Original Article

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Association between Systemic Hypertension and Ocular Perfusion Pressure in an Adult Population of North Karnataka, India: A Cross-sectional Study

Ophthalmology Section

REKHA R MUDHOL[1], LINGAMANENI SNEHA[2]

ABSTRACT

Introduction: Glaucoma, a major cause of irreversible blindness, is influenced by Intraocular Pressure (IOP) and ocular blood flow. Systemic hypertension may affect the risk of developing glaucoma by influencing Ocular Perfusion Pressure (OPP), although this relationship remains complex and not fully understood. Nocturnal hypotension, especially in individuals on antihypertensive treatment, may further compromise optic nerve perfusion. There is limited data on this association, warranting a focused investigation.

Aim: To evaluate the impact of blood pressure on OPP in the adult population of North Karnataka.

Materials and Methods: A cross-sectional study was conducted at the Department of Ophthalmology, BLDE (DU) SBPMC, Vijayapura, Karnataka, India, involving 168 participants (84 hypertensives and 84 normotensives) from May 2023 to December 2024. Comprehensive eye examinations, including the measurement of IOP and fundus evaluation, were performed. Blood pressure was recorded at 7 AM, 1 PM, 6 PM and 12 AM. OPP values—Mean Ocular Perfusion Pressure (MOPP), Systolic Perfusion Pressure (SPP), and Diastolic Perfusion Pressure (DPP)—were calculated. Statistical analysis included Chi-square, Mann-Whitney U, Spearman's rho, and Kruskal-Wallis tests (p-value <0.05).

Results: Hypertensive participants exhibited significantly (p-value <0.05) higher IOP and OPP at all time intervals. Peak values were observed at 1 PM and 6 PM. OPP correlated positively (r value=+0.7 to +0.91, p-value=0.001) with systolic, diastolic, and mean arterial pressure at each time point in hypertensives. Antihypertensive medications significantly influenced OPP (p-value=0.01).

Conclusion: Individuals with hypertension demonstrated elevated OPP and IOP, suggesting an increased risk of glaucoma. Regular screening and integrated management of blood pressure and ocular parameters are crucial for the prevention of glaucoma.

Keywords: Blood pressure, Glaucoma, Intraocular pressure, Mean ocular perfusion pressure

INTRODUCTION

Glaucoma is a slowly progressive disease that leads to the loss of Retinal Ganglion Cells (RGCs) and their neurons, typically presenting with optic neuropathy, Optic Nerve Head (ONH) cupping and distinct visual field defects [1,2]. Glaucoma is the leading cause of blindness globally, after cataracts and its pathophysiology is not fully understood due to its multifactorial nature [3,4]. Among the various factors linked to glaucoma, increased IOP is modifiable, as it causes a direct mechanical effect on the ONH [5,6]. Additional factors, particularly those influencing blood flow to the ONH, might play a crucial role [4]. Systemic hypertension may contribute to the risk of glaucoma by directly affecting the small vessels of the optic disc. However, systemic hypertension does not appear to be strongly linked with the onset of glaucoma; instead, nighttime reductions in blood pressure may be implicated in its advancement [1,3].

Some research indicates that elevated blood pressure could be a potential risk factor for glaucoma, while others suggest that low systemic blood pressure may play a role in its development and progression [6,7]. Despite these findings, the association remains unclear. Thus, the present study was undertaken to evaluate the impact of blood pressure on OPP in the adult population of North Karnataka, India.

MATERIALS AND METHODS

This was a prospective observational study conducted from May 2023 to December 2024 at the Department of Ophthalmology, BLDE (DU) SBPMC, Vijayapura, Karnataka, India. The study was approved by the Institute's Ethics Committee with approval number BLDE (DU)/IEC/865/2022-23.

Inclusion criteria: Cases consisted of individuals with a known history of hypertension for at least one year and on medication, as well as those without a prior diagnosis but with blood pressure ≥140/90 mmHg on two separate readings. Controls included participants without a history of hypertension and with blood pressure <140/90 mmHg.

Exclusion criteria: Patients with secondary hypertension (such as endocrine disorders, kidney disease, or steroid-induced hypertension) and those for whom IOP could not be measured were excluded from the study.

Sample size calculation: To ensure 99% power for detecting a difference in means between two independent groups using a t-test with a 1% significance level, the sample size was calculated using "G*Power ver. 3.1.9.4 software." Based on this calculation, the study was assigned a sample size of 168.

The study included a total sample size of 168 participants who fulfilled the eligibility criteria. Patients with hypertension were placed in the experimental (study) group (n=84), while patients without hypertension were placed in the control group (n=84).

Study Procedure

A complete ophthalmic examination was conducted for all patients, incorporating a detailed clinical history, best-corrected visual acuity, blood pressure recording, slit lamp examination, Goldman 4-mirror gonioscopy, IOP measurement, fundus examination and perimetry. The rebound tonometer (iCare IC100, Finland) was used to measure

the IOP in both eyes. This device calculates the IOP based on the probe's deceleration and rebound time after impact. For accuracy, the device calculates an average of six readings and this average was used for analysis. A sphygmomanometer was used to measure blood pressure on the right arm while the patient was in a sitting position. Individuals with blood pressure ≥140/90 mmHg, as recorded on two separate readings, were included in the study.

Perfusion pressures were calculated as follows [8-10]

1. Mean Ocular Perfusion Pressure (MOPP)=2/3(MAP)-IOP
   (MAP=1/3SBP+2/3 DBP)
   Where, MAP: Mean arterial pressure; IOP: Intra ocular pressure; DBP: Diastolic blood pressure; SBP: Systolic Blood Pressure
2. Systolic Perfusion Pressure (SPP)=SBP-IOP [10]
3. Diastolic Perfusion Pressure (DPP)=DBP-IOP [10]

Intraocular and blood pressures were recorded once daily, four times on the admitted patients at 7 AM, 1 PM, 6 PM, and 12 AM. Perfusion pressures were then calculated separately for each eye (RE: right eye and LE: left eye) at all time intervals. Patients were admitted for cataract and pterygium surgeries, and those with high blood pressure were admitted for blood pressure monitoring and treatment.

STATISTICAL ANALYSIS

The data collected were entered into a Microsoft Excel spreadsheet, and analyses were performed using Statistical Package for the Social Sciences (SPSS) version 20.0. Results are presented as means, standard deviations, counts, percentages and graphical representations. The two groups were compared using t-tests for normally distributed continuous variables. For non normally distributed variables, the Mann-Whitney U test was applied. Depending on the data distribution, categorical variables were analysed using either the Chi-square test or Fisher's exact test. All statistical tests were two-tailed, with significance defined as p-value <0.05.

RESULTS

A total of 168 participants were included in the study, with 84 classified as hypertensives (cases) and 84 as normotensives (controls). The age and gender distribution between the hypertensives and normotensives were compared using the Chi-squared test, and the results were not significant, with a p-value >0.05 [Table/Fig-1]. The mean age of participants in the case group was 64.20±8.659 years, while in the control group it was 63.83±8.713 years. The male-to-female ratio was equal (M:F=27:57) in both groups. The Chi-square test was used to compare diabetes, smoking and alcohol risk factors between the hypertensives and normotensives, which showed significance (p-value <0.05) [Table/Fig-2].

Parameters		Number of participants (n) (%)		Chi-square test value	p-value
		Hypertensives (n=84)	Normotensives (n=84)		
Age (years)	41-50	6 (7.1)	7 (8.3)	0.845	0.932
	51-60	23 (27.4)	26 (31.0)		
	61-70	39 (46.4)	35 (41.6)		
	71-80	14 (16.7)	15 (17.9)		
	>81	2 (2.4)	1 (1.2)		
Gender	Male	27 (32.1)	27 (32.1)	0.001	1.00
	Female	57 (67.9)	57 (67.9)		

[Table/Fig-1]: Comparison of age and gender between subjects with and without hypertension.

To compare the mean IOP values of both the right and left eyes in both groups, the Mann-Whitney U test was used [Table/Fig-3].

Parameters		Number of participants (n) (%)		Chi-square test value	p-value
		Hypertensives (n=84)	Normotensives (n=84)		
Diabetic	Yes	11 (13.1)	0	11.77	0.001*
	No	73 (86.9)	84 (100)		
Smoking	Yes	10 (11.9)	0	10.633	0.001*
	No	74 (88.1)	84 (100)		
Alcohol	Yes	10 (11.9)	0	10.633	0.001*
	No	74 (88.1)	84 (100)		

[Table/Fig-2]: Comparison of risk factors like diabetes, smoking and alcohol between subjects with and without hypertension.
*p-value <0.05 implies that it is significant statistically

IOP		Mean value (in mmHg)		Mann-Whitney U test	p-value
		Hypertensives	Normotensives		
Right eye	7 AM	14.81±3.287	12.88±1.929	2074.00	0.001*
	1 PM	13.36±3.033	11.94±1.846	2485.00	0.001*
	6 PM	13.15±3.262	11.62±1.862	2546.50	0.002*
	12 AM	12.32±2.743	11.23±1.623	2653.00	0.005*
Left eye	7 AM	14.86±3.387	12.79±1.994	2180.50	0.001*
	1 PM	13.25±3.515	11.63±1.925	2474.00	0.001*
	6 PM	12.96±2.796	11.26±1.876	2064.50	0.001*
	12 AM	12.52±2.852	11.02±1.575	2265.00	0.001*

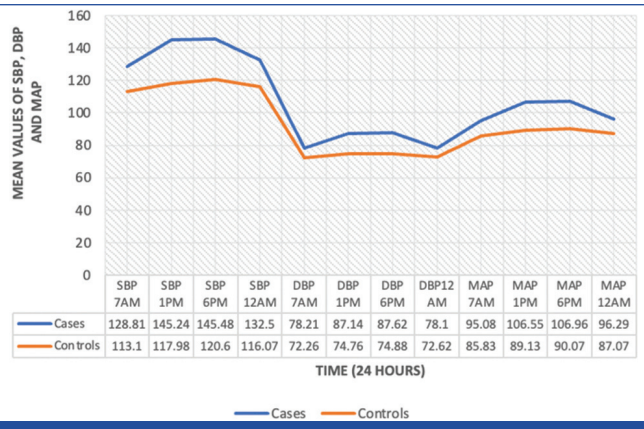
[Table/Fig-3]: Comparison of mean IOP values in both groups at different time intervals in 24 hours.
IOP: Intraocular pressure; mmHg: Millimeters of mercury; AM: Ante meridiem; PM: Post meridiem
*p-value <0.05 implies that it is significant statistically

Hypertensives showed higher values (Right eye=14.81 mmHg at 7 AM) than normotensives (Right eye=12.88 mmHg at 7 AM), but all mean values were within the normal range of 11 to 15 mmHg in both eyes and showed significance with a p-value <0.05 at all time intervals over 24 hours. At 7 AM, the mean IOP was slightly higher, gradually decreasing as the day progressed, illustrating the typical diurnal variation in IOP.

To compare the mean SBP, DBP, and MAP in both groups, the Mann-Whitney U test was performed [Table/Fig-4,5]. There was significance with a p-value <0.05 at all intervals over 24 hours. In hypertensives, the mean values were SBP=120 to 150 mmHg, DBP=70 to 90 mmHg, and MAP=90 to 110 mmHg; while in normotensives, SBP=110 to 120 mmHg, DBP=70 to 80 mmHg, and MAP=80 to 90 mmHg. Among the cases, the highest blood pressure was recorded at 1 PM (SBP=145.24±20.563, DBP=87.14±8.441) and at 6 PM (SBP=145.48±19.537, DBP=87.62±9.394). The MAP,

SBP, DBP and MAP		Mean value (in mmHg)		Mann-Whitney U test value	p-value
		Hypertensives	Normotensives		
SBP	7 AM	128.81±16.531	113.10±6.581	1368.50	0.001*
	1 PM	145.24±20.563	117.98±8.328	693.50	0.001*
	6 PM	145.48±19.537	120.60±7.816	784.0	0.001*
	12 AM	132.50±16.271	116.07±6.589	1211.50	0.001*
DBP	7 AM	78.21±9.205	72.26±5.672	2285.0	0.001*
	1 PM	87.14±8.441	74.76±5.906	927.50	0.001*
	6 PM	87.62±9.394	74.89±5.910	946.50	0.001*
	12 AM	78.10±7.835	72.62±5.833	2192.0	0.001*
MAP	7 AM	95.08±10.71	85.83±4.44	1575.50	0.001*
	1 PM	106.55±11.29	89.13±5.16	567.00	0.001*
	6 PM	106.96±11.89	90.07±4.93	729.00	0.001*
	12 AM	96.29±9.80	87.07±4.49	1458.00	0.001*

[Table/Fig-4]: Mean SBP, DBP and MAP values in both groups at different time intervals in 24 hours.
SBP: Systolic blood pressure; DBP: Diastolic blood pressure; MAP: Mean arterial pressure; mmHg: Millimeters of mercury; AM: Ante meridiem; PM: Post meridiem
*p-value <0.05 implies that it is significant statistically



[Table/Fig-5]: Graph representation of SBP, DBP and MAP in both groups.
SBP: Systolic blood pressure; DBP: Diastolic blood pressure; MAP: Mean arterial pressure; AM: Ante meridiem; PM: Post meridiem

calculated using SBP and DBP, was also high at 1 PM (106.55±11.29) and at 6 PM (106.96±11.89).

To compare the mean OPP of both eyes in both groups, the Mann-Whitney U test was used [Table/Fig-6]. The values were significant, with a p-value <0.05 at all time intervals over 24 hours. Although the OPP values were not within the normal range in a few participants, the overall mean OPP values fell within the normal limits of 40 to 60 mmHg. The values were higher in the hypertensive group compared to the normotensive group. The highest values were noted at 1 PM (RE=57.55±7.56, LE=57.65±7.13) and 6 PM (RE=58.01±7.98, LE=58.20±8.09) in the hypertensive participants, which corresponded with blood pressure readings that were also highest at 1 PM and 6 PM.

OPP		Mean value (in mmHg)		Mann-Whitney U test	p-value
		Hypertensives	Normotensives		
Right eye	7 AM	48.56±8.02	44.20±3.72	2368.50	0.001*
	1 PM	57.55±7.56	47.57±4.04	885.00	0.001*
	6 PM	58.01±7.98	48.46±4.22	1005.00	0.001*
	12 AM	51.74±6.54	46.73±4.03	1887.50	0.001*
Left eye	7 AM	48.51±8.19	44.30±3.79	2454.00	0.001*
	1 PM	57.65±7.13	47.88±3.95	784.50	0.001*
	6 PM	58.20±8.09	48.82±4.16	999.00	0.001*
	12 AM	51.54±7.00	46.94±4.07	2074.50	0.001*

[Table/Fig-6]: Mean OPP values in both groups at different time intervals in 24 hours.
OPP: Ocular perfusion pressure; mmHg: Millimeters of mercury; AM: Ante meridiem; PM: Post meridiem; *p-value <0.05 implies that it is significant statistically

Similar to mean OPP values, mean SPP and DPP values were also significantly higher in hypertensives than in normotensives (p-value <0.05) at all time intervals over 24 hours [Table/Fig-7,8]. The highest mean values of SPP and DPP were observed at 1 PM and 6 PM in the hypertensive group, which corresponded with the blood pressure, which was also highest at those times. The SPP at 1 PM and 6 PM was (RE=131.9±20.24, LE=132.01±19.7 and RE=132.3±19.3, LE=132.51±19.4), while the DPP at 1 PM and 6 PM was (RE=73.98±8.6, LE=74.10±8.36 and RE=74.8±9.4, LE=74.97±9.65).

The strength of the relationship between OPP and SBP, OPP and DBP, and OPP and MAP at 7 AM, 1 PM, 6 PM, and 12 AM over 24 hours was analysed using Spearman's rho. All values were positively correlated with a correlation coefficient (r-value) >0.75 and a significant p-value of 0.001 [Table/Fig-9-12].

A total of 64 patients were on antihypertensives. To compare the effect of antihypertensives on the OPP of the right eye over 24 hours [Table/Fig-13,14], the Kruskal-Wallis test was used. All values were significant, with a p-value <0.05. The overall lowest OPP (Mean=39) was observed in patients on angiotensin receptor blockers, beta blockers, and diuretics at 7 AM, while the highest OPP

SPP		Mean value (in mmHg)		Mann-Whitney U test	p-value
		Cases	Controls		
Right eye	7 AM	114±16.77	100±6.98	1670.00	0.001*
	1 PM	131.9±20.24	106.1±8.53	778.00	0.001*
	6 PM	132.3±19.3	109±8.11	810.50	0.001*
	12 AM	120.17±15.9	104.8±7.14	1401.50	0.001*
Left eye	7 AM	113.9±16.9	100.2±7.22	1665.00	0.001*
	1 PM	132.01±19.7	106.5±8.62	758.50	0.001*
	6 PM	132.51±19.4	109.5±8.07	861.00	0.001*
	12 AM	119.9±16.4	105.04±7.05	1519.50	0.001*

[Table/Fig-7]: Mean SPP values in both groups at different time intervals in a 24 hour period.
SPP: Systolic perfusion pressure; mmHg: Millimeters of mercury; AM: Ante meridiem; PM: Post meridiem; *p-value <0.05 implies that it is significant statistically

DPP		Mean value (in mmHg)		Mann-Whitney U test	p-value
		Cases	Controls		
Right eye	7 AM	63.88±10.18	59.66±6.33	2795.00	0.02*
	1 PM	73.98±8.6	63.22±6.4	1188.00	0.001*
	6 PM	74.8±9.4	63.6±7.2	1149.00	0.001*
	12 AM	66.01±8.20	61.71±6.66	2484.50	0.001*
Left eye	7 AM	63.6±10.13	59.8±6.3	2875.50	0.04*
	1 PM	74.10±8.36	63.53±6.25	1134.00	0.001*
	6 PM	74.97±9.65	63.92±7.18	1219.00	0.001*
	12 AM	65.80±8.42	61.95±6.80	2710.00	0.01*

[Table/Fig-8]: Mean DPP values in both groups at different time intervals in a 24 hour period.
DPP: Diastolic perfusion pressure; mmHg: Millimeters of mercury; AM: Ante meridiem; PM: Post meridiem; *p-value <0.05 implies that it is significant statistically

Cases		SBP		DBP		MAP	
		r-value	p-value	r-value	p-value	r-value	p-value
7 AM	OPPR	0.789	0.001*	0.838	0.001*	0.910	0.001*
	OPPL	0.790	0.001*	0.844	0.001*	0.913	0.001*

[Table/Fig-9]: Comparison of mean OPP with systolic, diastolic, and mean arterial pressures at 7 AM in hypertensives.
SBP: Systolic blood pressure; DBP: Diastolic blood pressure; MAP: Mean arterial pressure; OPPR: Ocular perfusion pressure of right eye; OPPL: Ocular perfusion pressure of left eye; r=correlation co-efficient, AM: Ante meridiem; *p-value <0.05 implies that it is significant statistically

Cases		SBP		DBP		MAP	
		r-value	p-value	r-value	p-value	r-value	p-value
1 PM	OPPR	0.801	0.001*	0.823	0.001*	0.908	0.001*
	OPPL	0.781	0.001*	0.790	0.001*	0.883	0.001*

[Table/Fig-10]: Comparison of OPP with systolic, diastolic, and mean arterial pressures at 1 PM in hypertensives.
SBP: Systolic blood pressure; DBP: Diastolic blood pressure; MAP: Mean arterial pressure; OPPR: Ocular perfusion pressure of right eye; OPPL: Ocular perfusion pressure of left eye; r=correlation co-efficient, PM: Post meridiem; *p-value <0.05 implies that it is significant statistically

Cases		SBP		DBP		MAP	
		r-value	p-value	r-value	p-value	r-value	p-value
6 PM	OPPR	0.827	0.001*	0.761	0.001*	0.875	0.001*
	OPPL	0.841	0.001*	0.798	0.001*	0.898	0.001*

[Table/Fig-11]: Comparison of OPP with systolic, diastolic, and mean arterial pressures at 6 PM in hypertensives.
SBP: Systolic blood pressure; DBP: Diastolic blood pressure; MAP: Mean arterial pressure; OPPR: Ocular perfusion pressure of right eye; OPPL: Ocular perfusion pressure of left eye; r=correlation co-efficient, PM: Post meridiem; *p-value <0.05 implies that it is significant statistically

(Mean=79.50±2.12) was seen in patients on angiotensin receptor blockers, beta blockers, and calcium channel blockers at 6 PM.

DISCUSSION

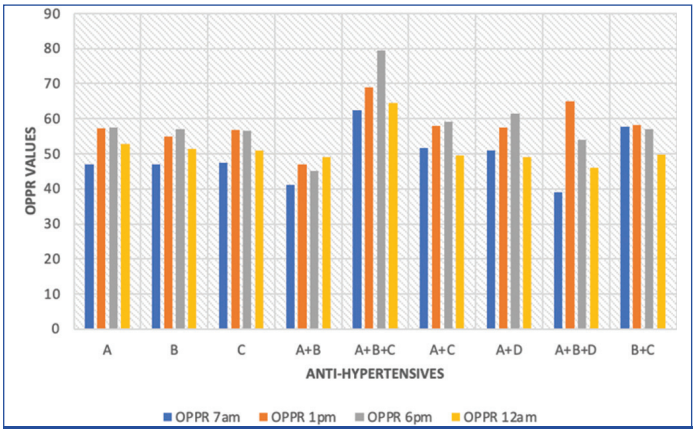
Glaucoma has long been associated with various risk factors, with IOP being a key indicator of disease progression. However, IOP levels in glaucoma patients can vary, making it essential to

Cases		SBP		DBP		MAP	
		r-value	p-value	r-value	p-value	r-value	p-value
12 AM	OPPR	0.858	0.001*	0.797	0.001*	0.896	0.001*
	OPPL	0.856	0.001*	0.786	0.001*	0.894	0.001*

[Table/Fig-12]: Comparison of OPP with systolic, diastolic, and mean arterial pressures at 12 AM in hypertensives.
SBP: Systolic blood pressure; DBP: Diastolic blood pressure; MAP: Mean arterial pressure; OPPR: Ocular perfusion pressure of right eye; OPPL: Ocular perfusion pressure of left eye; r=correlation co-efficient, AM: Ante meridiem; *p-value <0.05 implies that it is significant statistically

Medications	N	OPPR (Mean±SD)			
		7 AM	1 PM	6 PM	12 AM
Angiotensin receptor blockers (A)	19	46.89±7.5	57.16±5.8	57.58±5.8	52.74±6.1
Beta-blockers (B)	6	47±7.64	54.83±8.2	57±9.8	51.33±7.1
Calcium channel blockers (C)	22	47.32±6.25	56.77±8	56.55±7.9	50.86±5.92
A+B	1	41	47	45	49
A+B+C	2	62.5±0.7	69±8.4	79.5±2.12	64.5±4.9
A+C	7	51.71±9.3	58±2.6	59±5.7	49.57±5.9
A+Diuretics (D)	2	51±5.65	57.5±3.5	61.5±4.9	49±4.2
A+B+D	1	39	65	54	46
B+C	4	57.75±12.1	58.25±6.9	57±9.05	49.75±5.67
None	104	44.98±4.9	49.63±6.9	50.40±6.5	47.83±5.35
p-value		0.01*	0.01*	0.01*	0.01*

[Table/Fig-13]: Comparison of the effect of antihypertensive medications on Ocular Perfusion Pressure (OPP) of the right eye in 24 hours in hypertensives.
OPPR: Ocular perfusion pressure of right eye; N: Number of participants; AM: Ante meridiem; PM: Post meridiem; A-Angiotensin receptor blockers; B-Beta blockers; C-Calcium channel blockers; D-Diuretics; *p-value <0.05 implies that it is significant statistically



[Table/Fig-14]: Graphical representation comparing OPP in the right eye and the effect of antihypertensive medications in the case group in 24 hours.
OPPR: Ocular perfusion pressure of right eye; AM: Ante meridiem; PM: Post meridiem; A-Angiotensin receptor blockers; B-Beta blockers; C-Calcium channel blockers; D-Diuretics

assess the strength and consistency of the connection between ocular pressures and glaucoma [11]. The present study found that hypertensive individuals had significantly higher IOP and OPP across all time intervals compared to normotensive individuals. These findings suggest a potential link between systemic hypertension and an increased risk of glaucoma, especially in patients receiving antihypertensive therapy. The average participant age was 64.20±8.659 years in the hypertensive group, while it was 63.83±8.713 years in the normotensive group, with no significant difference. Research by On E et al., and Onakoya A et al., demonstrated similar age patterns [12,13].

The IOP of both eyes, blood pressure and perfusion pressures were recorded at four specific time points: 7 AM, 1 PM, 6 PM and 12 AM in both groups. For simplicity, the IOP and perfusion pressure values of the right eye were discussed. For consistency, the morning values at 7 AM were considered ideal, as this is the recommended time for blood pressure measurement [14]. When comparing the mean IOP values, the mean IOP was significantly higher in hypertensives (14.81 mmHg) compared to normotensives (12.88 mmHg), with p-value <0.05. This was similar to the findings of Deb AK et al., (hypertensives: 15.37 mmHg, normotensives: 13.41 mmHg, p-value <0.05) [3]. On E et al., and Onakoya A et al., also observed similar significance in their studies [12,13]. The mean blood pressure values were higher in hypertensives (SBP=128 mmHg, DBP=78.21 mmHg, MAP=95.08 mmHg) compared to normotensives (SBP=113.10 mmHg, DBP=72.26 mmHg, MAP=85.83 mmHg), with p-value <0.05, indicating statistical significance. This supports the results reported by On E et al., [12].

Leske MC showed that hypertension might provide some protection against glaucoma by enhancing perfusion to ONH. However, prolonged hypertension can impair ONH perfusion, potentially leading to glaucoma [15]. Low blood pressure can impair blood flow to the ONH, leading to RGC death, which can worsen glaucomatous damage, particularly when combined with elevated IOP [6,16]. Pache M and Flammer J highlighted in their study that a nocturnal decrease in blood pressure may significantly increase glaucoma risk, possibly as a result of antihypertensive medications taken before bedtime [1]. This study observed a decline in blood pressure at 7 AM in both groups, likely influenced by participants' evening antihypertensive medications.

The mean OPP was significantly higher in hypertensives (Mean OPP=48.56 mmHg) than in normotensives (Mean OPP=44.20 mmHg) with p-value <0.05, suggesting a protective effect on the ONH. These findings contrast with the study by On E et al., which reported a lower Mean OPP in hypertensives (Mean=47.10 mmHg) compared to normotensives (Mean=48.99 mmHg) with a significant p-value (p-value=0.012). Mean OPP, which is responsible for sustaining proper perfusion to the ONH, is influenced by both IOP and blood pressure. These factors must be considered in hypertensive individuals when assessing optic nerve health risk [12].

A positive association between Mean Ocular Perfusion Pressure (MOPP) and Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), and Mean Arterial Pressure (MAP) was also found in the current study, using Spearman's rho test (r=+0.7 to +1.0, p-value <0.05). Lower Ocular Perfusion Pressure (OPP) can restrict optic nerve perfusion, impairing autoregulation and ultimately contributing to glaucomatous nerve damage [10,11]. Sharp drops in blood pressure result in low perfusion pressure, causing ischaemic conditions that harm the optic nerve [17]. Conversely, elevated blood pressure can lead to arteriosclerosis, lowering perfusion pressure and hindering the proper nourishment of the optic nerve [3].

Like MOPP, the mean SPP and DPP were significantly higher in hypertensives than in normotensives. Gore V et al., showed that low MAP, SPP and DPP increase the prevalence of Primary Open-Angle Glaucoma (POAG), highlighting the critical role of perfusion pressures in glaucoma mechanisms [6]. OPP was highest in patients taking calcium channel blockers (Mean=47.32 mmHg), followed by beta-blockers (Mean=47 mmHg) and angiotensin receptor blockers (Mean=46.89 mmHg), suggesting a potential effect of calcium channel blockers (CCBs) on optic nerve health. This contrasts with the study by Muskens RPHM et al., which indicated that beta-blockers might protect optic nerve health and linked CCBs to increased glaucoma risk [18].

Unlike many studies that relied on single readings, the strength of this study lies in the whole-day (24-hour) monitoring of blood pressure, IOP and perfusion pressures.

Limitation(s)

This study was conducted in a single centre, and hence the findings cannot be generalised. A more comprehensive approach with follow-up assessments is necessary to evaluate glaucoma progression.

CONCLUSION(S)

This study examines the relationship between blood pressure, perfusion pressures and glaucoma. Individuals with hypertension showed higher IOP, potentially increasing the risk of glaucoma. The MOPP, MSPP and MDPP were significantly higher in hypertensives than in normotensives, supporting the vascular role in glaucoma development. Low blood pressure and nocturnal blood pressure drops, often influenced by antihypertensive medications, reduce ONH blood supply, exacerbating ischaemic damage when combined with elevated IOP. Autoregulatory failures in ONH blood flow further contribute to optic nerve injury. Comprehensive screening of hypertensive patients for glaucoma and careful evaluation of blood pressure, IOP and perfusion pressures like OPP, SPP and DPP should be prioritised by ophthalmologists to ensure effective prevention.

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PARTICULARS OF CONTRIBUTORS:
1. Professor and Head, Department of Ophthalmology, BLDE (Deemed to be University), Shri B. M. Patil Medical College Hospital and Research Centre, Bangaramma Sajjan Campus, Vijayapura, Karnataka, India.
2. Postgraduate Student, Department of Ophthalmology, BLDE (Deemed to be University), Shri B. M. Patil Medical College Hospital and Research Centre, Bangaramma Sajjan Campus, Vijayapura, Karnataka, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Lingamaneni Sneha,
16-2-227/117, 118/203, Lakshmi Suseela Nivas, Sardarpatel Nagar, KPHB,
Hyderabad-500085, Telangana, India.
E-mail: snehachowdary972@gmail.com

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