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STUDY OF THE EFFECT OF HYPERTENSION ON INTRAOCULAR PRESSURE AND RETINAL NERVE FIBER LAYER THICKNESS

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ABSTRACT

Background: Systemic arterial hypertension is a long-term medical disorder marked by consistently raised arterial pressure. It is a widespread illness impacting approximately 1.3 billion individuals globally and a primary contributor to cardiovascular diseases.

Aims and Objectives: To investigate changes in retinal nerve fiber layer (RNFL) thickness and intraocular pressure (IOP) in hypertensive patients compared to normotensive patients.

Materials and Methods: The study included 400 adults (200 hypertensives and 200 normotensives) aged 40-75 years. RNFL thickness was measured using Spectral Domain Optical Coherence Tomography (SD-OCT), and IOP was measured using Goldmann Applanation Tonometry.

Results: Hypertensive patients showed significantly higher systolic blood pressure, diastolic blood pressure and mean arterial pressure compared to normotensives. RNFL thickness was significantly reduced in the superior, inferior, nasal, and temporal quadrants in hypertensives. The IOP was also significantly higher in hypertensives.

Conclusion: Systemic hypertension is associated with structural changes in the retina, including RNFL thinning and a slight increase in IOP. These findings highlight the importance of considering ocular parameters in the management of hypertensive patients to prevent potential vision-related disability.

Keywords: Hypertension, Intraocular Pressure, Retinal Nerve Fibre Layer Thickness, Optical Coherence Tomography.

INTRODUCTION

Systemic arterial hypertension, commonly known as high blood pressure, is a prevalent and chronic medical condition characterized by persistently elevated arterial pressure. Hypertension is defined by a systolic blood pressure above 130 mmHg and/or a diastolic blood pressure exceeding 80 mmHg. [1,2] It affects approximately 31.1% of adults worldwide, with a higher prevalence in low- and middle-income countries. The prevalence of hypertension has increased significantly in recent decades, particularly in South, Eastern, and Southeast Asia, Oceania, and sub-Saharan Africa. [3]

Hypertension is a major risk factor for cardiovascular diseases, including ischemic heart disease and stroke, accounting for 10-20% of global mortality. It also contributes to other non-transmissible illnesses such as chronic kidney failure, dementia and hypertensive heart disease. Uncontrolled hypertension has significant economic implications for individuals, families, and healthcare systems, including direct costs for medications and care, and indirect costs due to lost productivity.

Hypertension can lead to hypertensive retinopathy, a condition characterized by damage to the retinal microvasculature. [4,5] Chronic hypertension can cause vasoconstriction of retinal arterioles, damage the blood-retinal barrier, and lead to retinal changes such as microaneurysms, hemorrhages, and exudates. These changes can be detected by ophthalmoscopy and imaging techniques like optical coherence tomography (OCT). [6]

Glaucoma is a leading cause of irreversible vision loss globally, with intraocular pressure (IOP) being a major modifiable risk factor. [7] Hypertension can influence both IOP and ocular perfusion pressure (OPP), which are critical for optic nerve health. [10,11] Studies have shown a complex relationship between hypertension and IOP, with hypertension potentially causing both increases and decreases in IOP.

Retinal nerve fiber layer (RNFL) thinning is an early indicator of glaucomatous damage, often preceding visual field changes. [8,9] OCT is a crucial tool for measuring RNFL thickness and detecting early structural changes in glaucoma.

The relationship between hypertension, IOP, and RNFL thickness is still under investigation. Some studies have shown an association between hypertension and RNFL thinning, while others have not found significant changes, possibly due to variations in study methodologies and patient populations. [10]
This study aims to clarify the relationship between hypertension, IOP, and RNFL thickness to improve early disease detection and intervention strategies.

AIM AND OBJECTIVES

Aim

To investigate changes in RNFL thickness and IOP in systemic arterial hypertensive patients compared to normotensive patients.

Objectives

1. To determine the effect of hypertension on Intraocular Pressure (IOP).
2. To determine the effect of hypertension on Retinal Nerve Fibre Layer (RNFL) thickness.
   The patients were classified into two groups:

- Group 1: Hypertensives (cases)
- Group 2: Normotensives (controls)

MATERIALS AND METHODS

This study was conducted over a period of 18 months at the Department of Ophthalmology, Muzaffarnagar Medical College, Muzaffarnagar. The study included 400 adult participants, with 200 individuals in the hypertensive group and 200 in the normotensive group

Study Population

The study population comprised of adults aged between 40 to 75 years.

Inclusion Criteria:

- Age between 40-75 years
- For the hypertensive group: Systolic blood pressure ≥ 130 mmHg and/or Diastolic blood pressure ≥ 80 mmHg [1]
- For the normotensive group: Systolic blood pressure < 130 mmHg and Diastolic blood pressure < 80 mmHg

Exclusion Criteria:

- Patients with any pre-existing ocular diseases (e.g., glaucoma, diabetic retinopathy, macular degeneration)
- Patients with systemic comorbidities that could affect ocular parameters (e.g., diabetes mellitus)
- Patients with a history of ocular surgery or trauma
- Patients taking medications known to affect IOP (other than antihypertensive medications in the hypertensive group)

Study Procedure

1. **Demographic Data Collection:** Age and gender were recorded for all participants.
2. **Blood Pressure Measurement:** Blood pressure was measured using a standardized sphygmomanometer after a 5-minute rest period, with the average of two readings taken.
3. **Visual Acuity Assessment:** Uncorrected and best-corrected visual acuity were measured using a LogMar chart.
4. **Intraocular Pressure (IOP) Measurement:** IOP was measured in both eyes using Goldmann Applanation Tonometry.
5. **Retinal Nerve Fiber Layer (RNFL) Thickness Measurement:** RNFL thickness was measured using Spectral Domain Optical Coherence Tomography (SD-OCT).[11] Measurements were taken in the superior, inferior, nasal, and temporal quadrants, as well as the average RNFL thickness around the optic disc.

Statistical Analysis

Data were analyzed using appropriate statistical software. Continuous variables were presented as mean ± standard deviation, and categorical variables as frequencies and percentages. The independent t-test was used to compare continuous variables between the two groups. Chi-square test was used to compare categorical variables. A p-value of <0.05 was considered statistically significant.

RESULTS

Demographics

The study included a total of 400 participants, with 200 in each group. The mean age of the hypertensive group was 57.75 ± 4.80 years, and the mean age of the non-hypertensive group was 58.0 ± 7.76 years (p=0.6986), indicating no significant difference in age between the groups.

Parameter	Hypertensive Group (n=200)	Non-Hypertensive Group (n=200)	p-value
Mean Age (years)	57.75 ± 4.80	58.0 ± 7.76	0.6986

Table 1: Age Distribution of Study Groups

There was no significant difference in gender distribution between the two groups (p=0.241), with females comprising 69% of the hypertensive group and 73% of the non-hypertensive group.

Gender	Hypertensive	Non-Hypertensive	p-value
Male	62 (31%)	54 (27%)	0.241
Female	138 (69%)	146 (73%)	
Total	200 (100%)	200 (100%)	

Table 2: Gender Distribution of Study Groups

Blood Pressure Parameters

As expected, blood pressure parameters were significantly higher in the hypertensive group compared to the non-hypertensive group (p<0.0001 for all comparisons).

Blood Pressure Parameter	Hypertensive Group	Non-Hypertensive Group	p-value
Systolic BP (mmHg)	146.6 ± 19.8	127.6 ± 13.2	<0.0001
Diastolic BP (mmHg)	89.0 ± 10.7	74.0 ± 8.0	<0.0001
Mean Arterial Pressure (mmHg)	115.3 ± 9.1	87.7 ± 8.5	0.0001

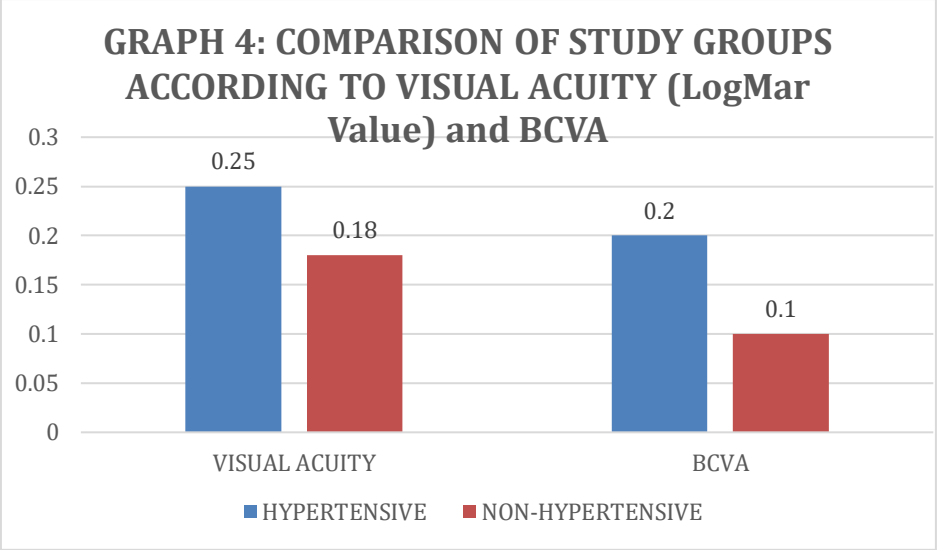
Table 3: Blood Pressure Parameters in Study Groups

Visual Acuity

Both uncorrected and best-corrected visual acuity were significantly poorer in the hypertensive group compared to the non-hypertensive group (p=0.01 and p<0.001, respectively).

Visual Acuity	Hypertensive Group	Non-Hypertensive Group	p-value
Uncorrected	0.25 ± 0.15	0.18 ± 0.10	0.01
Best Corrected	0.20 ± 0.12	0.10 ± 0.08	<0.001

Table 4: Visual Acuity in Study Groups

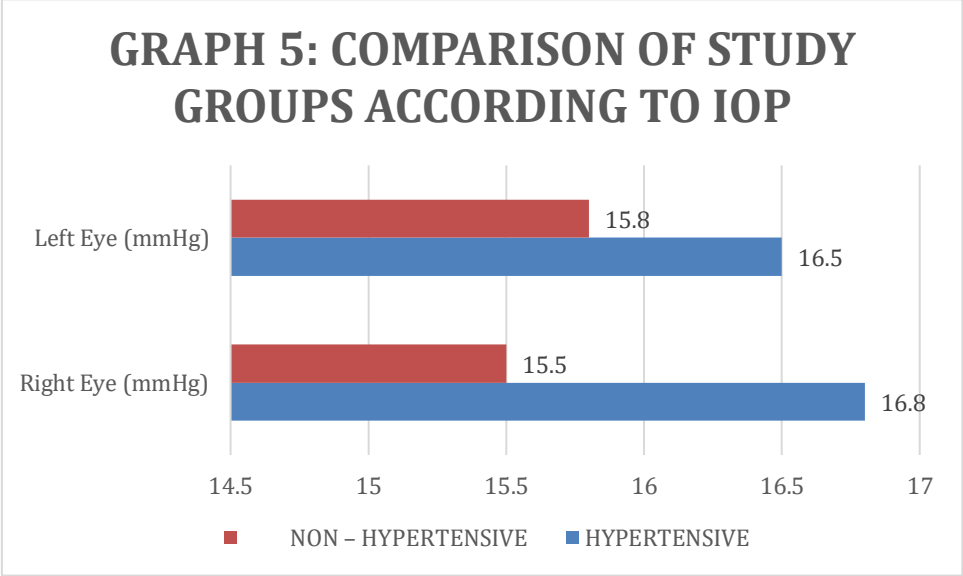


Intraocular Pressure (IOP)

The mean IOP in the right eye was significantly higher in the hypertensive group (16.8 ± 3.0 mmHg) compared to the non-hypertensive group (15.5 ± 2.5 mmHg, p=0.04). While the left eye also showed a higher mean IOP in the hypertensive group (16.5 ± 3.2 mmHg vs. 15.8 ± 2.7 mmHg), this difference was not statistically significant (p=0.12).

IOP (mmHg)	Hypertensive Group	Non-Hypertensive Group	p-value
Right Eye	16.8 ± 3.0	15.5 ± 2.5	0.04
Left Eye	16.5 ± 3.2	15.8 ± 2.7	0.12

Table 5: Intraocular Pressure (IOP) in Study Groups



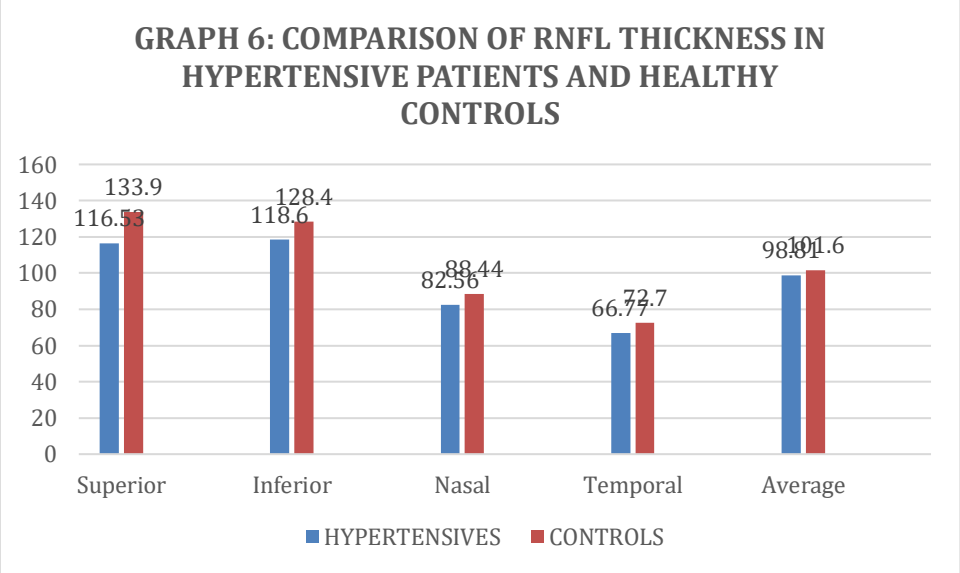
Retinal Nerve Fiber Layer (RNFL) Thickness

RNFL thickness was significantly reduced in the hypertensive group in all quadrants (p<0.001 for all comparisons). The average RNFL thickness was also significantly lower in the hypertensive group (98.81 ± 10.60 µm) compared to the non-hypertensive group (101.60 ± 7.40 µm, p=0.0024).

RNFL	HYPERTENSIVES	CONTROLS	P-VALUE
Superior	116.53 ± 6.87	133.9 ± 8.24	<0.001

Inferior	118.60 ± 9.00	128.40 ± 7.50	<0.001
Nasal	82.56 ± 6.90	88.44 ± 11.5	<0.001
Temporal	66.77 ± 9.20	72.70 ± 8.11	<0.001
Average	98.81 ± 10.60	101.60 ± 7.40	0.0024

Table 6: Retinal Nerve Fibre Layer (RNFL) Thickness in Study Groups



DISCUSSION

This study investigated the impact of systemic hypertension on intraocular pressure (IOP) and retinal nerve fiber layer (RNFL) thickness by comparing 200 hypertensive patients with 200 normotensive controls. The age and gender distributions were similar between the two groups, ensuring that these factors did not confound the results. As expected, hypertensive patients exhibited significantly higher systolic, diastolic, and mean arterial blood pressure compared to normotensive individuals.

Our findings indicate that systemic hypertension is associated with significant alterations in both visual acuity and retinal structure. [12] Hypertensive patients showed poorer uncorrected and best-corrected visual acuity, suggesting that hypertension affects visual function. [13] These results are consistent with previous studies that have reported a decline in retinal function and perfusion in hypertensive individuals, potentially due to microvascular damage and reduced ocular perfusion.

In our study, the right eye IOP was significantly higher in the hypertensive group, while the left eye IOP showed a non-significant trend towards elevation. This observation aligns with some previous research indicating a positive correlation between systemic blood pressure and IOP.

The most notable finding was the significant reduction in RNFL thickness in all quadrants of the retina in hypertensive patients. This suggests that hypertension is associated with structural changes in the retina, potentially indicative of early glaucomatous damage or hypertensive retinopathy. [14]

The mechanisms underlying RNFL thinning in hypertension are likely multifactorial. Chronic hypertension can lead to microvascular damage, impaired autoregulation of blood flow, and ischemia, all of which can contribute to neuronal damage and RNFL loss.

Our findings have important clinical implications. The detection of RNFL thinning in hypertensive patients highlights the need for regular ophthalmological examinations and advanced imaging techniques like OCT to identify early structural changes. [15] Early detection can facilitate timely intervention and management to prevent further vision loss.

CONCLUSION

This study provides evidence that systemic hypertension has a significant impact on ocular parameters. Hypertensive patients exhibited higher IOP, reduced visual acuity, and significant RNFL thinning compared to normotensive controls. These findings underscore the importance of considering ocular health in the management of hypertensive patients and suggest that regular eye examinations and OCT imaging may be beneficial for early detection of hypertensive ocular complications.

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