

IMPACT OF SYSTEMIC HYPERTENSION ON INTRAOCULAR PRESSURE: A COMPARATIVE STUDY

Puyam Subhajit Singh¹, Jayalakshmi Thokchom²

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Corresponding Author:

Dr. Puyam Subhajit Singh,
Email: subhajitpuyam@gmail.com

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¹Associate Professor, Department of Ophthalmology, JNIMS, Imphal, Manipur, India
²Post-graduate Trainee, Department of Ophthalmology, JNIMS, Imphal, Manipur, India

ABSTRACT

Background: Intraocular pressure (IOP) is a critical factor of ocular health, particularly in the risk of developing glaucoma. Systemic hypertension has been suggested to be a contributing factor of elevated IOP. This study compares IOP levels in systemic hypertensive and normotensive patients attending JNIMS Eye OPD. **Materials and Methods:** Patients with known hypertension under treatment or diagnosed newly at the time of presentation and a age and sex-matched control group of normotensives attending the Ophthalmology OPD were the study participants. IOP measurements were obtained by using Schiotz and non-contact tonometry in both the groups and their correlation with blood pressure levels was analyzed using a cross-sectional study design. **Result:** IOP measured both by Schiotz and non-contact tonometry was found to be significantly different among hypertensive participants and normotensive participants ($p=0.000$). **Conclusion:** The findings indicate a significant association between systemic hypertension and IOP, which emphasizes the need for regular ophthalmic examination in hypertensive individuals particularly unstable diastolic blood pressure to prevent from the risk of Open angle glaucoma (OAG) incidence.

INTRODUCTION

Intraocular pressure (IOP) plays a crucial role in maintaining the structural integrity of eyeball.^[1] According to data from the Global Burden of Illness research, non-optimal blood pressure remains the greatest risk factor for both the global burden of illness and the global all-cause mortality, accounting for 9.4 million deaths and 212 million lost healthy life years annually (8.5% of the total).^[2] A key role in the pathophysiology of hypertension is endothelial dysfunction. In the context of chronic hypertension, endothelial dysfunction is linked to both elevated oxidative stress and direct pressure-induced damage.^[3] People with hypertension typically have higher activity on the SNS than people with normotension.^[3,4] The development of hypertension and associated target organ damage is significantly influenced by inflammation. Increased vascular permeability and the production of strong mediators such metalloproteinases, NO, cytokines, and reactive oxygen species are linked to inflammation.^[5] Hypertension can also be linked to a number of other eye conditions, including glaucoma, age-related macular degeneration, retinal vascular occlusion, retinal arteriolar emboli, and retinal macroaneurysm.^[6] Several variables, including age, blood pressure, and blood sugar level, influence

intraocular pressure. Due to increased capillary pressure in the ciliary body, variations in systolic blood pressure also cause slight alterations in the generation of aqueous humour. In fact, this may lead to elevated intraocular pressure. Episcleral venous pressure, which is crucial for controlling the flow of aqueous past the trabecular meshwork into Schlemm's canal, is similarly influenced by blood pressure.^[7] According to Umetsu et al., patients with elevated IOP are independently linked to the onset of new hypertension at a 10-year follow-up, even when their IOP is within the normal range.^[8] The renin-angiotensin system (RAS), for instance, has been proposed as a common cause of elevated blood pressure and intraocular pressure. According to studies, glaucoma patients' visual field progression is linked to long-term blood pressure variability. The mechanisms that underlie the association between hypertension, glaucoma, and high intraocular pressure are most likely complex. In conclusion, glaucoma, hypertension, and high IOP interact quietly but clearly.

Objective: The present study was done to determine the association between systemic hypertension and intra-ocular pressure as well as visual acuity.

MATERIALS AND METHODS

A cross-sectional study was conducted at Department of Ophthalmology, Jawaharlal Nehru Institute of Medical Sciences, Porompat, Imphal East for a duration of one year (July 2023-June 2024). The study participants were adult patients with known history of hypertension or newly diagnosed in the Ophthalmology OPD (by taking two measurements at an interval of 05 minutes, and the average of the two being taken to diagnose hypertension) and age and sex-matched normotensive patients. A mercury sphygmomanometer (Diamond company, France) was used for measuring the blood pressure. Consecutive sampling method was used for recruiting them. Patients with history of ocular surgery and or having corneal pathology or scar were excluded from the study. A detailed history for each selected candidate was taken by using a pre-tested proforma. A detailed ocular examination, visual acuity and IOP measurement were done.

A Schiottz tonometer (Biro company, German and non-contact tonometer were used for measuring the intra-ocular pressure. The intraocular pressure was measured by Schiottz tonometer and by non-contact tonometer. The Schiottz tonometer was tested using the spherical mould in the box with a 5.5 gm weight. The pointer was checked to ensure it was at the zero marking. The plunger and disc of the tonometer were cleaned with methylated spirit and a gauze swab, then wiped dry with a sterile cotton swab. The patient was placed in a supine position, and the examiner stood upright behind the patient after washing hands. Local anaesthetic eye drops were instilled, and about 30 seconds were allowed for the effect. The patient was asked to look at a fixed object or their own thumb held directly in front of their eyes to maintain absolute stillness. While the patient's eyes were fixed on the thumb of one hand, the examiner gently held open the patient's eyelid and, with the other hand, held the tonometer (with 5.5 gm) between the thumb and index finger, placing the plunger in the centre of the cornea. The scale reading was noted. If the reading was 2 or less, the 5.5 gm weight was replaced with a 7.5 gm weight, and the procedure was repeated. The new reading was recorded.

For the non-contact tonometer, the measurement of IOP was done by making the patient sit comfortably in front of the machine. The pupillary area was focused using the calibration marking, and an air puff was given. The automated reading provided by the machine was recorded. A minimum of three readings was taken, and the measurements were recorded first in the right eye and then in the left eye.

Statistical analysis: The data collected were entered in MS Excel 2016 and analysis was performed using statistical package for social science (SPSSv20). The mean values of IOP measured by Schiottz and Non-contact tonometer was calculated separately from the cases. Determination of correlation between systemic blood pressure and IOP was done by using Pearson's correlation coefficient test. A p value <0.05 was considered statistically significant.

Ethical considerations: Informed consent was obtained from all the study participants. Privacy during interview and clinical examination was assured. Data confidentiality was maintained. Identifiers were not used. Instead, unique code numbers were given to the study participants. Ethical approval for the study was obtained from the Institutional Ethics Committee of JNIMS, Imphal.

RESULTS

Completed data sets could be obtained from 114 participants during the study period. The age of the participants varied from 41-70 years. There was no statistically significant difference between the two groups in terms of age and sex ($p=0.851$).

[Table 1] shows a comparison of uncorrected visual acuity in hypertensive and normotensive groups. A significantly higher proportion of hypertensive individuals (36) had reduced uncorrected visual acuity compared to normotensive individuals (5), with $p = 0.005$. This indicates a strong association between hypertension and reduced visual acuity. The findings suggest that hypertensive individuals are more likely to experience visual impairment, emphasizing the potential impact of blood pressure on vision.

Table 1: Comparison of Uncorrected Visual Acuity between Hypertensive and Normotensive Groups

Variable	Group		P value
	Hypertensive (n=57)	Normotensive (n=57)	
Uncorrected VA			
Normal	21	52	0.005
Total Reduced	36	5	

A significantly higher proportion of hypertensive individuals (36) had reduced corrected visual acuity compared to normotensive individuals (6), with a p-value of <0.001. This indicates a strong association between hypertension and persistent visual

impairment even after correction. The results suggest that hypertension may contribute to long-term visual deficits that are not fully corrected with standard vision correction methods [Table 2].

Table 2: Comparison of corrected Visual Acuity between Hypertensive and Normotensive Groups

Variable	Group		P value
Corrected VA	Hypertensive (%)	Normotensive (%)	
Normal	21 (36.8)	51 (89.5)	0.001
Reduced	36 (63.2)	6 (10.5)	

Intraocular pressure (IOP) was significantly elevated in hypertensive individuals, both in Schiotz tonometry (21.46 mmHg vs. 17.95 mmHg) and non-contact tonometry (23.40 mmHg vs. 19.88 mmHg),

with p-values <0.001. These findings suggest a strong correlation between hypertension and increased IOP. [Table 3]

Table 3: Comparison of corrected IOP between Hypertensive and Normotensive Groups

Variable	Group	Mean (SD)	P value
Variable	Hypertensive	58.02 (6.099)	0.381
	Normotensive	50.70 (5.428)	
BP (Systolic)	Hypertensive	144.74 (17.785)	0.000
	Normotensive	122.77 (11.843)	
BP (Diastolic)	Hypertensive	93.16 (11.646)	0.000
	Normotensive	79.49 (8.345)	
IOP (Schiotz Tonometry)	Hypertensive	21.46 (3.279)	0.000
	Normotensive	17.95 (2.394)	
IOP (Non-contact Tonometry)	Hypertensive	23.40 (3.353)	0.000
	Normotensive	19.88 (2.421)	

DISCUSSION

The findings from this study highlight the significant differences in intraocular pressure (IOP) and other physiological parameters between hypertensive and normotensive individuals. Hypertension is well-established as a systemic condition that impacts various organs, including the eyes. The results of this study further reinforce the association between increased blood pressure and elevated intraocular pressure, which is a critical factor in ocular health and potential risk for conditions such as glaucoma.

A significantly higher proportion of hypertensive individuals have reduced uncorrected visual acuity, highlighting a potential impact of hypertension on vision quality. Even after correction, hypertensive individuals show reduced visual acuity, suggesting persistent visual deficits associated with high blood pressure. These findings suggest that hypertension may contribute to a decline in ocular health, potentially due to microvascular changes affecting the eye. In a review by Fraser-Bell et al (2017) mentioned that, hypertension negatively impacts vision quality by increasing the risk of conditions such as retinal vascular occlusion, retinal macroaneurysm, and non-arteritic anterior ischaemic optic neuropathy. It also exacerbates diabetic retinopathy and contributes to age-related macular degeneration.^[9]

The findings from this study highlight the significant differences in intraocular pressure (IOP) and visual acuity between hypertensive and normotensive individuals. The analysis reveals a significant association. In a review by Fraser-Bell et al, it was mentioned that, hypertension negatively impacts vision quality by increasing the risk of conditions such as retinal vascular occlusion, retinal macroaneurysm, and non-arteritic anterior ischaemic optic neuropathy.^[10] Irum et al. determined the mean

intraocular pressure (IOP) in adult patients who had already been diagnosed with hypertension and found a positive correlation between the rise in blood pressure and an increase in the mean intraocular pressure.^[11] Rofiq et al investigated the relationship between intraocular pressure (IOP) and blood pressure (BP), a positive association was discovered between intraocular pressure and blood pressure in both the right and left eyes. BP and intraocular pressure (IOP) were shown to have a statistically significant association (p=0.000), which meant that the higher the BP, the higher the IOP was in both eyes.^[12]

Hypertensive patients had significantly higher intraocular pressure, as measured by both Schiotz tonometry (21.46 mmHg vs. 17.95 mmHg) and non-contact tonometry (p value<0.06). Samal et al indicated that, intraocular pressure (IOP) increases with age, and hypertensive patients exhibit statistically significant higher IOP compared to non-hypertensives.^[13] This suggests that systemic hypertension significantly impacts intraocular pressure.

The present study has a few limitations notably, the small sample size included in the study. Only the cases reported within the study period were taken in without any scientifically calculated sample size. This will impact on the generalizability of the study finding. Hence, the study findings are to be relied with caution.

CONCLUSION

The study highlights strong association between systemic hypertension and various parameters, like intra-ocular pressure and visual acuity. Key findings indicate that hypertensive individuals have significantly higher IOP as compared to the normotensive individuals which reinforces the

potential impact of systemic hypertension on ocular health. These findings emphasize the importance of regular monitoring and early intervention to manage systemic hypertension and its potential complications.

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