



Original Article

## Prevalence of Hypertensive Retinopathy and Its Association with Blood Pressure Control Among Adults with Systemic Hypertension: A Hospital-Based Cross-Sectional Study

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### ABSTRACT

**Background:** Hypertensive retinopathy is an important ocular marker of microvascular injury in adults with systemic hypertension. Its detection provides clinically useful evidence of target-organ involvement and supports timely optimization of blood pressure control.

**Objectives:** To estimate the prevalence and grading pattern of hypertensive retinopathy among adults with systemic hypertension and to assess its association with blood pressure control.

**Methods:** This hospital-based cross-sectional observational study was conducted among 100 adults with systemic hypertension at Santhiram Medical College, Nandyal, Andhra Pradesh, India, from May 2025 to October 2025. Demographic details, hypertension duration, comorbidities, blood pressure control status, and ophthalmic findings were recorded using a structured proforma. Dilated fundus examination was performed, and hypertensive retinopathy was graded according to standard clinical criteria. Associations were assessed using chi-square test and odds ratios with 95% confidence intervals.

**Results:** The mean age of participants was  $57.4 \pm 10.6$  years, and males constituted 56.0%. The mean duration of hypertension was  $8.7 \pm 5.4$  years. Overall, 54.0% had uncontrolled blood pressure. Hypertensive retinopathy was present in 42.0% of participants. Grade I changes were most common, followed by Grade II, Grade III, and Grade IV changes. Retinopathy was significantly higher among patients with uncontrolled blood pressure than those with controlled blood pressure. Longer hypertension duration and diabetes mellitus were also significantly associated with retinal involvement.

**Conclusion:** Hypertensive retinopathy was common among adults with systemic hypertension. Poor blood pressure control showed a strong association with retinal changes, emphasizing the need for regular fundus screening and integrated physician-ophthalmologist care.

**Keywords:** Hypertensive retinopathy; Systemic hypertension; Blood pressure control; Fundus examination; Target-organ damage.

### INTRODUCTION

Systemic hypertension remains one of the leading modifiable contributors to cardiovascular, cerebrovascular, renal, and ocular morbidity worldwide. Sustained elevation of arterial blood pressure produces structural and functional damage in small vessels, and the retina offers a unique opportunity to directly visualize these microvascular changes in vivo [1,2].

Hypertensive retinopathy represents the spectrum of retinal vascular alterations caused by raised blood pressure, including generalized arteriolar narrowing, focal narrowing, arteriovenous nicking, retinal hemorrhages, cotton wool spots, hard exudates, and optic disc edema in severe disease [3,4].

The clinical importance of hypertensive retinopathy extends beyond ocular diagnosis. Retinal microvascular signs reflect systemic vascular injury and have been linked with cardiovascular morbidity, stroke risk, renal dysfunction, and mortality [5,6]. In routine clinical practice, fundus examination can therefore provide indirect evidence of target-organ damage, especially in patients with long-standing or poorly controlled hypertension. Although advanced imaging methods such as fundus photography and optical coherence tomography angiography improve objectivity, simple ophthalmoscopic evaluation remains relevant in hospital settings where resources vary [7,8].

The prevalence of hypertensive retinopathy differs widely across populations because of variations in age distribution, duration of hypertension, blood pressure control, diabetes burden, screening method, and grading criteria [9,10]. Recent hospital-based studies from South Asian and African settings have reported substantial retinopathy burden among adults with hypertension, with mild grades being more frequent than advanced sight-threatening changes [11,12]. These findings are relevant for Indian tertiary care hospitals, where hypertension is frequently detected late and follow-up adherence is inconsistent.

Blood pressure control is a central determinant of target-organ protection. Guidelines emphasize accurate measurement, regular follow-up, and sustained treatment to reduce vascular complications [1,2]. However, retinal findings are not always incorporated into routine hypertension assessment. Studying the association between blood pressure control and retinopathy in local clinical populations can help strengthen screening protocols and improve interdisciplinary referral between medicine and ophthalmology departments. The coexistence of diabetes, dyslipidaemia, chronic kidney disease, and smoking further increases the clinical need for early ocular evaluation in hypertensive adults because these factors contribute to shared endothelial dysfunction and microvascular stress.

The present study was conducted to estimate the prevalence and grading pattern of hypertensive retinopathy among adults with systemic hypertension attending Santhiram Medical College, Nandyal, Andhra Pradesh, India. The study also aimed to assess the association between hypertensive retinopathy and blood pressure control, duration of hypertension, diabetes mellitus, age, and sex.

## METHODOLOGY

**Study design and setting:** This hospital-based cross-sectional observational study was conducted at Santhiram Medical College, Nandyal, Andhra Pradesh, India, from May 2025 to October 2025. The design was selected to estimate the prevalence of hypertensive retinopathy and evaluate its association with blood pressure control at a single point of clinical assessment.

**Study population and sampling:** The study population included adults with previously diagnosed systemic hypertension who attended the ophthalmology and general medicine outpatient services during the study period. A total of 100 eligible participants were included by consecutive sampling until the required sample was completed. This sampling approach was used to reduce selection bias within the routine outpatient clinical flow.

**Eligibility criteria:** Adults aged 18 years and above with systemic hypertension diagnosed by a physician or receiving antihypertensive treatment were included. Patients who declined consent, had media opacity preventing fundus visualization, had retinal vascular occlusion, advanced diabetic retinopathy obscuring hypertensive changes, optic nerve disease unrelated to hypertension, or incomplete clinical data were excluded from analysis.

**Data collection and clinical assessment:** Data were collected using a structured study proforma. Age, sex, duration of hypertension, diabetes mellitus, dyslipidaemia, chronic kidney disease, smoking history, and antihypertensive treatment history were recorded from clinical interview and medical records. Blood pressure was measured using a calibrated sphygmomanometer after adequate rest, and the average of two readings was considered for analysis. Controlled blood pressure was defined as systolic blood pressure below 140 mmHg and diastolic blood pressure below 90 mmHg; values

equal to or above these thresholds were classified as uncontrolled blood pressure in accordance with standard hypertension practice recommendations [1,2].

**Ophthalmic evaluation:** All participants underwent anterior segment assessment followed by dilated fundus examination using direct or indirect ophthalmoscopy. Hypertensive retinopathy was graded using the Keith-Wagener-Barker clinical grading system. Grade I represented mild arteriolar narrowing; Grade II included more marked narrowing with arteriovenous crossing changes; Grade III included hemorrhages, exudates, or cotton wool spots; and Grade IV included Grade III changes with optic disc edema [3,7,8].

**Statistical analysis:** Data were entered into a spreadsheet and analysed using standard statistical methods. Continuous variables were summarized as mean and standard deviation. Categorical variables were expressed as frequencies and percentages. Associations between hypertensive retinopathy and clinical variables were assessed using the chi-square test. Odds ratios with 95% confidence intervals were calculated for selected risk factors. A p-value less than 0.05 was considered statistically significant.

**Ethical considerations:** Institutional Ethics Committee approval was obtained from Santhiram Medical College, Nandyal, Andhra Pradesh, India, before initiation of the study. Written informed consent was obtained from all participants. Confidentiality was maintained by anonymizing clinical data during analysis and reporting.

## RESULTS

A total of 100 adults with systemic hypertension were included in the final analysis. The mean age of the study participants was  $57.4 \pm 10.6$  years. Most participants were in the 50–59 years age group, followed by 60–69 years. Males constituted 56 patients (56.0%), while females accounted for 44 patients (44.0%). The mean duration of systemic hypertension was  $8.7 \pm 5.4$  years. Diabetes mellitus was present in 34 patients (34.0%), and dyslipidaemia was documented in 29 patients (29.0%). Overall, 54 patients (54.0%) had uncontrolled blood pressure at the time of evaluation (Table 1).

**Table 1. Baseline characteristics of study participants (n=100)**

Variable	Frequency	Percentage
Age group		
<50 years	20	20.0
50–59 years	34	34.0
60–69 years	30	30.0
≥70 years	16	16.0
Sex		
Male	56	56.0
Female	44	44.0
Duration of hypertension		
<5 years	28	28.0
5–10 years	42	42.0
>10 years	30	30.0
Comorbidities		
Diabetes mellitus	34	34.0
Dyslipidaemia	29	29.0
Chronic kidney disease	8	8.0
Smoking history	26	26.0
Blood pressure control status		
Controlled blood pressure	46	46.0
Uncontrolled blood pressure	54	54.0

Hypertensive retinopathy was observed in 42 patients, giving an overall prevalence of 42.0%. Grade I hypertensive retinopathy was the most common finding, noted in 22 patients (22.0%), followed by Grade II in 14 patients (14.0%). More advanced retinal changes were less frequent, with Grade III changes seen in 5 patients (5.0%) and Grade IV changes in 1 patient (1.0%) (Table 2).

**Table 2. Prevalence and grading of hypertensive retinopathy (n=100)**

Fundus finding	Frequency	Percentage
No hypertensive retinopathy	58	58.0
Grade I hypertensive retinopathy	22	22.0
Grade II hypertensive retinopathy	14	14.0
Grade III hypertensive retinopathy	5	5.0
Grade IV hypertensive retinopathy	1	1.0
Total hypertensive retinopathy	42	42.0

The prevalence of hypertensive retinopathy was higher among patients with uncontrolled blood pressure compared with those with controlled blood pressure. Among patients with controlled blood pressure, 10 of 46 patients (21.7%) had hypertensive retinopathy. In contrast, 32 of 54 patients (59.3%) with uncontrolled blood pressure showed retinal changes. This association was statistically significant ( $p < 0.001$ ) (Table 3).

**Table 3. Association between blood pressure control and hypertensive retinopathy**

Blood pressure control status	Retinopathy present	Retinopathy absent	Total	Percentage with retinopathy	p-value
Controlled BP	10	36	46	21.7	
Uncontrolled BP	32	22	54	59.3	<0.001
Total	42	58	100	42.0	

Hypertensive retinopathy was also more frequent among patients with longer duration of hypertension. Retinopathy was present in 6 patients (21.4%) with hypertension duration <5 years, 17 patients (40.5%) with duration of 5–10 years, and 19 patients (63.3%) with duration >10 years. A significant increasing trend was observed with longer disease duration ( $p = 0.006$ ) (Table 4).

**Table 4. Association between duration of hypertension and hypertensive retinopathy**

Duration of hypertension	Retinopathy present	Retinopathy absent	Total	Percentage with retinopathy	p-value
<5 years	6	22	28	21.4	
5–10 years	17	25	42	40.5	0.006
>10 years	19	11	30	63.3	
Total	42	58	100	42.0	

On bivariate analysis, uncontrolled blood pressure, longer duration of hypertension, and presence of diabetes mellitus were significantly associated with hypertensive retinopathy. Patients with uncontrolled blood pressure had 5.24 times higher odds of developing hypertensive retinopathy compared with patients with controlled blood pressure. Duration of hypertension >10 years was also strongly associated with retinal involvement (Table 5).

**Table 5. Factors associated with hypertensive retinopathy**

Variable	Retinopathy present n/N (%)	Odds ratio	95% CI	p-value
Uncontrolled BP	32/54 (59.3)	5.24	2.16–12.70	<0.001
Hypertension duration >10 years	19/30 (63.3)	3.53	1.44–8.63	0.008
Diabetes mellitus	20/34 (58.8)	2.86	1.22–6.71	0.019
Age ≥60 years	23/46 (50.0)	1.84	0.82–4.12	0.135
Male sex	25/56 (44.6)	1.28	0.57–2.86	0.546

Overall, the findings show that hypertensive retinopathy was common among adults with systemic hypertension, affecting more than two-fifths of the study population. Poor blood pressure control showed a strong and statistically significant association with retinal involvement.

## DISCUSSION

The present study found that hypertensive retinopathy was present in 42.0% of adults with systemic hypertension. Most retinal changes belonged to Grade I and Grade II categories, while Grade III and Grade IV changes were less frequent. This pattern suggests that mild and moderate microvascular retinal changes form the major burden in routine outpatient

hypertension populations, whereas malignant or severe retinopathy is comparatively uncommon. Similar observations have been reported in hospital-based studies where early arteriolar changes constituted the largest proportion of hypertensive retinal involvement [11,12].

Poor blood pressure control showed a strong association with hypertensive retinopathy in this study. Retinopathy was observed in 59.3% of patients with uncontrolled blood pressure compared with 21.7% of those with controlled blood pressure. This finding supports the biological relationship between sustained pressure load and retinal microvascular injury. Elevated blood pressure initially produces vasoconstriction and increased arteriolar tone; persistent elevation leads to arteriolar wall thickening, narrowing, leakage, and ischemic signs [3,4]. The significantly higher odds of retinopathy among uncontrolled hypertensive patients highlight the clinical value of fundus examination as an accessible marker of vascular control.

Duration of hypertension was another important determinant. Retinopathy prevalence increased from 21.4% among patients with hypertension duration below five years to 63.3% among those with duration above ten years. Long-standing hypertension permits cumulative endothelial injury and arteriosclerotic remodeling, which explains the graded rise in retinal involvement. Previous literature has also reported duration of hypertension as a relevant predictor of hypertensive retinopathy and target-organ damage [5,9,12].

Diabetes mellitus was significantly associated with hypertensive retinopathy in bivariate analysis. Coexisting diabetes and hypertension accelerate microvascular dysfunction through endothelial damage, capillary leakage, oxidative stress, and altered autoregulation. Although the present analysis focused on hypertensive retinopathy, the coexistence of diabetes emphasizes the need for careful fundus interpretation and regular follow-up in patients with multiple cardiometabolic risk factors. Dyslipidaemia and chronic kidney disease were also recorded as comorbidities, but the present sample size restricted detailed multivariable evaluation.

Age and male sex were not statistically significant in this study, although retinopathy proportions were numerically higher among older adults and males. This result indicates that blood pressure control and disease duration were more influential markers than demographic variables in the present cohort. Larger studies using standardized retinal photography and multivariable modelling can refine the independent contribution of each risk factor.

The findings support routine retinal screening for adults with systemic hypertension, particularly those with uncontrolled blood pressure, longer disease duration, and diabetes mellitus. Integration of medicine and ophthalmology services can improve early detection of microvascular damage and guide intensification of systemic management.

### **Limitations**

This study had certain limitations. The sample size was limited to 100 participants from a single tertiary care hospital, restricting wider generalization. Consecutive sampling was used, so community prevalence was not estimated. Fundus grading was based on clinical examination rather than standardized retinal photography. Multivariable adjustment was limited by the available sample size. Findings should be interpreted within this hospital-based context.

### **CONCLUSION**

Hypertensive retinopathy was identified in more than two-fifths of adults with systemic hypertension in this hospital-based study. Mild retinal changes were the predominant pattern, but advanced grades were also observed in a small proportion. Uncontrolled blood pressure showed a strong and statistically significant association with retinopathy, and longer duration of hypertension further increased retinal involvement. Diabetes mellitus also contributed to higher retinal risk. These findings emphasize the need for regular fundus evaluation among hypertensive adults, especially those with poor blood pressure control or long-standing disease. Coordinated care between physicians and ophthalmologists can support early detection of target-organ damage and timely strengthening of systemic hypertension management.

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