distinction between controlled and uncontrolled hypertension—on IOP remains inadequately studied.

The present study aims to compare intraocular pressure among individuals with systemic hypertension and those with normal blood pressure, and to assess the impact of blood pressure control on IOP levels.

MATERIALS AND METHODS

Study Design and Setting

This was a hospital-based, case-control study conducted in the Department of Ophthalmology at MediCiti Institute of Medical Sciences, Medchal, Telangana, India, over a period of one year from January 2023 to January 2024.

Study Population

The study included 200 participants: 100 individuals diagnosed with systemic hypertension (cases) and 100 normotensive individuals (controls), all of whom attended the ophthalmology outpatient department. Each participant contributed data from both eyes (total 400 eyes).

Inclusion Criteria

- Age above 45 years
- Both male and female participants
- Hypertensive patients on antihypertensive medications and those newly diagnosed (BP ≥140/90 mmHg)
- Normotensive individuals not on any antihypertensive medication

Exclusion Criteria

- Age below 45 years
- Patients with diabetes mellitus or other systemic illnesses
- Myopia or any ocular pathology known to raise IOP
- History of glaucoma or glaucomatous optic disc changes
- Corneal abnormalities interfering with accurate IOP measurement

Data Collection Procedure

A detailed history including comorbidities and medication use was obtained. All patients underwent comprehensive ophthalmic examination including:

Best corrected visual acuity (Snellen's chart)

Near vision assessment (Jaeger's chart)

Colour vision testing (Ishihara plates)

Slit lamp biomicroscopy for anterior segment evaluation

Fundus examination (direct, indirect ophthalmoscopy and +90D lens)

IOP measurement using Goldmann applanation tonometer. Three readings were taken for each eye, and the average was recorded at a fixed time in the morning to minimize diurnal variation.

Blood pressure was measured using a calibrated sphygmomanometer

Statistical Analysis

Data were analyzed using SPSS version 25. Descriptive statistics summarized demographic and clinical parameters. Student's *t*-test was used to compare mean IOP between groups. A p-value < 0.05 was considered statistically significant.

Ethical Considerations

The study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval was obtained from the Institutional Ethics Committee of MediCiti Institute of Medical Sciences. Written informed consent was obtained from all participants prior to their inclusion in the study.

RESULTS

A total of 400 eyes were included in the study: 200 eyes from 100 individuals with systemic hypertension (cases) and 200 eyes from 100 normotensive individuals (controls). The baseline demographic characteristics were comparable between the two groups.

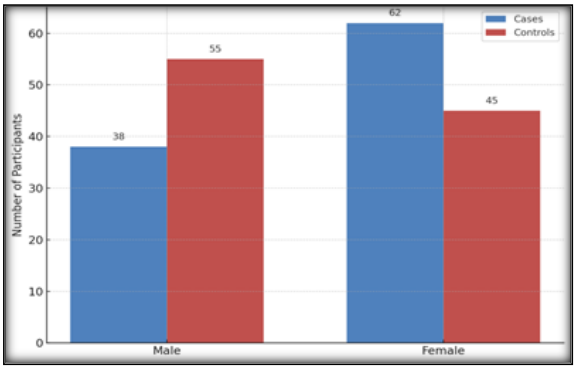

Figure 1: Gender Distribution of Study Participants

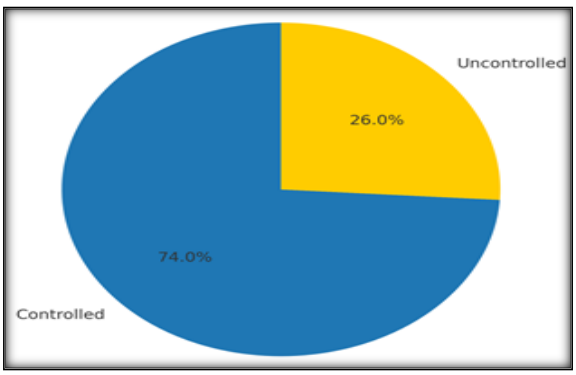

Figure 2: Distribution of Hypertensive Patients Based on BP Control

ISSN (O): 2687-5365; ISSN (P): 2753-6556

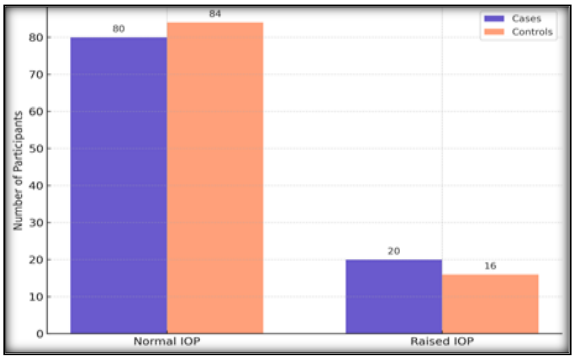

Figure 3: Distribution of Patients Based on Intraocular Pressure

Demographic Profile: The age distribution among participants is presented in [Table 1]. The majority of cases (36%) and controls (35%) were in the 56–65 and 45–55 years age groups, respectively. The mean age was comparable between cases (62.83 ± 9.18 years) and controls (61.49 ± 10.72 years), and the difference was not statistically significant.

Gender distribution is shown in [Table 2]. Among the hypertensive group, 62% were female and 38% were male. In contrast, the control group comprised 55% males and 45% females.

Blood Pressure Control Among Cases: Of the 100 hypertensive patients, 74 had controlled blood pressure, while 26 had uncontrolled hypertension [Table 3]. This subdivision was used for subgroup analysis of intraocular pressure.

Intraocular Pressure Distribution: The distribution of patients with normal and elevated intraocular pressure (IOP) is summarized in [Table 4]. Among the hypertensive group, 20% had raised IOP, compared to 16% in the normotensive group. Although raised IOP was more frequent among cases, the difference was not statistically significant.

Comparison of Mean Intraocular Pressure: The mean IOP among hypertensive patients was 16.67 ± 7.09 mmHg, and among normotensive individuals, it was 15.44 ± 6.72 mmHg [Table 5]. This difference was not statistically significant (p = 0.5949). However, when the hypertensive group was further analyzed, individuals with uncontrolled blood pressure had significantly higher mean IOP (20.72 ± 8.84 mmHg) compared to those with controlled blood pressure (15.32 ± 5.86 mmHg), and this difference was statistically significant (p = 0.0076).

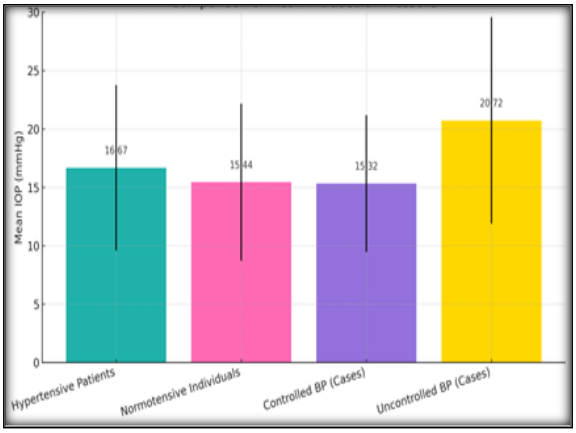

Figure 4: Comparision of Mean Intraocular Pressure

Table 1: Age Distribution of Study Participants

Age Group (Years)	Number of Cases	Number of Controls
45–55	24	35
56–65	36	27
66–75	35	27
76 and above	5	11

Table 2: Gender Distribution of Study Participants.

Gender	Number of Cases	Number of Controls
Male	38	55
Female	62	45

Table 3: Distribution of Hypertensive Patients Based on Blood Pressure Control.

Blood Pressure Status	Number of Hypertensive Patients
Controlled	74
Uncontrolled	26

Table 4: Distribution of Patients Based on Intraocular Pressure.

IOP Status	Number of Cases	Number of Controls
Normal IOP	80	84
Raised IOP	20	16

Table 5: Comparison of Mean Intraocular Pressure.

Group	Mean IOP (mmHg)	Standard Deviation	p-value
Hypertensive Patients (Cases)	16.67	7.09	0.5949
Normotensive Individuals	15.44	6.72	
Controlled BP (among Cases)	15.32	5.86	0.0076
Uncontrolled BP (among Cases)	20.72	8.84	

ISSN (O): 2687-5365; ISSN (P): 2753-6556

DISCUSSION

This study evaluated and compared intraocular pressure (IOP) among individuals with systemic hypertension and normotensive individuals, with a specific focus on the effect of blood pressure control. While no statistically significant difference in mean IOP was observed between hypertensives and normotensives overall, a significant elevation in IOP was noted among hypertensive patients with uncontrolled blood pressure.

The mean IOP among hypertensives was 16.67 ± 7.09 mmHg, compared to 15.44 ± 6.72 mmHg in normotensive individuals ($p = 0.5949$). However, within the hypertensive group, patients with uncontrolled blood pressure had a significantly higher mean IOP (20.72 ± 8.84 mmHg) compared to those with controlled blood pressure (15.32 ± 5.86 mmHg, $p = 0.0076$). These findings underscore the role of blood pressure regulation in influencing IOP levels.

Our results are supported by previous findings that systemic hypertension, particularly when uncontrolled, may elevate IOP. Chang et al. reported that systemic hypertension may contribute to glaucomatous damage by exacerbating fluctuations in IOP and compromising optic nerve head perfusion.[7] Nislawati et al., in a systematic review and meta-analysis, identified hypertension as a significant risk factor for open-angle glaucoma.[9]

Pathophysiological mechanisms proposed to explain this association include increased aqueous humour production due to higher ciliary capillary perfusion pressure and elevated episcleral venous pressure, which can impede aqueous outflow. Guidoboni et al. developed a mathematical model linking systemic and ocular hemodynamics, highlighting how impaired autoregulation of ocular blood flow may elevate IOP and predispose to glaucoma in hypertensive individuals.[8]

Experimental evidence also supports systemic influences on ocular parameters. Schwenn et al. demonstrated altered ocular pulse amplitude in glaucomatous and hypertensive eyes, reflecting changes in ocular vascular dynamics.[10] Furthermore, De Moraes et al. emphasized that evolving systemic hypertension treatment guidelines must consider their ocular implications, particularly regarding glaucoma risk and progression.[11]

Additional support comes from broader physiological studies. Shang et al. showed that both IOP and systemic blood pressure may influence cerebral structures, reinforcing the systemic impact of ocular pressure regulation.[6] Rochtchina et al., in the Blue Mountains Eye Study, observed that IOP tends to increase with age, an important covariate in hypertensive populations.[12]

Limitations

IOP measurements in this study were recorded during a single session, without accounting for diurnal variation, which may influence accuracy. Additionally, potential confounding factors such as central corneal thickness and use of corticosteroids were not assessed. A larger multicentric study with long-term follow-up is recommended to validate these findings.

CONCLUSION

This study found no statistically significant difference in intraocular pressure (IOP) between individuals with systemic hypertension and normotensive individuals. However, a significant elevation in IOP was observed among hypertensive patients with uncontrolled blood pressure compared to those with controlled levels. These findings highlight the role of blood pressure regulation in influencing IOP and potentially increasing the risk of glaucomatous damage. Regular ophthalmologic evaluations, including IOP screening, should be considered essential for hypertensive patients, especially those with suboptimal blood pressure control. Early identification and intervention may help in preventing ocular hypertension and the development of primary open-angle glaucoma in this at-risk population.

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ISSN (O): 2687-5365; ISSN (P): 2753-6556

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ISSN (O): 2687-5365; ISSN (P): 2753-6556