

# Assessing the Relationship between Hypertension and Visual Impairment

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## Abstract

**Background:** Hypertension is an elevated arterial blood pressure. It is one of the most common systemic diseases often leading to lethal complications if left untreated. The presence of hypertension is associated with the presence of cardiovascular structural alterations. The principal target organs of hypertensive disease are the heart, brain, kidneys, and eyes. Hypertension may be unknown to patients, and eye may yield the first clue to this relative asymptomatic systemic disease. In the eye, it can affect the retinal, choroidal, and optic nerve circulation.

**Aim:** The aim of this study is to assess (1) the relation of hypertension to visual impairment, (2) the impact of hypertension on severity of visual loss, (3) the relation between various causes of visual impairment and control of systemic hypertension.

**Material and Methods:** Study design – Case–control study. Study area – Department of Ophthalmology of Dr. B.R.A.M. Hospital, Raipur. Study duration – February 2016–August 2017. Data collection – Prospective based on clinical examination. Study technique – Interview, clinical and ophthalmic examination, investigation, and interventions.

**Results:** There were a total of 51 study participants; 25 were cases and 26 were controls. Male-to-female ratio in both the groups was 1.7:1. (1) Most of the study subjects, i.e. 44.4%, had hypertension for nearly 4 years. The mean duration of hypertension was 5.02 years. Males had more duration as compared to females (5.9 years vs. 3.4 years). (2) The severity of visual impairment was significantly more among cases as compared to controls. (3) Among cases, maximum, i.e. 48%, had diminution of vision for <5 years. (4) On eye examination for fundus vitreous hemorrhage and retinal hemorrhage, attenuation was significantly more among cases as compared to controls. (5) Among cases, 11.1% of females had bilateral hemianopia and another 11.1% of females had localized defect while no abnormality was detected among controls. (6) The fundus findings showed significantly more abnormalities among cases than controls ( $P = 0.0001$ ) (7) Hypertensive retinopathy and glaucomatous changes were found to be more significant among cases than controls. (8) Among cases, 43.8% of males and 44.4% of females had raised lipid profile which was significantly raised as compared to controls.

**Conclusion:** (1) The significant visual impairment was found more among hypertensive study subjects as compared to non-hypertensives. (2) The higher age, greater duration of hypertension, behavior of not taking medicine, and raised lipid profile among hypertensives were significantly associated with visual impairments.

**Key words:** Hypertension, visual impairment, hypertensive retinopathy

## INTRODUCTION

In a community-based survey carried out by the Indian Council of Medical Research during 2007-

2008, the prevalence of hypertension was found to be 17–21% in all states with marginal rural and urban difference.<sup>[1]</sup>

The presence of hypertension is associated with the presence of cardiovascular structural alterations. The principal target organs of hypertension are the heart, brain, kidneys, and eyes. Hypertension may be unknown to patients, and eye may yield the first clue to this relative asymptomatic systemic disease. In the eye, it can affect the retinal, choroidal, and optic nerve circulation.<sup>[2]</sup>

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www.surgeryijss.com

Month of Submission : 07-2019  
Month of Peer Review: 08-2019  
Month of Acceptance : 09-2019  
Month of Publishing : 10-2019

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Hypertension is the increase in blood pressure (BP) above the normal level recommended by the WHO: Systolic BP (SBP)  $\geq 140$  mmHg and/or diastolic BP (DBP)  $\geq 90$  mmHg.

Classification of BP measurements.<sup>[3]</sup>

Category	Systolic blood pressure	Diastolic blood pressure
Normal	<120	<80
Pre-hypertension	120–139	80–90
Hypertension stage 1	140–159	90–99
Hypertension stage 2	>160	>100

Fundoscopy changes in hypertension are put under the heading of:

1. Hypertensive retinopathy.
2. Hypertensive choroidopathy.
3. Hypertensive optic neuropathy.

### Hypertensive Retinopathy<sup>[4]</sup>

The fundus picture of hypertensive retinopathy is characterized by:

- a) Vasoconstriction
- b) Leakage
- c) Arteriosclerosis.

### Hypertensive Choroidopathy

The same pathology that occurs in small blood vessels due to hypertension can occur in the choroidal blood vessels. Acute hypertension of any etiology may cause fibrinoid necrosis of the choroidal arteries and arterioles with occlusion of the choriocapillaries. Clinically focal areas of opaque retinal pigment epithelium with detachment may occur. Rarely, an extensive exudative retinal detachment develops.<sup>[5]</sup>

### Hypertensive Optic Neuropathy

Hypertensive optic disc edema is influenced by the blood supply and extracellular tissue fluid pressure of the optic nerve head.<sup>[6]</sup> The disc changes range from hyperemia to papilledema. Most of these changes are reversible with BP control, but resultant secondary optic atrophy and the vessel wall change are not.

### Scheie Classification<sup>[7]</sup>

#### Hypertension

- Grade I: Slight generalized attenuation of retinal arterioles.
- Grade II: Obvious arteriolar narrowing with focal areas of attenuation.
- Grade III: Grade II plus retinal exudate, cotton-wool spots (CWSs), and hemorrhage.

#### Arteriolar sclerosis

- Grade I: Broadening of arteriolar light reflex and minimal AV crossing changes.

- Grade II: Obvious broadening of arteriolar light reflex and AV crossing changes.
- Grade III: Copper-wiring arterioles and more marked AV crossing changes.
- Grade IV: Silver-wiring arterioles and severe AV crossing changes.

### Grading of hypertensive retinopathy<sup>[8]</sup>

- Grade I consists of mild generalized arteriolar attenuation particularly of small branches with broadening of arteriolar light reflex and vein concealment.
- Grade II is characterized by more severe generalized as well as focal arteriolar constriction associated with deflection of veins at arteriovenous crossing (Salu's sign).
- Grade III is characterized by copper wiring of arterioles banking of veins on either side of the crossings (Gunn's sign) and right-angled deflection of veins. Flame-shaped hemorrhages, CWSs, and hard exudates are also present.
- Grade IV consists of all Grade III changes in addition to silver wiring of arterioles and disc swelling

### Glaucoma

The role that BP has in the genesis of glaucoma represents a clinically modifiable risk factor. The interplay between BP and intraocular pressure (IOP) determines the ocular perfusion pressure, which regulates blood flow to the optic nerve.<sup>[9]</sup>

In general, each 10 mmHg rise in SBP is associated with only a small increase in IOP (approximately 0.27 mmHg).<sup>[10-14]</sup>

### Central Retinal Artery Occlusion (CRAO)

CRAO, or a stroke of the eye, is an ocular emergency.<sup>[15]</sup> It represents end-organ ischemia and is analogous to terminal branch occlusion in cerebral stroke.

A recent single-center, randomized audit found that 64% of patients suffering from CRAO had at least one undiagnosed vascular risk factor, with hyperlipidemia, hypertension, and diabetes the most common.<sup>[16]</sup>

### Branched Retinal Vein Occlusion (RVO)

RVO is the second most common retinal vascular disease after diabetic retinopathy.

### Risk Factors

RVO has many known ophthalmic and systemic risk factors. As we know from its pathogenesis, Virchow's triad is important: Hemodynamic changes (venous stasis), degenerative changes of the vessel wall, and blood hypercoagulability.

## Age-related Macular Degeneration (AMD)

Factors such as hypertension,<sup>[17-23]</sup> previous vascular events, obesity, and diabetes have been significantly associated with early and advanced AMD in several studies. Hypertension and atherosclerosis have been hypothesized by Friedman<sup>[24]</sup> to increase the risk of AMD through the reduction of blood flow through the choroidal vasculature and lipid deposition in Bruch's membrane with a reduction of permeability leading to the upregulation of vascular endothelial-derived growth factor.

## METHODOLOGY

After the permission from the institutional human ethics committee was sought, the present case-control study was conducted in the Department of Ophthalmology, Pt. JNMHC and Dr. B.R.A.M.H, Raipur, from February 2016 to August 2017 the inclusion criteria was participants who were selected as cases when they had hypertension with sudden or gradual impairment of vision. While controls were age- and sex-matched normotensive patients presenting with visual impairment. The exclusion criteria considered were patients having diminution of vision due to cataract, diabetes, ocular inflammation, neoplasia, vitreoretinal degenerations, trauma, and secondary hypertension. The cases were age- and sex-matched for the controls, and equal ratio was taken for cases versus controls. All the participants were informed about the risk and benefit about the study in their local language. The study subjects fulfilling our inclusion and exclusion criteria and consenting to participate were included in the study. Written informed consent was taken from each of the study subjects. All the demographic and clinical information were collected in the pre-designed and pre-tested questionnaires.

### Examination Included

1. Best-corrected visual acuity was recorded using Snellen's visual acuity chart for distant vision
2. Slit-lamp biomicroscopy for anterior segment examination
3. Slit-lamp biomicroscopy with +90 D lens and indirect ophthalmoscopy for posterior segment evaluation. Pupils were dilated with tropicamide 0.5% and phenylephrine hydrochloride 10% instilled twice. The central fundus was examined with a +90 D convex lens (Volk Optical Inc., Mentor, Ohio, USA). The peripheral retina was evaluated using a binocular indirect ophthalmoscope with +20 D.
4. Optical coherence tomography, perimetry, and fundus fluorescein angiography were performed (when required).

## DISCUSSION

In the present study, there were a total of 51 study participants; 25 were cases and 26 were controls. As evident from Table 1, male-to-female ratio in both the groups was 1.7:1. A maximum number of individuals were in their 5<sup>th</sup> and 6<sup>th</sup> decades of life. The mean age among cases was  $58 \pm 11.2$  years, while in controls, it was  $51.1 \pm 10.6$  years.

Our finding is comparable with that of the Los Angeles Latino Eye Study, in which hypertension was present in 43.2% of participants. Men and women were equally hypertensive (43.9% vs. 42.6%, respectively).<sup>[25]</sup> Hypertensives in our study are more than that of the Beaver Dam Eye Study, in which 69.1% were normotensive and 30.9% were hypertensive at baseline.<sup>[26]</sup>

As evident from Table 2, 44.4% of the subjects in our study had hypertension for nearly 4 years. The mean duration of hypertension was 5.02 years. Males had

**Table 1: Age- and sex-wise distribution of cases**

Age group (years)	Cases			
	Male		Female	
	n	%	n	%
25-34	1	6.3	1	11.1
35-44	0	0.0	1	11.1
45-54	3	18.8	2	22.2
55-64	7	43.8	2	22.2
65-74	4	25.0	3	33.3
75-85	1	6.3	0	0.0
Grand total	16	100.0	9	100.0

**Table 2: Duration of hypertension and treatment taken**

Duration of hypertension (years)	Cases			
	Male		Female	
	n	%	n	%
0-2	1	6.3	3	33.3
2-4	4	25.0	3	33.3
4-6	5	31.3	1	11.1
6-8	3	18.8	0	0.0
10-12	1	6.3	2	22.2
14-16	2	12.5	0	0.0
Grand total	16	100.0	9	100.0

**Table 3: Status of treatment taken by cases**

Treatment taken	Cases			
	Male		Female	
	n	%	n	%
Yes	15	93.8	4	44.4
No	1	6.3	5	55.6
Grand total	16	100.0	9	100.0

hypertension for 5.9 years as compared to females which had hypertension for 3.4 years. In our study [Table 3], 55.6% of females were not taking antihypertensive treatment as compared to 6.3% of male hypertensive subjects, which is comparable with that of Cheung *et al.*<sup>[27]</sup> who found that tighter BP control is linked with reduction in microvascular disease and lower rates of progression to severe visual loss.

As evident from Table 4, the mean SBP in male hypertensives is  $147.1 \pm 19.1$  and in female hypertensives is  $152.8 \pm 20.3$ . Moreover, the mean DBP in male hypertensives is  $87.8 \pm 9.3$  and in female hypertensives is  $86 \pm 7.4$ . Our finding is comparable with that of Wang *et al.* who found that the frequency of generalized arteriolar narrowing was significantly higher in hypertensive individuals, especially those with elevated BP despite medication, compared with

those whose BP was controlled or those who were normotensive.<sup>[28]</sup> Chew *et al.* estimated that each 10 mm Hg increase in mean arterial pressure is associated with a 3-mm narrowing in mean retinal arteriolar diameter.<sup>[29]</sup>

Hayreh and Zimmerman found that arterial hypertension was a common risk factor for retinal arterial occlusion with systemic hypertension seen in more than 50% association of these patients.<sup>[30]</sup> Systemic hypertension is found to be the strongest independent risk factor associated with all types of RVO, especially in the older (over 50 years) patients.<sup>[29,31,32]</sup>

As evident from Table 5, 43.75% of hypertensive males and 22.2% of hypertensive females had retinal hemorrhage. 62.5% of hypertensive males and 66.7% of hypertensive females had attenuation. 37.5% of hypertensive males and 22.2% of hypertensive females had exudates. 75% of hypertensive males and 77.8% of hypertensive females had dull foveal reflex. 6.3% of hypertensive males had cherry red reflex and 12.5% of hypertensive males had edema. Our finding is consistent with that of the Beaver Dam Eye Study<sup>[12]</sup> which found arteriolar narrowing in 9.9% and arteriovenous nicking in 6.5% of subjects.

**Table 4: Systolic and diastolic blood pressures**

Mean blood pressure	Cases		Controls	
	Male	Female	Male	Female
Systolic	147.1±19.1	152.8±20.3	123.6±9.8	127.8±6.5
Diastolic	87.8±9.3	86±7.4	77.7±5.4	81.2±4.3

**Table 5: Eye examination**

Serial number	Eye examination	Cases				Controls				P
		Male		Female		Male		Female		
		n	%	n	%	n	%	n	%	
1	Fundus media									0.9 <sup>#</sup>
	Clear	6	37.5	2	22.2	15	93.8	10	100	
	hazy	10	62.5	7	77.8	0	0.0	0	0	
2	Vitreous hemorrhage	0	0	0	0.0	1	6.3	0	0	0.03*
	Retinal hemorrhage									
	Yes	7	43.75	2	22.2	3	18.8	0	0	
3	Nil	9	56.25	7	77.8	13	81.3	10	100	0.003*
	Attenuation									
	Yes	10	62.5	6	66.7	1	6.3	3	30	
4	Nil	6	37.5	3	33.3	15	93.8	7	70	0.008*
	Exudates									
	Yes	6	37.5	2	22.2	0	0.0	1	10	
5	Nil	10	62.5	7	77.8	16	100.0	9	90	1 <sup>#</sup>
	OCT									
	Normal	16	100	9	100.0	16	100.0	10	100	
6	Abnormal	0	0	0	0.0	0	0.0	0	0	0.11 <sup>#</sup>
	Fundus fluorescein angiography									
	Macular edema	2	12.5	1	11.1	0	0.0	0	0	
7	Not available	14	87.5	8	88.9	16	100.0	10	100	0.97
	Gonioscopy									
	Close	1	6.25	1	11.1	1	6.3	0	0	
8	Not available	0	0	1	11.1	0	0.0	0	0	0.97
	Open	15	93.75	7	77.8	15	93.8	10	100	
	Grand total	16	100	9	100.0	16	100.0	10	100	

<sup>#</sup>Fisher exact test, \*Significant, OCT: Optical coherence tomography

## CONCLUSION

The presence of hypertension is associated with the presence of structural alterations. It targets organs such as heart, brain, kidneys, and eyes. Hypertension may be unknown to patients, and eye may yield the first clue to this relative asymptomatic systemic disease.

It has been noted that visual impairment was found more among hypertensive study subjects as compared to non-hypertensives.

The higher age, greater duration of hypertension, behavior of not taking medicine, and raised lipid profile among hypertensives were significantly associated with visual impairments. Diseases such as CRAO, central retinal vein occlusion, Glaucoma, hypertensive retinopathy, and branch retinal vein occlusion were found to be more common in hypertensive patients.

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**How to cite this article:** Garg ML, Tyagi S. Assessing the Relationship between Hypertension and Visual Impairment. *IJSS Journal of Surgery* 2019;5(5):1-6.

**Source of Support:** Nil, **Conflict of Interest:** None declared.