

An Observational Study on Hypertensive Fundus Changes in Pregnancy-Induced Hypertension at Tertiary Care Centre

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Abstract

Background: Pregnancy-induced hypertension (PIH) is associated with systemic vascular changes that may involve the retina. Fundus examination can provide a non-invasive means of assessing the severity of hypertensive disease and its systemic vascular effects. This study evaluated the pattern of fundus changes in women with PIH and their association with hypertension severity and proteinuria.

Material and Methods: This prospective observational study included 120 pregnant women with PIH beyond 28 weeks of gestation at Sir T. Hospital and Government Medical College, Bhavnagar. Participants underwent detailed ophthalmic examination, including dilated fundus evaluation. Hypertensive retinal changes were graded using the Keith-Wagener-Barker classification. Fundus findings were correlated with PIH severity, blood pressure, and proteinuria grade.

Results: Grade 1 hypertensive retinopathy (HTNR) was the most common finding (35.8%), followed by Grade 2 (17.5%), Grade 3 (10.0%), and Grade 4 (6.7%); 26.7% had a normal fundus. Macular edema and retinal detachment occurred in 1.7% each. Fundus findings were significantly associated with PIH severity ($\chi^2=34.716$, $p=0.0005$) and proteinuria grade ($\chi^2=43.227$, $p<0.0001$). Grade 4 HTNR, macular edema, and retinal detachment occurred exclusively in women with eclampsia. Mean systolic blood pressure increased significantly across PIH severity categories for several fundus groups ($p<0.0001$).

Conclusion: Fundus abnormalities were frequent in PIH and were significantly associated with disease severity and proteinuria, supporting the role of ophthalmic evaluation in identifying severe hypertensive disease.

Keywords: Pregnancy-Induced Hypertension; Preeclampsia; Eclampsia; Hypertensive Retinopathy; Fundus Changes; Proteinuria.

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Introduction

Hypertensive disorders of pregnancy, including gestational hypertension, preeclampsia, and eclampsia, remain important causes of maternal and perinatal morbidity and mortality worldwide. These conditions are characterized by widespread endothelial dysfunction, vasospasm, and increased vascular permeability, resulting in multiorgan involvement affecting the kidneys, liver, brain, and eyes [1,2]. Pregnancy-induced hypertension (PIH) usually develops after 20 weeks of gestation and may progress to severe complications if not identified and managed promptly [1].

The retinal circulation provides a unique opportunity to directly visualize microvascular

changes associated with systemic hypertension. Ocular manifestations of PIH include generalized arteriolar narrowing, arteriovenous crossing changes, retinal hemorrhages, cotton-wool spots, retinal edema, serous retinal detachment, and, occasionally, optic disc edema [2,3]. Visual symptoms such as blurred vision, photopsia, scotoma, and diplopia may occur, particularly in severe preeclampsia and eclampsia [4].

Recent advances in retinal imaging have also demonstrated subclinical alterations in retinal and choroidal microcirculation in women with preeclampsia, indicating that ocular changes may precede overt fundus abnormalities [5]. Several

studies have shown that the severity of retinal changes correlates with the degree of hypertension and proteinuria, reflecting the extent of systemic vascular involvement [2,6]. Fundus examination is therefore considered a simple, non-invasive, and valuable tool for assessing disease severity and identifying women at increased risk of adverse maternal outcomes. Despite the clinical importance of ocular manifestations in PIH, data from Indian populations remain limited.

The present study was undertaken to evaluate the pattern of fundus changes in women with pregnancy-induced hypertension and to determine their association with the severity of hypertension and the degree of proteinuria in a tertiary care setting.

Materials and Methods

Study Design and Setting: This was a hospital-based prospective observational study conducted jointly by the Departments of Obstetrics and Gynaecology and Ophthalmology at Sir T. Hospital and Government Medical College, Bhavnagar, over a period of 12 months. The study was designed to evaluate the pattern of fundus changes in women with PIH and to determine their association with the severity of hypertension and the degree of proteinuria.

Study Population: A total of 120 pregnant women diagnosed with pregnancy-induced hypertension were enrolled from the antenatal outpatient and inpatient services of the Department of Obstetrics and Gynaecology and referred to the Department of Ophthalmology for detailed fundus evaluation.

Inclusion criteria: Pregnant women beyond 28 weeks of gestation presenting with new-onset hypertension accompanied by proteinuria were included in the study.

Exclusion criteria: Women with pre-existing chronic hypertension, diabetes mellitus, or known renal disease prior to pregnancy were excluded, in order to isolate fundus changes attributable specifically to pregnancy-induced hypertension rather than to a pre-existing systemic condition.

Ethical Considerations: Institutional Ethics Committee approval was obtained from the Government Medical College, Bhavnagar, prior to initiation of the study. Written informed consent was obtained from every participant after explaining the purpose and procedures of the study in a language and manner understood by them.

Data Collection and Examination Procedure: After enrolment, a detailed obstetric history was recorded, along with relevant biochemical and haematological investigations, including blood pressure measurement and quantification of urinary protein. Each patient subsequently underwent a

comprehensive ophthalmic evaluation, comprising visual acuity assessment using a Snellen chart, anterior segment examination, and direct ophthalmoscopy. Pupils were dilated using standard mydriatic agents, following which detailed fundus examination was carried out using both direct and indirect ophthalmoscopy; fundus photographs were captured in ambulatory patients where feasible.

Hypertensive retinal changes identified on fundus examination were graded using the Keith-Wagener-Barker classification system [7]. Severity of pregnancy-induced hypertension was categorized as mild preeclampsia, severe preeclampsia, or eclampsia, and proteinuria was graded semi-quantitatively (1+, 2+, 3+) based on dipstick urinalysis, in accordance with standard obstetric criteria. Fundus findings were then correlated with the severity of hypertension and grade of proteinuria for each patient.

Statistical Analysis: Data were entered and compiled in a Microsoft Excel spreadsheet and analyzed using SPSS software, version 26.0 (IBM Corp., Armonk, NY). Qualitative variables were expressed as frequencies and percentages, while quantitative variables were expressed as mean $\pm$ standard deviation. The Chi-square test was applied to assess associations between categorical variables, and analysis of variance was used for comparison of continuous variables across groups where applicable. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 120 pregnant women with pregnancy-induced hypertension (PIH) were enrolled. Most participants were aged 21–30 years (65.8%) and were primigravida (70.8%). The mean systolic and diastolic blood pressures were 170.08 ± 15.69 mmHg and 103.83 ± 7.91 mmHg, respectively. Severe preeclampsia was present in 45.8% of participants, followed by eclampsia (40.0%) and mild preeclampsia (14.2%) (Table 1).

Grade 1 hypertensive retinopathy (HTNR) was the most common fundus abnormality (35.8%), followed by Grade 2 (17.5%), Grade 3 (10.0%), and Grade 4 HTNR (6.7%). Macular edema and retinal detachment were each observed in 1.7% of participants, while 26.7% had a normal fundus. Proteinuria was graded as 1+ in 56.7%, 2+ in 21.7%, and 3+ in 21.7%. Most participants were asymptomatic (84.2%); blurred vision was reported by 4.2% and headache by 3.3%. CSCR was documented in 6.7% of participants. Visual acuity was FC 19–20 ft in 88.34% (Table 2).

Fundus findings were significantly associated with PIH severity ($\chi^2 = 34.716$, $p = 0.0005$). Grade 3 HTNR was observed only in severe preeclampsia

and eclampsia, while Grade 4 HTNR, macular edema, and retinal detachment occurred exclusively in women with eclampsia. A normal fundus was more frequent in mild preeclampsia (47.06%) and progressively less common with increasing disease severity (Table 3).

Mean systolic blood pressure increased significantly across PIH severity categories for Grade 1, Grade 2, Grade 3 HTNR, and normal fundus findings ($p < 0.0001$ for each). Diastolic blood pressure also showed significant variation for Grade 1 and Grade 2 HTNR and normal fundus findings, whereas the difference for Grade 3 HTNR was not significant (Table 4).

A significant association was also observed between hypertensive retinopathy grade and proteinuria ($\chi^2 = 43.227$, $p < 0.0001$). Grade 1 HTNR predominated among women with 1+ proteinuria, whereas Grade 4 HTNR, macular

edema, and retinal detachment were more frequent among those with 3+ proteinuria. Normal fundus findings decreased progressively with increasing proteinuria grade (Table 5).

For Grade 1 HTNR, mean systolic blood pressure increased significantly from 163.47 ± 12.32 mmHg in women with 1+ proteinuria to 181.67 ± 11.70 mmHg in those with 3+ proteinuria ($p < 0.0001$). Significant variation in diastolic blood pressure across proteinuria grades was observed only for Grade 2 HTNR ($p = 0.0330$). Other comparisons were not statistically significant (Table 6).

Compared with published studies, the prevalence and distribution of hypertensive retinopathy in the present study were broadly comparable. Grade 1 HTNR occurred in 35.8%, Grade 2 in 17.5%, and Grade 3 in 10.0%. Exudative retinal detachment was observed in 1.7%, while macular edema occurred in 1.7% of participants (Table 7).

Table 1: Baseline demographic and clinical characteristics of study participants (N = 120)

Variable	Category	Value
Age (years)	≤ 20	15 (12.5%)
	21–30	79 (65.8%)
	31–40	25 (20.8%)
	> 40	1 (0.8%)
Gravidity	Primigravida	85 (70.8%)
	Multigravida	35 (29.2%)
Blood pressure	Systolic BP (mmHg), mean $\pm$ SD	170.08 ± 15.69
	Diastolic BP (mmHg), mean $\pm$ SD	103.83 ± 7.91
Severity of PIH	Mild preeclampsia	17 (14.2%)
	Severe preeclampsia	55 (45.8%)
	Eclampsia	48 (40.0%)

Table 2: Distribution of fundus findings, proteinuria grade, presenting symptoms, and visual acuity (N = 120)

Domain	Category	Value
Fundus finding	Grade 1 HTNR	43 (35.8%)
	Grade 2 HTNR	21 (17.5%)
	Grade 3 HTNR	12 (10.0%)
	Grade 4 HTNR	8 (6.7%)
	Macular edema	2 (1.7%)
	Retinal detachment	2 (1.7%)
	Normal fundus	32 (26.7%)
Proteinuria grade	1+	68 (56.7%)
	2+	26 (21.7%)
	3+	26 (21.7%)
Presenting symptom	Blurred vision	5 (4.2%)
	Central serous chorioretinopathy with blurred vision	2 (1.7%)
	Central serous chorioretinopathy	8 (6.7%)
	Headache	4 (3.3%)
	No symptoms	101 (84.2%)
Visual acuity	FC 19–20 ft	107 (88.34%)
	FC 9–10 ft	1 (0.84%)
	FC 5–6 ft	1 (0.84%)
	FC 2–3 ft	1 (0.84%)
	PL+, PR inaccurate	1 (0.84%)
	Not cooperative for testing	9 (7.50%)

Table 3: Association between grade of hypertensive retinopathy and severity of PIH

Fundus finding	Mild PE	Severe PE	Eclampsia	Total	P Value
Grade 1 HTNR	7 (41.18%)	23 (41.82%)	13 (27.09%)	43	$\chi^2 = 34.716$ p = 0.0005
Grade 2 HTNR	2 (11.77%)	6 (10.91%)	13 (27.09%)	21	
Grade 3 HTNR	0 (0%)	7 (12.73%)	5 (10.42%)	12	
Grade 4 HTNR	0 (0%)	0 (0%)	8 (16.67%)	8	
Macular edema	0 (0%)	0 (0%)	2 (4.17%)	2	
Retinal detachment	0 (0%)	0 (0%)	2 (4.17%)	2	
Normal fundus	8 (47.06%)	19 (34.55%)	5 (10.42%)	32	
Total	17	55	48	120	

Table 4: Mean systolic and diastolic blood pressure across fundus findings, stratified by severity of PIH

Fundus finding	SBP Mild PE	SBP Severe PE	SBP Eclampsia	p (SBP)	DBP Mild PE	DBP Severe PE	DBP Eclampsia	p (DBP)
Grade 1 HTNR	147.15±4.88	166.96±4.71	182.31±6.00	<0.0001	98.58±3.78	102.18±6.00	106.93±7.52	0.0170
Grade 2 HTNR	145.00±7.08	161.67±4.09	181.54±5.55	<0.0001	100.00±0.00	100.00±6.33	107.70±6.00	0.0320
Grade 3 HTNR	—	165.72±5.35	188.00±10.96	<0.0001	—	102.86±4.88	106.00±8.95	0.4480
Grade 4 HTNR	—	—	192.50±8.87	—	—	—	110.00±7.56	—
Macular edema	—	—	205.00±21.22	—	—	—	125.00±21.22	—
Retinal detachment	—	—	190.00±0.00	—	—	—	110.00±0.00	—
Normal fundus	143.75±5.18	161.58±3.75	180.00±0.00	<0.0001	96.25±5.18	101.06±6.58	108.00±8.37	<0.0001

Table 5: Association between grade of hypertensive retinopathy and grade of proteinuria

Fundus finding	1+	2+	3+	Total	p Value
Grade 1 HTNR	26 (38.24%)	11 (42.31%)	6 (23.08%)	43	$\chi^2 = 43.227$, p < 0.0001
Grade 2 HTNR	12 (17.65%)	3 (11.54%)	6 (23.08%)	21	
Grade 3 HTNR	3 (4.42%)	6 (23.08%)	3 (11.54%)	12	
Grade 4 HTNR	0 (0%)	2 (7.70%)	6 (23.08%)	8	
Macular edema	0 (0%)	0 (0%)	2 (7.70%)	2	
Retinal detachment	0 (0%)	0 (0%)	2 (7.70%)	2	
Normal fundus	27 (39.71%)	4 (15.39%)	1 (3.85%)	32	
Total	68	26	26	120	

Table 6: Mean systolic and diastolic blood pressure across fundus findings, stratified by proteinuria grade

Fundus finding	SBP 1+	SBP 2+	SBP 3+	p (SBP)	DBP 1+	DBP 2+	DBP 3+	p (DBP)
Grade 1 HTNR	163.47±12.32	172.73±6.47	181.67±11.70	<0.0001	103.08±7.89	100.91±3.02	106.67±5.17	0.2470
Grade 2 HTNR	167.50±14.23	173.34±11.55	181.67±9.84	0.1160	101.67±5.78	106.67±5.78	110.00±6.33	0.0330
Grade 3 HTNR	170.00±10.00	170.00±8.95	190.00±17.33	0.0810	100.00±0.00	103.34±5.17	110.00±10.00	0.1740
Grade 4 HTNR	—	185.00±7.08	195.00±8.37	0.1840	—	115.00±7.08	108.34±7.53	0.3150
Macular edema	—	—	205.00±21.22	—	—	—	125.00±21.22	—
Retinal detachment	—	—	190.00±0.00	—	—	—	110.00±0.00	—
Normal fundus	160.38±11.26	152.50±15.00	180.00±0.00	0.1190	101.49±7.19	95.00±5.78	110.00±0.00	0.1190

Table 7: Comparison of hypertensive retinopathy prevalence and grading with published studies

Finding	Present study	S.C. Reddy et al.	Tadin et al.	Mithila R. et al.
Hypertensive retinopathy (overall)	71.67%	59%	45%	50%
Exudative retinal detachment	1.7%	—	—	2%
Macular edema	1.7%	—	—	—
Grade 1 HTNR	35.8%	39.3%	25%	34%
Grade 2 HTNR	17.5%	6.4%	15%	13%
Grade 3 HTNR	10.0%	—	5%	3%

Discussion

The present study demonstrated that hypertensive fundus changes were frequent among women with pregnancy-induced hypertension, with 71.7% showing some form of retinal abnormality. Grade 1 hypertensive retinopathy was the predominant finding, followed by Grades 2 and 3, while Grade 4 changes, macular edema, and retinal detachment were less frequent. This pattern is consistent with the concept that the retinal circulation reflects systemic microvascular involvement in hypertensive disorders of pregnancy. Recent evidence indicates that retinal abnormalities are common in preeclampsia, although their frequency varies according to disease severity, timing of examination, and imaging methodology. A 2026 systematic review also emphasized substantial heterogeneity among studies assessing retinal involvement in preeclampsia [8].

A significant association was observed between the severity of PIH and the grade of hypertensive retinopathy ($\chi^2=34.716$, $p=0.0005$). The proportion of advanced retinal changes increased with disease severity, and Grade 4 retinopathy, macular edema, and retinal detachment were confined to women with eclampsia. These findings support the relationship between severe maternal hypertension and retinal vascular injury. Similarly, Wali et al. reported that the magnitude and severity of hypertensive retinopathy increased significantly with increasing severity of hypertensive disorders of pregnancy [9].

The progressive increase in systolic blood pressure across PIH severity categories provides further support for this association. In the present study, mean systolic blood pressure increased significantly across mild preeclampsia, severe preeclampsia, and eclampsia for Grade 1, Grade 2, Grade 3, and normal fundus groups. This finding is clinically relevant because severe elevations in blood pressure can produce marked retinal arteriolar vasoconstriction and breakdown of the blood-retinal barrier. Recent OCTA research has demonstrated measurable alterations in retinal microvascular parameters in preeclampsia and has suggested that these changes may occur even before clinically apparent hypertensive retinopathy [10].

Proteinuria was also significantly associated with the severity of retinal involvement. Normal fundus findings became progressively less frequent with increasing proteinuria, whereas severe retinal abnormalities were concentrated among women with higher-grade proteinuria. This observation is consistent with the multisystem nature of preeclampsia, in which renal and vascular involvement may occur concurrently. However, the relationship was not uniform for every blood-pressure comparison, indicating that proteinuria and retinal manifestations may represent related but non-identical aspects of disease severity.

The present study also identified relatively few visual symptoms despite the high prevalence of fundus abnormalities. Most participants were asymptomatic, while only a small proportion reported blurred vision or headache. This finding suggests that clinically significant retinal changes may be present without prominent ocular complaints. Wali et al. similarly reported ocular symptoms among women with hypertensive disorders of pregnancy but found that retinal changes could occur as part of the broader systemic disease process [10].

The occurrence of macular edema and retinal detachment exclusively in women with eclampsia is noteworthy. These severe ocular manifestations are consistent with extensive vascular and choroidal dysfunction associated with severe hypertensive disease. Contemporary retinal studies have demonstrated reduced retinal capillary density and altered choroidal parameters in preeclampsia, supporting the biological basis for more severe ocular manifestations in advanced disease [9].

The clinical importance of retinal assessment is further supported by recent work demonstrating that retinal imaging may have predictive as well as descriptive value. Wu et al. developed a retinal-image-based prediction model in 1812 pregnancies and reported an area under the curve of 0.87 for prediction of preeclampsia, increasing to 0.91 for preterm preeclampsia when using the combined model [5]. These findings suggest that retinal vascular features may eventually complement conventional maternal risk factors and blood-pressure assessment for risk stratification.

The potential role of retinal imaging extends beyond conventional funduscopy. A recent clinical

perspective highlighted the retina as an accessible window into maternal systemic microcirculation and described OCT and OCTA as promising methods for quantifying retinal vascular density and related parameters in preeclampsia. However, the authors emphasized that existing evidence remains heterogeneous and is predominantly derived from cross-sectional studies [11,12]. Thus, while the present findings support routine fundus assessment in women with significant PIH, prospective studies using standardized retinal imaging and longitudinal maternal and fetal outcomes are required before retinal parameters can be incorporated into formal risk-prediction algorithms.

Conclusion

Hypertensive fundus changes were common among women with pregnancy-induced hypertension and showed a significant association with both the severity of hypertension and degree of proteinuria. Increasing disease severity was accompanied by a greater frequency of advanced retinal changes, including Grade 3 and Grade 4 hypertensive retinopathy, macular edema, and retinal detachment. These findings highlight the value of routine fundus evaluation in women with PIH, particularly in those with severe hypertension or marked proteinuria, as retinal examination may provide a useful indicator of systemic disease severity and help identify women requiring closer maternal and ophthalmic surveillance.

References

1. Cífková R. Hypertension in Pregnancy: A Diagnostic and Therapeutic Overview. *High Blood Press Cardiovasc Prev.* 2023 Jul;30(4): 289-303. doi: 10.1007/s40292-023-00582-5.
2. Soullane S, Rhéaume MA, Auger N. Preeclampsia and the Retina. *Curr Hypertens Rep.* 2024 Apr;26(4):169-174. doi: 10.1007/s11906-023-01290-0.
3. Rashidian P, Safari R, Salehi SA, Karami S. Retinal changes in preeclampsia. *Med Hypothesis Discov Innov Optom.* 2024;5(2):76-84. doi:10.51329/mehdiptomet ry201.
4. Lee H, Yang SW, Kim Y, Shin H, Seo YS, Oh MJ, et al. Risk of retinopathy in women with pregnancy-induced hypertension: a nationwide population-based cohort study of 9-year follow-up after delivery. *Am J Obstet Gynecol MFM.* 2023 Jul;5(7):100985. doi: 10.1016/j.ajogmf.2023.100985.
5. Tang C, Pan S, Zeng X, Fu X, Deng J, Shi K. Diminished retinal microcirculation in mild preeclampsia without obvious retinopathy in high-altitude native Tibetans by OCTA. *Photodiagnosis Photodyn Ther.* 2024 Dec;50:104396. doi: 10.1016/j.pdpdt.2024.104396.
6. Lee YH, Kim DY, Bae JG, Kim YC, et al. Relationship between proteinuria and changes in antepartum and postpartum choroidal thickness in patients with pre-eclampsia. *Sci Rep.* 2024;14:12672. doi:10.1038/s41598-024-63359-3.
7. Aissopou EK, Papathanassiou M, Nasothimiou EG, Konstantonis GD, Tentolouris N, Theodossiadis PG, et al. The Keith-Wagener-Barker and Mitchell-Wong grading systems for hypertensive retinopathy: association with target organ damage in individuals below 55 years. *J Hypertens.* 2015 Nov;33(11):2303-9. doi: 10.1097/HJH.0000000000000702.
8. Kitmiridou D, Mitrogiannis I, Charakida M, Nicolaides KH. Retinal imaging in pre-eclamptic pregnancy: systematic review. *Ultrasound Obstet Gynecol.* 2026 Apr;67(4):435-443. doi: 10.1002/uog.70162.
9. Wali K, Mudanur SR, Kuruvila MM, et al. Retinal microvascular characteristics and outcomes in hypertensive disorders of pregnancy. *Cureus.* 2024;16(8):e67043. doi:10.7759/cureus.67043.
10. Erkan Pota Ç, Doğan ME, Alkan Bülbül G, Sanhal CY, Pota A. Optical coherence tomography angiography assessment of retinochoroidal microcirculation differences in preeclampsia. *Photodiagnosis Photodyn Ther.* 2024 Apr;46:104004. doi: 10.1016/j.pdpdt.2024.104004.
11. Wu Y, Shen L, Zhao L, Lin X, Xu M, Tu Z, et al. Noninvasive early prediction of preeclampsia in pregnancy using retinal vascular features. *NPJ Digit Med.* 2025 Apr 5;8(1):188. doi: 10.1038/s41746-025-01582-6.
12. Saccone G, Matarazzo F, Motta M, Rinaldi M, Guida M, Costagliola C. The eye as a window to placental health: retinal imaging as a novel biomarker for preeclampsia and fetal growth restriction. *Am J Obstet Gynecol MFM.* 2026 Feb;8(2):101855. doi: 10.1016/j.ajogmf.2025.101855.