

## A Prospective Clinical Association of Glaucoma with Systemic Hypertension and its Effect on Visual Morbidity

Archana Kumari<sup>1</sup>, Govind Kumar Mandal<sup>2</sup>, Uma Shankar Singh<sup>3</sup>

<sup>1</sup>Assistant Professor, Department of Ophthalmology, JLNMC, Bhagalpur, Bihar, India

<sup>2</sup>Assistant Professor, Department of Ophthalmology, JLNMC, Bhagalpur, Bihar, India

<sup>3</sup>professor and HOD, Department of Ophthalmology, JLNMC, Bhagalpur, Bihar, India

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Corresponding author: Dr. Govind Kumar Mandal

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### Abstract

**Aim:** To evaluate the association between hypertension and occurrence of glaucoma.

**Methodology:** A prospective study was conducted over a period of 1.5 years in the Department of Ophthalmology, JLNMC, Bhagalpur, Bihar, India including 100 patients between the age groups of 30 to 70 years diagnosed with hypertension. Patients with other systemic diseases or vascular pathologies were excluded from the study. All the patients were followed up for at-least 6 months and the need for regular review visits was explained to them. During the first visit and each follow up opinions regarding the progress of hypertension was obtained from departments of cardiology and internal medicine. The oral hypertensive medication taken by patients were categorized into 5 groups as calcium channel blockers (CCB), diuretics, angiotensin converting enzyme inhibitors (ACE), angiotensin receptor blockers and beta blockers. A detailed history of age, sex, duration of hypertension, history of other co-morbidities and treatment were collected. The participants then underwent a detailed ophthalmological evaluation. IOP measurement was done by applanation tonometry with Goldman Applanation Tonometer. The same procedure was repeated in the other eye. Phasing technique of repeating recordings was done and the average IOP was used in the study. Visual field assessment was done using Humphrey's Automated Perimeter.

**Results:** Among the 100 hypertension patients involved in the study, 58% patients were found to have glaucoma. 52% patients were female, and 48% patients were male. Age group affected was 11% between 30-40 years, 14% between 41 to 50 years, 26% between 51 to 60 years and 49% between 61 to 70 years. 35.8% patients taking CCB, 44% taking ACE inhibitors, and 42.2% taking ARB, 60% taking beta blockers, and 42.8% taking diuretics had reduced IOP. The range of IOP in the treated population was between 10-16mmHg and this difference in those on hypertension medications was statistically significant.

**Conclusion:** It can be concluded from this study that there is a correlation between higher systemic blood pressure and higher intraocular pressure, and this also produces effects to be regarded as risk factors for glaucoma.

**Keywords:** Glaucoma, ocular, hypertension.

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## Introduction

Glaucoma is a common blinding disease which is due to damage to the optic nerve and raised intraocular pressure being a major modifying risk factor [1]. It initially results in peripheral visual field loss followed by loss of central visual field and eventually leads to tunnel vision if not treated early and appropriately [2]. Hypertension due to raised systemic blood pressure (BP) both diastolic and/or systolic is associated with morbidities like stroke, cardiovascular, renal or ocular disease. It has been reported that high blood pressure is a significant risk factor for glaucoma progression [3].

An abnormally high blood pressure (BP) is a major cause of morbidity and mortality in the Western countries [4] and is one of the most common clinical conditions requiring long term medical care [5]. Hypertension is characterized by a persistent systolic BP of more than 140 mmHg and a diastolic BP of more than 90 mmHg [6]. Increased BP can result in symptoms such as dizziness, headache as well as more serious complications such as coronary artery disease, heart failure or even death [7].

Glaucoma affects more than 66 million people worldwide and as a result at least 6.8 million individuals have bilateral blindness [5]. In India, glaucoma is estimated to affect over 11 million people [8] and is the third most common cause of blindness after cataract and corneal blindness [9]. Risk factors for glaucoma include increasing age, high pressure in the eye, a family history of glaucoma, and use of steroid medication [10]. For eye pressures, a value of 21 mmHg or 2.8 kPa above atmospheric pressure (760 mmHg) is often used, with higher pressures leading to a greater risk [11, 12].

However, some may have high eye pressure for years and never develop damage [11]. Conversely, optic nerve damage may occur with normal pressure, known as normal-tension glaucoma [13].

Drugs used in the treatment of hypertension are also known to produce changes in the intraocular pressure. This study was performed to evaluate the association between hypertension and occurrence of glaucoma.

## Materials and Methods:

A prospective study was conducted over a period of 1.5 years in the Department of Ophthalmology, JLNMC, Bhagalpur, Bihar, India including 100 patients between the age groups of 30 to 70 years diagnosed with hypertension. Patients with other systemic diseases or vascular pathologies were excluded from the study. Those with hypertension but less than 30 years of age were not enrolled into the study as both glaucoma and hypertension could be due to congenital causes in young individuals. All the patients were followed up for at least 6 months and the need for regular review visits was explained to them. During the first visit and each follow up opinions regarding the progress of hypertension was obtained from departments of internal medicine.

Patients were classified as hypertensive based on elevated BP readings of >120/80 mm Hg on two separate occasions according to current American Heart Association [14]. Blood pressure measurements were made over 3 visits and the average of last two measurements was used for analysis. Recording was done with manual sphygmomanometer. The oral hypertensive medication taken by patients were categorized into 5 groups as calcium channel blockers (CCB), diuretics, angiotensin converting enzyme inhibitors (ACE), angiotensin receptor blockers and beta blockers. A detailed history of age, sex, duration of hypertension, history of other co-morbidities and treatment were collected.

The participants then underwent a detailed ophthalmological evaluation including visual acuity, anterior segment evaluation

using slit-lamp bio-microscopy and fundus evaluation using a + 90 D lens/ indirect ophthalmoscope. IOP measurement was done by applanation tonometry with Goldman Applanation Tonometer and visual field evaluation with Humphrey Automated Perimeter. For IOP measurement fluorescein was instilled in each eye and the tonometer was set at 10mmHg. Mires were viewed through the prism and measurements were read from the rotating dial. The same procedure was repeated in the other eye. Phasing

technique of repeating recordings was done and the average IOP was used in the study.

### Results:

Among the 100 hypertension patients involved in the study, 58% patients were found to have glaucoma. 52% patients were female, and 48% patients were male. Age group affected was 11% between 30-40 years, 14% between 41 to 50 years, 26% between 51 to 60 years and 49% between 61 to 70 years.

**Table 1: Demographic details and presence of glaucoma in hypertensive patients**

Variables		Number
Gender	Male	48
	Female	52
Age (in years)	30-40	11
	41-50	14
	51-60	26
	61-70	49
Glaucoma	Present	58
	Absent	42

The increased incidence of OHT among hypertensive's was statistically significant ( $p$  value < 0.005). In those with OHT, predominant fundus changes were seen as increased cup disc ratio in 14% and neuroretinal thinning in 8%. Corneal thickness in patients diagnosed with ocular hypertension was on an average 0.740 +/- 0.03mm. Thicker cornea was noted in 28%. Thinner cornea was noted in 4% of patients.

The oral hypotensive medication taken by patients were categorized into 5 groups as

calcium channel blockers (CCB), diuretics, angiotensin converting enzyme inhibitors (ACE inhibitors), angiotensin receptor blockers (ARB) and beta blockers. 35.8% patients taking CCB, 44% taking ACE inhibitors, and 42.2% taking ARB, 60% taking beta blockers, and 42.8% taking diuretics had reduced IOP. The range of IOP in the treated population was between 10-16mmHg and this difference in those on hypertension medications was statistically significant.

**Table 2: Correlation between hypertensive medication and IOP reduction**

Medication	Glaucoma		Total
	Yes	No	
CCB	25 (64.2%)	14 (35.8%)	39
ACE inhibitors	14 (56%)	11 (44%)	25
ARB	11 (57.8%)	8 (42.2%)	19
Beta blockers	4 (40%)	6 (60%)	10
Diuretics	4 (57.1%)	3 (42.8%)	7
Total	58	42	100

## Discussion:

Intraocular pressure is affected by raised systemic blood pressure. The overlapping pathogenesis in both hypertension and glaucoma has been found to be due to an increased blood pressure especially systolic which increases ciliary artery perfusion pressure [15]. This in turn leads to an increased filtration of aqueous fluid through the ciliary body thus causing elevation in IOP [16]. Raised blood pressure also affects the episcleral venous pressure which regulates the aqueous flow across trabecular meshwork through Schlemms canal [17]. It has been reported following various studies that for every 1mm increase in perfusion pressure there will be an increase of 1mm in IOP. There is an alteration in sodium transport in the distal nephrons and ciliary epithelium, leading to increased excursion of sodium into the renal filtrate and aqueous humour respectively. This is mediated by corticosteroid hormone (cortisol and aldosterone) and glucocorticoid and mineralocorticoid receptors [18].

In a prospective long-term study by Tokunaga et al. [24], the relation between nocturnal BP dip and the progression of the visual field defect in NTG and HTG over a period of 4 years was examined. The degree of nocturnal BP reduction was classified as nondipper (dip of 20%). Interestingly, there was a tendency for the visual field defect to progress not only in the extreme dipper group, but also in the nondipper group. Kashiwagi et al. [25] demonstrated that a lack of the physiologic dipping might be an independent risk factor for progression. The fact that both nondipping and over dipping are associated with GON indicates that an underlying vascular dysregulation, and not simply a low perfusion pressure, might be causal. Such a general vascular dysregulation might interfere with OBF regulation.

Klein et al. stated that beta blocker drugs had a protective effect for glaucoma and

hypertension [21]. In our study we noted that those on calcium channel blockers had least involvement of the ONH but those on beta blockers had lowest recordings of IOP. This variation of effects on glaucoma has not been reported in previous studies to the best of our knowledge. Leske et al. found that antihypertensive drugs were not associated with any increased risk of open angle glaucoma, but that ocular perfusion pressure has a significant effect on IOP [22].

Systemic hypertension exerts an oxidative stress to the arterial wall which in addition to atherosclerosis can then impair autoregulation such that an elevation of IOP above a criteria level will comprise the ocular blood flow and induce optic nerve damage even though IOP may still be within normal range [23, 24].

## Conclusion:

It can be concluded from this study that there is a correlation between higher systemic blood pressure and higher intraocular pressure, and this also produces effects to be regarded as risk factors for glaucoma. Increased BP and IOP may have adverse effects if left unattended. This suggests the need for patients to be always examined for any BP or IOP changes whenever they visit primary eye care professionals.

## References:

1. Maurya RP. Glaucoma Burden: Indian Scenario. *Indian J Clin Exp Ophthalmol.* 2017;3(4):387–8.
2. Maurya RP. Recent advances in glaucoma management. *Indian J Clin Expl Ophthalmol.* 2019;5(2):140–1.
3. Deb AK, Kaliaperumal S, Rao VA, Sengupta S. Relationship between systemic hypertension, perfusion pressure and glaucoma: A comparative study in an adult Indian population. *Indian J Ophthalmol.* 2014;62(9):917–22.
4. Feeman WE. Prediction of the population at risk of atherothrombotic

- disease. *ExpClinCardiol* 2004 9 235-241.
5. Perlman JI, Delay CM, Sothorn RB, Skolnick KA, Murray D, Jacobs RW, Shue JL, Kaplan E, Friedman NC, Nemchausky BA, Ryan MD, Kanabrocki EL. Relationships between 24h observations in intraocular pressure vs blood pressure, heart rate, nitric oxide and age in the medical chronobiology aging project. *ClinTer* 2007 158 31-47.
  6. Liang Y, Downs JC, Fortune B, Cull GA, Cioffi GA, Wang L. Impact of systemic blood pressure on the relationship between intraocular pressure and blood flow in the optic nerve head of non-human primates. *Invest Ophthalmol Vis Sci* 2009 50 2154-2160.
  7. Khaw KT, Foster P. The eye - window to the soul or a mirror of systemic health? Or: What weight to give retinopathy as a risk factor for IHD. *Heart* 2009 95 348-349.
  8. George R, Ve RS, Vijaya L. Glaucoma in India: Estimated burden of disease. *J Glaucoma* 2010; 19:391-7.
  9. Rekhi GS, Kulshreshtha OP. Common causes of blindness: A pilot survey in Jaipur, Rajasthan. *Indian J Ophthalmol* 1991; 39:108-11.
  10. "Facts About Glaucoma". National Eye Institute. Archived from the original on 28 March 2016. Retrieved 2 January 2022
  11. Mantravadi AV, Vadhar N (September 2015). "Glaucoma". *Primary Care*. 42 (3): 437–49.
  12. Rhee DJ (2012). *Glaucoma* (2 ed.). Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins. p. 180.
  13. Mi XS, Yuan TF, So KF. "The current research status of normal tension glaucoma". *Clinical Interventions in Aging*. (16 September 2014)9: 1563–71.
  14. Costa VP, Arcieri ES, Harris A. Blood pressure and glaucoma. *Br J Ophthalmol*. 2009;93(10):1276–82.
  15. Bill A. The role of ciliary blood flow and ultrafiltration in aqueous humor formation. *Exp Eye Res*. 1973;16(4):287–98.
  16. Moraes CGD, Cioffi GA, Weinreb RN, Liebmann JM. New Recommendations for the Treatment of Systemic Hypertension and their Potential Implications for Glaucoma Management. *J Glaucoma*. 2018;27(7):567–71.
  17. Melgarejo JD, Lee JH, Petitto M. Glaucomatous optic neuropathy associated with nocturnal dip in blood pressure: findings from the Maracaibo Aging Study. *Ophthalmol*. 2018; 125:807–14.
  18. Hasibuan, D. A., & Petrus, A. Character Determination in Elementary School Children of Madrasah Ibtidaiyah Al Jamiyatul Washliyah in 2021 Based on the Fingerprint of Right Hands. *Journal of Medical Research and Health Sciences*, 2021;4(11), 1545–1550.
  19. Chen HY, Lai SW. Relation between intraocular pressure and systemic health parameters in Taiwan. *South Med J*. 2005;98(1):28–32.
  20. Tokunaga T, Kashiwagi K, Tsumura T, et al. Association between nocturnal blood pressure reduction and progression of visual field defect in patients with primary open-angle glaucoma or normal-tension glaucoma. *Jpn J Ophthalmol* 2004; 48:380—385
  21. Kashiwagi K, Hosaka O, Kashiwagi F, et al. Systemic circulatory parameters. comparison between patients with normal tension glaucoma and normal subjects using ambulatory monitoring. *Jpn J Ophthalmol* 2001; 45:388—396.
  22. Klein BE, Klein R, Knudtson MD. Intraocular pressure and systemic blood pressure: longitudinal perspective: the Beaver Dam Eye

- Study. Br J Ophthalmol. 2005;89(3):284–291.
23. Leske MC. Ocular perfusion pressure and glaucoma: clinical trial and epidemiologic findings. Curr Opin Ophthalmol. 2009;20(2):73–8.
24. V. P. Costa, E. S. Arcieri, and A. Harris, Blood pressure and glaucoma. British Journal of Ophthalmology, vol. 93, no. 10, pp. 1276–1282, 2009.