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Original Research Article

# Relationship between Intraocular Pressure and Mean Ocular Perfusion Pressure in Hypertensive and Non Hypertensive Adult Population

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**Abstract:** Aim of study was to evaluate the relationship between intraocular pressure (IOP), blood pressure (BP) and mean ocular perfusion pressure (MOPP) in patients with hypertension (HT) and compare it to a control group of normotensives. 102 hypertensive patients (HT) and 100 normotensive age matched controls were included. Best corrected visual acuity (BCVA), intraocular pressure (IOP) measurement by noncontact tonometry (NCT) and dilated fundus examination was done. Single recording of BP was taken. Visual field evaluation and gonioscopy was done for IOP >21mmHg and cup disc ratio>0.5 or asymmetry >0.2. MOPP was calculated. Duration of hypertension, details of antihypertensives, dosage and time of intake was noted. The mean IOP in right eye (RE) in HT group was 13.135 and in normotensives were 13.02. In left eye (LE) mean IOP was 13.288 in HT and 13.349 in normotensives. There was no statistically significant difference in IOP between the two groups. The MOPP was significantly higher in HT group (57.28 in RE and 57.197 in LE) than in normotensives (52.51 in RE and 52.356 in LE) with a p value<0.001.There were seven glaucoma suspects in HT group and 11 in normotensive group. There were 2 cases of ocular hypertension in HT group and 3 in normotensive group. Two subjects were diagnosed as primary open angle glaucoma (POAG) one in each group. Mean ocular perfusion pressure was significantly higher in HT group. Glaucoma suspects and Ocular HTN were significantly higher in non HTN group suggesting that decreased ocular perfusion plays a role in development of POAG.
**Keywords:** Intraocular pressure, systemic hypertension, means ocular perfusion pressure, primary open angle glaucoma, ocular hypertension, glaucoma suspect

## INTRODUCTION

Glaucoma is one of the major causes of irreversible blindness, affecting more than 60 million people worldwide [1].It is a chronic progressive optic neuropathy caused by a group of ocular conditions, which lead to damage of the optic nerve with loss of visual function. The most common risk factor known is a raised intraocular pressure [2].

Glaucoma is a multifactorial disease. The pathogenesis of optic nerve damage in glaucoma is attributed to a combination of factors. Besides the mechanical changes due to the rise of intraocular pressure (IOP), several vascular factors such as systemic hypertension, atherosclerosis and vasospasm have also been implicated as risk factors in open angle glaucoma (OAG) [3, 4, 5]. A fall in perfusion pressure at the optic disc may be caused by hypotension, vasospasm or acute blood loss. Ocular perfusion pressure is an estimate for the local intraocular blood flow, calculated as difference between the objective values for the diastolic or systolic systemic blood

pressure (BP) and IOP. A low mean ocular perfusion pressure (MOPP) can impair perfusion of optic nerve head leading to glaucomatous cupping and visual field loss.

As MOPP engulfs both systemic BP and IOP, it could be used to evaluate the presence and evolution of OAG better. Understanding the relationship between IOP, systemic hypertension and MOPP can be helpful in assessing the risk factors of development of OAG.

The aim is to study the relationship between intraocular pressure (IOP), blood pressure (BP) and mean ocular perfusion pressure (MOPP) in patients with hypertension (HT) and compare it to a control group of normotensives.

## MATERIALS AND METHODS

A cross sectional observational study was conducted in the department of Ophthalmology over a period of six months. 102 hypertensive patients (HT) and 100 normotensive age matched controls were included in the study after obtaining clearance of the institutional ethics committee and informed consent. Patients above the age group of 35 years were included in the study. Already diagnosed open angle glaucoma patients and patients with diabetes mellitus, those with hypertension due to secondary causes were excluded. Single recording of BP was measured in right upper arm in sitting position using sphygmomanometer.

Duration of hypertension, details of antihypertensive drugs taken, dosage and time of intake was noted. Best corrected visual acuity (BCVA), intra ocular pressure (IOP) measurement by noncontact tonometry (NCT) (Canon Fully Auto tonometer TX-F) and dilated fundus examination was done in all cases.

Automated perimeter using Humphrey field analyzer-2 (Zeiss) (C 30-2 field evaluation) and gonioscopy was done for individuals with IOP >21mmHg and cup disc ratio >0.5 or asymmetry of >0.2 between the two eyes. Mean arterial pressure (MAP) was calculated using the formula MAP=DBP+1/3(SBP-DBP). (SBP-Systolic BP, DBP-Diastolic BP) [6,7]. MOPP was calculated using the formula MOPP=2/3×MAP-IOP. The factor of 2/3 accounts for the drop in BP between the brachial and ophthalmic artery when the subject is seated [8].

## DATA ANALYSIS

Values were presented as mean with a standard deviation. Statistical analyses were conducted using SPSS software. The level of statistical significance was set as $p < 0.001$.

## RESULTS

A total of 202 individuals were included in the study of which 102 were HT and 100 were age matched normotensives. Mean age in the HT group was 56.7 and in normotensive group was 52.8. In the HT group 48 were males and 54 were females and in normotensive group males and females were 50 each. The mean systolic BP in HT group was 132.71mm Hg and in normotensive group was 123.54 mmHg. The mean diastolic BP in the HT group was 82.25 mmHg and in normotensive group was 76.1mmHg (Table 1).

**Table-1: comparison of demographic parameters, systolic and diastolic bp in ht and normotensive group**.

| VARIABLES | HT | NORMOTENSIVE |
|---|---|---|
| Age (mean) | 56.7 | 52.8 |
| Gender Males | 48 | 50 |
| Females | 54 | 50 |
| SBP (mm hg) (mean) | 132.71 | 123.54 |
| DBP (mm hg) (mean) | 82.25 | 76.1 |

The mean IOP in RE in HT group was 13.135 and in normotensive group was 13.02 mmHg. In the left eye mean IOP was 13.288 in HT group and 13.349mmHg in normotensive group. There was no statistical significance in IOP between the two groups. **T**he MOPP was significantly higher in HT group (57.28 in RE and 57.197 in LE) than in normotensives (52.51 in RE and 52.356 in LE) with a p value<0.001.(Fig:1)

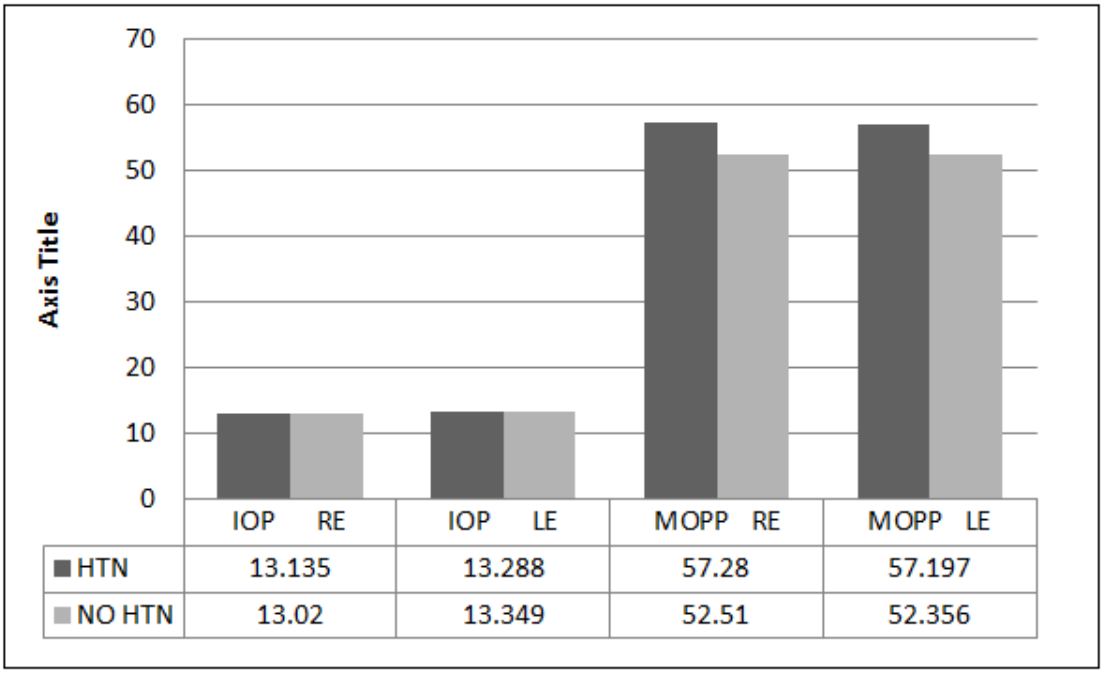


**Fig-1**: **mean IOP and MOPP in HT and normotensives**

There were only 6 patients who were not on any antihypertensive medications but were on salt restricted diet. There was no significant difference in IOP and MOPP between the HT patients who were taking medications and those who were not on treatment.

**Table-2: Mean IOP and MOPP between HT on treatment and not on treatment.**

| HTN ON TREATMENT | TOTAL NUMBERS | MEAN | STD DEVIATION |
|---|---|---|---|
| IOP RE | | | |
| YES | 96 | 13.015 | 2.8291 |
| NO | 6 | 15.067 | 3.2995 |
| IOP LE | | | |
| YES | 96 | 13.200 | 2.7901 |
| NO | 6 | 14.700 | 3.3347 |
| MOPP RE | | | |
| YES | 96 | 57.28 | 5.227 |
| NO | 6 | 57.38 | 4.747 |
| MOPP LE | | | |
| YES | 96 | 57.170 | 5.2471 |
| NO | 6 | 57.633 | 5.5004 |

Seven subjects were diagnosed as glaucoma suspects (optic disc changes present but IOP and visual fields were normal) in HT group and 11 in normotensive group. There were 2 cases of ocular hypertension (IOP>21mm Hg with normal optic disc and visual fields) in HT group and 3 in normotensive group. Two subjects were diagnosed as primary open angle glaucoma (POAG) one each in HT-group and normotensive group.

Among the HT patients on medication 46(47.9%) were on calcium channel blockers, 23(23.9%) were on angiotensin antagonists and 22(22.9%) were on beta blockers. Only 9(9.38%) were on diuretics and one was on angiotensin converting

enzyme (ACE) inhibitors. Regarding the time of intake 42 (43.7%) were on morning dose of medication, 12(12.5%) were on night time dose, 41(42.7%) were on morning and night dosage and 2 were taking medication in afternoon. There was no statistical significance in IOP and MOPP with regard to class of antihypertensive and time of intake of medication.

## DISCUSSION

In this study we found a significantly higher MOPP in subjects with HT than in normotensive individuals.There was no significant difference in IOP between the two groups. Relation between systemic HT and OAG has been evaluated in various studies with contradictory results. Our findings were consistent with the Rotterdam study in which presence of systemic HT was not significantly associated with IOP [9]. Vijaya *et al*. in their study in a rural and urban South Indian population also did not find any association of POAG with systemic hypertension [10,11]. But in the Blue Mountains eye study, a significant association was seen between HT and OAG and association was strongest in those with uncontrolled HTN [12].

MOPP was significantly higher in HT subjects in our study. The Baltimore Eye Survey showed an age related association between BP and glaucoma. In younger patients hypertension had a protective effect, thereby improving MOPP where as in older patients this positive effect is lost due to blood vessel alterations induced by arterial hypertension. Thus they may have decreased MOPP and are at risk for glaucomatous damage to ocular structures [13]. Glaucoma suspects and ocular hypertension were higher in normotensive group in our study. The risk of developing glaucoma is greater in lower MOPP suggesting that POAG is associated with an alteration in factors related to ocular blood flow and a breakdown of autoregulation. These findings were echoed in the Rotterdam Eye Study [9] and the Barbados Eye Study [14]. Oku *et al*. had found in a study that optic nerve head (ONH) ischemia could contribute to enlargement and excavation of optic cup independent of IOP level [15].

In addition circadian fluctuation of ocular perfusion pressure (OPP) is a contributory factor in the pathogenesis of glaucomatous optic neuropathy [6, 16]. A 24 hour MOPP fluctuation was found to be the most consistent risk factor for determining glaucoma severity in patients with normal tension glaucoma (NTG), as reduction of OPP may lead to short term ocular tissue ischemia, followed by reperfusion injury and consequent retinal ganglion cell loss [17].

In our study there was no significant difference in IOP and MOPP between patients on antihypertensive medication and those who were not on treatment. There was also no significant difference between those on morning dose of medication and those who were on night dosing and among the class of antihypertensive taken. In the Thessaloniki Eye Study low OPP was associated with an increased risk of POAG in subjects on antihypertensive treatment [18]. Deb A.K *et al*. in their study found that increase in MOPP was associated with reduced risk of glaucoma in a dose dependant manner [19]. Those on antihypertensive medication had two to three fold increased likelihood of having glaucoma or being glaucoma suspects. This was related to bed time dosing and greater disruption of auto regulatory mechanism of blood flow in the ONH leading to reduced MOPP. Nocturnal hypotension may exacerbate the progression of visual field loss in patients with glaucoma [6]. In the Thessaloniki eye study it was found that ACE inhibitors, angiotensin antagonists and diuretics alone or combined were significantly associated with larger cup size and higher cup-disc ratio. This association was not found for beta blockers and calcium channel blockers [20].

The exact physiological status of ocular perfusion may not be represented by the calculation of MOPP using theoretical formula. BP and IOP are subject to diurnal variation. So, a single BP or IOP recording may not be representative of the subject's real BP or IOP status. Therefore a more extensive study taking into account the diurnal fluctuation of IOP and frequent BP monitoring may be more accurate.24 hour ambulatory BP monitoring can be done to find out the characteristics of circadian BP variability in glaucoma subjects Our study is also limited by lack of follow up of the subjects for development of glaucoma or progression of glaucoma in subjects diagnosed as OAG and glaucoma suspects.

## CONCLUSION

There is no significant difference in IOP between the HT and normotensive groups, but mean ocular perfusion pressure was significantly higher in the HT group. The number of glaucoma suspects and ocular hypertension were significantly higher in non HT group where the MOPP was lower. This suggests that decreased ocular perfusion plays a role in the development of open angle glaucoma. Blood Pressure should be monitored closely in patients with glaucoma regarding disease progression despite having a controlled IOP.

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