



STUDY OF FUNDUS CHANGES IN PREGNANCY-INDUCED HYPERTENSION (PIH)

Ophthalmology

Dr. Harshwardhan Bhongade

Junior Resident Department of Ophthalmology, Dr. D.Y. Patil Medical College Hospital and Research Institute, Kolhapur, Maharashtra, India. D.Y Patil Education Society Deemed to be University Kolhapur,

Dr. Milind Sabnis*

HOD Department of Ophthalmology' Dr. D.Y. Patil Medical College Hospital and Research Institute, Kolhapur, Maharashtra, India. D.Y Patil Education Society Deemed to be University Kolhapur*Corresponding Author

ABSTRACT

Background: Pregnancy-induced hypertension (PIH) is a major cause of maternal and perinatal morbidity and mortality. Retinal vascular changes in PIH reflect systemic vascular involvement and may provide valuable information regarding disease severity and prognosis. This study aimed to evaluate fundus changes in patients with PIH and correlate them with maternal and foetal outcomes. **Methods:** A cross-sectional observational study was conducted in the Departments of Ophthalmology and Gynaecology at Dr. D. Y. Patil Medical College, Hospital and Research Institute, Kolhapur, over 18 months. Sixty-five pregnant women diagnosed with PIH and having gestational age >20 weeks were enrolled. Patients with pre-existing hypertension or diabetes mellitus were excluded. Detailed ophthalmic evaluation, including dilated fundus examination using direct and indirect ophthalmoscopy, was performed. Retinal findings were graded using the Shukla-Prasad classification and correlated with blood pressure, proteinuria, PIH severity, maternal outcomes, and foetal outcomes. **Results:** Fundus abnormalities were observed in 76.9% of patients. Generalized arteriolar narrowing was the most common finding, followed by haemorrhages, exudates, cotton wool spots, retinal oedema, and papilledema. Fundus grading showed significant associations with systolic blood pressure ($p=0.044$), urine albumin levels, medication intensity ($p=0.003$), and severity of PIH ($p=0.019$). Advanced retinal grades were associated with increased maternal morbidity, adverse foetal outcomes, foetal compromise, and greater need for emergency obstetric intervention. Retinal involvement increased progressively with worsening PIH severity. **Conclusion:** Fundus examination is a simple, non-invasive, and cost-effective tool for assessing disease severity in PIH. Retinal changes correlate significantly with systemic involvement, maternal morbidity, and adverse foetal outcomes, supporting the routine incorporation of ophthalmic evaluation in the management of patients with pregnancy-induced hypertension.

KEYWORDS

Pregnancy-induced Hypertension, Preeclampsia, Fundus Changes, Hypertensive Retinopathy, Ophthalmoscopy, Maternal Outcome, Foetal Outcome.

INTRODUCTION

Pregnancy-induced hypertension (PIH) represents one of the most common and serious medical complications of pregnancy and continues to be a major contributor to maternal and perinatal morbidity and mortality worldwide. It is characterized by the development of new-onset hypertension after 20 weeks of gestation, with or without associated proteinuria and systemic manifestations. The spectrum of hypertensive disorders in pregnancy ranges from gestational hypertension to preeclampsia and eclampsia, each associated with varying degrees of systemic involvement. Despite advances in antenatal care, PIH remains a significant public health concern, particularly in developing countries where late presentation and limited resources contribute to poor outcomes. The multisystem nature of PIH affects the cardiovascular, renal, neurological, hepatic, haematological, and visual systems, making early detection and appropriate monitoring crucial for optimal maternal and foetal outcomes. Among the various organs involved, the eye provides a unique opportunity to directly visualize the effects of systemic hypertension on the microvasculature, thereby serving as a window to the severity and progression of the disease. Retinal examination offers a non-invasive method to assess vascular changes that closely parallel those occurring in other vital organs such as the placenta and kidneys, highlighting the importance of ophthalmic evaluation in patients with PIH [1,2].

The pathophysiology of PIH is complex and multifactorial, involving abnormal placentation, endothelial dysfunction, generalized vasospasm, increased vascular permeability, and activation of inflammatory pathways. These changes lead to reduced organ perfusion and ischemia, which are reflected in the retinal and choroidal circulation. The retinal vasculature, being an end-arterial system with autoregulatory mechanisms, is particularly sensitive to changes in blood pressure and vascular tone. In PIH, sustained vasospasm results in narrowing of retinal arterioles, impaired blood flow, and disruption of the blood-retinal barrier. This may subsequently lead to retinal haemorrhages, cotton wool spots, hard exudates, and in severe cases, optic disc oedema and serous retinal detachment. Choroidal ischemia, resulting from acute hypertension, can also manifest as focal retinal pigment epithelial changes and exudative retinal detachments. These

ocular findings not only indicate local vascular compromise but also mirror the severity of systemic endothelial damage, making fundus changes an important marker of disease severity in PIH [3,4].

Fundus changes in PIH and their prevalence has been reported to vary widely depending on the severity of hypertension, duration of disease, and timing of ophthalmic examination. Mild forms of PIH may show minimal retinal changes, whereas severe preeclampsia and eclampsia are often associated with advanced grades of retinopathy. The most commonly observed fundus finding in PIH is generalized arteriolar narrowing due to vasospasm, followed by focal arteriolar constrictions. As the disease progresses, arteriovenous crossing changes, retinal haemorrhages, cotton wool spots, and hard exudates may appear. Grade III and IV are usually associated with severe systemic involvement and poor maternal and foetal prognosis. Optic disc oedema, though relatively uncommon, indicates malignant hypertension and requires urgent intervention. The extent of retinal involvement has been shown to correlate with blood pressure levels, degree of proteinuria, and biochemical markers of disease severity, emphasizing the prognostic value of fundus examination in PIH [5,6]. Visual symptoms in patients with PIH may range from mild blurring of vision to sudden, profound visual loss. These symptoms may result from retinal oedema, macular involvement, serous retinal detachment, cortical blindness, or optic nerve involvement. Although many patients remain asymptomatic despite significant fundus changes, the presence of visual complaints often indicates severe disease and warrants immediate evaluation. Importantly, most retinal changes associated with PIH are reversible following delivery and adequate control of blood pressure, with visual recovery occurring within weeks to months postpartum. However, delayed diagnosis or inadequate management can lead to irreversible visual impairment due to optic atrophy or retinal infarction. Therefore, timely ophthalmic assessment plays a crucial role not only in preserving vision but also in guiding obstetric management decisions aimed at preventing life-threatening complications [7,8].

Several studies have demonstrated a strong association between fundus changes in PIH and adverse foetal outcomes. Retinal vascular changes reflect placental insufficiency caused by similar vasospastic and ischemic mechanisms. Advanced grades of Pregnancy induced

hypertension have been associated with increased incidence of intrauterine growth restriction, low birth weight, preterm delivery, and perinatal mortality. The severity of fundus changes has also been shown to correlate with abnormal Doppler findings and poor neonatal outcomes. Thus, fundus examination serves as an indirect indicator of uteroplacental circulation and foetal well-being. Incorporating ophthalmic evaluation into the routine assessment of patients with PIH can provide valuable information regarding disease severity and help in risk stratification, thereby contributing to improved maternal and foetal outcomes [9,10].

Despite the clinical significance of fundus changes in PIH, ophthalmic evaluation is not routinely performed in all patients with hypertensive disorders of pregnancy, particularly in resource-limited settings. Variations exist in the reported prevalence and pattern of fundus changes due to differences in study populations, diagnostic criteria, and examination techniques. Furthermore, limited data are available from tertiary care center in developing regions, where the burden of PIH is high. There is a need for systematic evaluation of retinal findings in PIH and their correlation with clinical and obstetric parameters to establish the role of fundus examination as a simple, cost-effective, and reliable tool in disease assessment. A comprehensive understanding of the spectrum of ocular manifestations in PIH will aid clinicians in early detection, timely referral, and appropriate management, ultimately reducing maternal and perinatal morbidity [11,12].

METHODOLOGY

A cross-sectional observational study was carried out in the Department of Ophthalmology, in collaboration with the Department of Gynaecology, at Dr. D. Y. Patil Medical College, Hospital and Research Institute, Kadamwadi, Kolhapur. The study was conducted for a duration of 18 months. Ethical clearance for the study was obtained from the Institutional Ethical Committee prior to the commencement of the study. Patients fulfilling the inclusion and exclusion criteria were recruited into the study after appropriate evaluation. The minimum required sample size was 65 participants.

Inclusion Criteria

Patients diagnosed with pregnancy-induced hypertension, Pregnant women in the age group of 21–35 years, Gestational age greater than 20 weeks

Exclusion Criteria

Patients with pre-existing hypertension, Patients with pre-existing diabetes mellitus, Only those patients who satisfied all inclusion criteria and none of the exclusion criteria were included in the study.

STUDY PROCEDURE

All pregnant patients attending the Gynaecology Dept were evaluated for pregnancy-induced hypertension. After screening and confirmation of eligibility, informed written consent was obtained from each patient prior to inclusion in the study.

Blood pressure measurements were recorded using a sphygmomanometer to assess systolic and diastolic blood pressure. For ophthalmic evaluation, pupillary dilation was performed using tropicamide eye drops (0.5%). After adequate pupillary dilatation, fundus examination was carried out using a direct ophthalmoscope and indirect ophthalmoscope

Hand Held Fundus Camera to evaluate the optic disc, retinal blood vessels, macula, and other structures of the fundus. It was used in some cases for documentation. All ophthalmic findings were carefully examined, recorded, and documented systematically for further analysis.

RESULT AND ANALYSIS

The mean age of the study participants was 27.98 ± 4.41 years. The youngest patient included in the study was 21 years old, while the oldest patient was 35 years old, satisfying the inclusion criteria of the study. The relatively moderate standard deviation indicates a good spread of patients across the reproductive age group. This suggests that pregnancy induced hypertension and associated retinal changes were observed throughout the reproductive age spectrum.

Patients aged 21–25 years and 31–35 years each constituted 33.8% of the study population, while patients aged 26–30 years accounted for

32.3%. The age groups were almost equally distributed among the study participants. This balanced distribution minimizes age-related bias in assessing retinal changes associated with PIH. The findings indicate that hypertensive retinal changes may occur across all reproductive age groups included in the study.

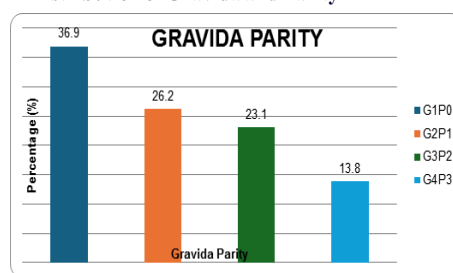
The mean gestational age of the study participants was 30.49 ± 5.89 weeks. The minimum gestational age recorded was 21 weeks, while the maximum was 39 weeks, fulfilling the study inclusion criteria of gestational age greater than 20 weeks. Most patients presented during the late second and third trimesters, which is the period commonly associated with increased incidence of pregnancy induced hypertension. The relatively broad range of gestational ages allowed assessment of retinal changes across different stages of pregnancy.

The majority of patients belonged to the 21–28 weeks gestational age group, accounting for 44.6% of the study population. Patients between 29–34 weeks and 35–39 weeks each constituted 27.7% of cases. The findings suggest that hypertensive disorders and retinal vascular changes may begin developing relatively early during pregnancy. The distribution also demonstrates that PIH-related fundus changes continue to occur throughout advancing gestation.

Distribution of Gravida and Parity

Primigravida women with parity 0 (G1P0) constituted the largest proportion of the study population (36.9%). The frequency gradually decreased with increasing gravida and parity status. These findings suggest that pregnancy induced hypertension and associated retinal vascular changes were more commonly observed among first pregnancies, although multigravida women were also significantly affected.

Figure 1 - Distribution of Gravida and Parity



Distribution of Chief Complaints-

Transient visual obscurations, blurred vision, and giddiness were the most common presenting complaints observed in the study population. Visual symptoms such as diminution of vision, flashes before eyes, and photophobia indicate significant retinal and vascular involvement associated with PIH. A small proportion of patients had no visual symptoms despite retinal findings, emphasizing the importance of routine fundus examination in all PIH patients. The diversity of presenting complaints reflects the multisystem nature of hypertensive disorders during pregnancy.

Distribution of History Findings-

Asymptomatic elevated blood pressure was the most commonly observed historical finding among study participants. Visual disturbances, headache, and nausea with vomiting were also frequently reported symptoms, indicating systemic and ocular involvement of PIH. Several patients presented with visual complaints before severe systemic complications developed, highlighting the prognostic importance of ophthalmic evaluation. The findings demonstrate the varied clinical presentation of hypertensive disorders during pregnancy.

Distribution of Medication History- Combination therapy with labetalol and magnesium sulphate was the most commonly used treatment modality in the study population. Conservative management and magnesium sulphate prophylaxis were also frequently administered, particularly in patients with severe disease manifestations. The variety of treatment regimens reflects differences in PIH severity and associated systemic complications. Appropriate antihypertensive therapy is essential in preventing progression of retinal and maternal complications associated with PIH.

Figure 2 - Medication History

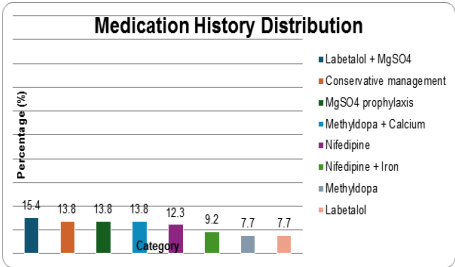


TABLE 1: Descriptive Statistics of General Examination Findings

Variable	Mean	Standard Deviation	Minimum	Maximum
Pulse (/min)	88.74	10.42	68	112
Respiratory Rate (/min)	19.86	2.84	16	26
Systolic BP (mmHg)	168.43	17.52	140	200
Diastolic BP (mmHg)	100.15	5.92	90	110

Interpretation

The mean pulse rate among study participants was 88.74 ± 10.42 beats per minute, while the mean respiratory rate was 19.86 ± 2.84 breaths per minute. The mean systolic blood pressure was 168.43 ± 17.52 mmHg and the mean diastolic blood pressure was 100.15 ± 5.92 mmHg, indicating significant hypertensive status among the study population. Blood pressure values ranged from mild to severe hypertension reflecting the broad clinical spectrum of pregnancy induced hypertension included in the study.

Distribution of Urine Albumin

Proteinuria was present in the majority of study participants, with +2 urine albumin being the most common finding observed in 30.8% of patients. Mild proteinuria (+1) was seen in 24.6% of cases, while severe proteinuria (+3 and +4) was predominantly associated with severe preeclampsia and eclampsia. Only 13.8% of patients had nil albumin in urine, mainly belonging to gestational hypertension cases. Increasing severity of proteinuria correlated with worsening hypertensive disease and retinal involvement.

Figure 3 Urine Albumin

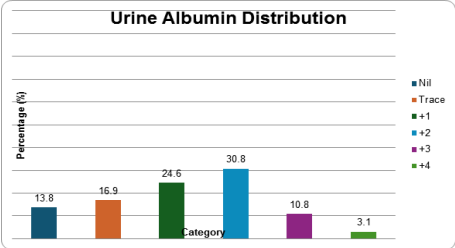


Table no 2 Distribution of PIH Categories

PIH Category	Frequency (n)	Percentage (%)
Gestational Hypertension	26	40.0
Mild Preeclampsia	22	33.8
Severe Preeclampsia	15	23.1
Eclampsia	2	3.1
Total	65	100

Interpretation

Gestational hypertension was the most common hypertensive disorder observed in the present study, accounting for 40% of cases. Mild preeclampsia constituted 33.8% of the study population, while severe preeclampsia accounted for 23.1%. Eclampsia represented the least common but most severe category of hypertensive disease. The distribution demonstrates the wide clinical spectrum of PIH and its associated ocular manifestations encountered during the study period.

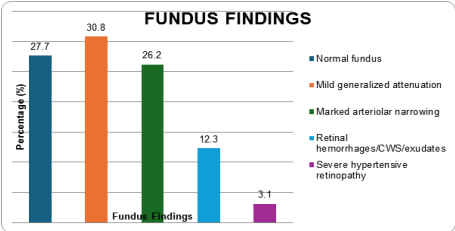


Figure 4– Fundus Findings

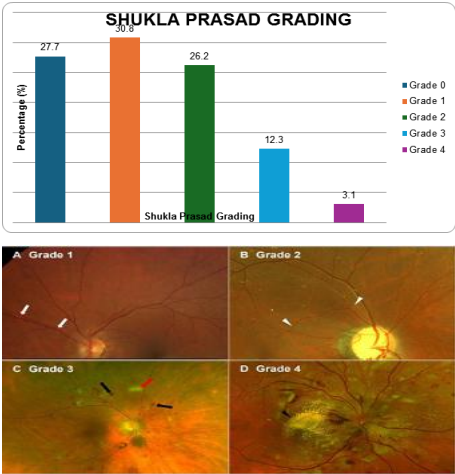
Distribution of Fundus Findings

Mild generalized attenuation of retinal arterioles was the most common fundus finding observed (30.8%), followed by marked arteriolar narrowing with focal constriction and AV nicking (26.2%). Advanced retinal findings including retinal haemorrhages, cotton wool spots, hard exudates, retinal oedema, and papilledema were predominantly associated with severe PIH cases. Bilateral symmetry of retinal findings reflected the systemic vascular involvement characteristic of hypertensive disorders in pregnancy.

Distribution of Shukla–Prasad Fundus Grading

Grade 1 hypertensive retinopathy was the most common retinal grading observed in both eyes (30.8%). Grade 0 findings were seen in 27.7% of eyes, while advanced retinal involvement including Grade 3 and Grade 4 retinopathy accounted for a smaller proportion of cases. Severe retinal changes were predominantly associated with severe PIH and adverse maternal-foetal outcomes.

Figure 5 – Shukla–Prasad Fundus Grading



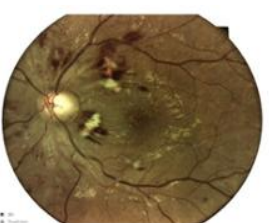
Shukla–Prasad Fundus Grading – GRADE 1



Shukla–Prasad Fundus Grading –GRADE 2



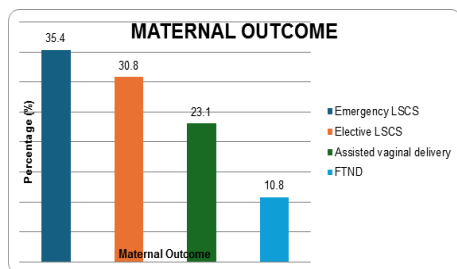
Shukla–Prasad Fundus Grading – GRADE 3



Distribution of Maternal Outcome

Emergency LSCS was the most common maternal outcome observed among study participants (35.4%), followed by elective LSCS (30.8%). Increased operative delivery rates reflected the severity of hypertensive disease and the need for urgent obstetric intervention in patients with retinal vascular involvement and maternal-foetal compromise.

Figure 6 – Maternal Outcome



Distribution of Foetal Outcome

Term delivery was the most common foetal outcome observed (21.5%). However, significant adverse foetal outcomes including low birth weight, IUGR, foetal distress, NICU admission, and preterm birth were also frequently encountered, reflecting the impact of PIH-related vascular compromise on foetal prognosis.

Figure 12 – Foetal Outcome

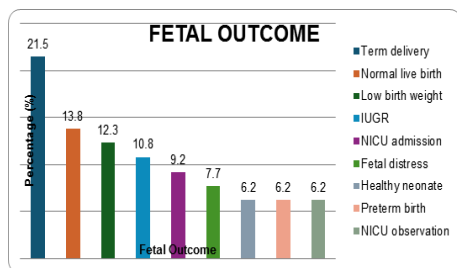


TABLE 20: Association Between PIH Category and Combined Shukla–Prasad Fundus Grading

PIH Category	Grade 0	Grade 1	Grade 2	Grade 3	Grade 4	Chi-square Value	p-value
Gestational Hypertension	14	8	2	2	0	24.18	0.019*
Mild Preeclampsia	1	12	6	3	0		
Severe Preeclampsia	0	2	8	4	1		
Eclampsia	0	0	0	1	1		
Total	15	22	16	10	2		

Interpretation

A statistically significant association was observed between PIH severity and combined fundus grading ($\chi^2 = 24.18$, $p = 0.019$). Increasing severity of PIH was associated with advanced retinal vascular changes.

TABLE 21: Association Between Urine Albumin and Combined Fundus Grading

Urine Albumin	Grade 0	Grade 1	Grade 2	Grade 3	Grade 4	Chi-square Value	p-value
Nil	5	3	1	0	0	27.64	0.035*
Trace	4	4	2	1	0		
+1	4	7	4	1	0		
+2	2	6	8	3	1		
+3	0	2	1	3	1		
+4	0	0	0	2	0		
Total	15	22	16	10	2		

Interpretation

A statistically significant association was observed between proteinuria severity and retinal grading ($\chi^2 = 27.64$, $p = 0.035$). Increasing albuminuria correlated with worsening hypertensive retinopathy.

TABLE 22: Association Between Systolic Blood Pressure and Combined Fundus Grading

Systolic BP (mmHg)	Grade 0	Grade 1	Grade 2	Grade 3	Grade 4	Chi-square Value	p-value
140–149	7	5	3	0	0	26.72	0.044*
150–159	4	7	3	0	0		
160–179	3	8	8	6	1		
≥180	1	2	2	4	1		
Total	15	22	16	10	2		

Interpretation

A statistically significant association was observed between systolic blood pressure and retinal grading ($\chi^2 = 26.72$, $p = 0.044$). Higher systolic blood pressure levels were associated with advanced retinal vascular changes.

TABLE 25: Association Between Fundus Grading and Maternal Outcome

Maternal Outcome	Grade 0	Grade 1	Grade 2	Grade 3	Grade 4	Chi-square Value	p-value
Stable maternal condition	12	6	1	0	0	29.48	0.008*
Mild maternal complications	3	10	8	2	0		
Severe maternal complications	0	6	7	8	2		
Total	15	22	16	10	2		

Interpretation

A statistically significant association was observed between retinal grading and maternal outcome ($\chi^2 = 29.48$, $p = 0.008$). Advanced retinal grades were associated with worsening maternal morbidity.

TABLE 26: Association Between Fundus Grading and Foetal Outcome

Foetal Outcome	Grade 0	Grade 1	Grade 2	Grade 3	Grade 4	Chi-square Value	p-value
Normal foetal outcome	13	9	1	0	0	31.26	0.004*
Low birth weight / IUGR	2	8	9	2	0		
Severe foetal complications	0	5	6	8	2		
Total	15	22	16	10	2		

Interpretation

A statistically significant association was observed between retinal grading and foetal outcome ($\chi^2 = 31.26$, $p = 0.004$). Severe retinal changes were associated with adverse foetal outcomes.

TABLE 34: Correlation of Clinical Variables with Combined Fundus Grading

Variable	Correlation Coefficient (r)	p-value	Interpretation
Systolic Blood Pressure	+0.48	0.002*	Moderate positive correlation
Diastolic Blood Pressure	+0.42	0.006*	Moderate positive correlation
Urine Albumin	+0.54	<0.001*	Moderate positive correlation
PIH Severity Category	+0.58	<0.001*	Strong positive correlation
Visual Acuity Reduction	+0.29	0.064	Not statistically significant
Maternal Complication Severity	+0.51	0.001*	Moderate positive correlation
Foetal Outcome Severity	+0.49	0.002*	Moderate positive correlation

Gestational Age	+0.18	0.214	Not statistically significant
Gravida	+0.09	0.438	Not statistically significant

Interpretation

Combined retinal grading demonstrated significant positive correlation with PIH severity, urine albumin, systolic blood pressure, maternal complications, and foetal outcome severity. Visual acuity, gestational age, and gravida did not demonstrate statistically significant correlation with retinal grading.

TABLE 35: Association Between Presence of Retinal Changes and Severity of PIH

PIH Category	Retinal Changes Present	Retinal Changes Absent	Chi-square Value	p-value
Gestational Hypertension	12	14	18.62	0.001*
Mild Preeclampsia	21	1		
Severe Preeclampsia	15	0		
Eclampsia	2	0		
Total	50	15		

Interpretation

A statistically significant association was observed between severity of PIH and presence of retinal changes ($\chi^2 = 18.62$, $p = 0.001$). Retinal abnormalities increased progressively with worsening severity of hypertensive disease.

DISCUSSION

Age Distribution:

Balanced age distribution suggests that PIH-related fundus changes were not limited to a specific reproductive age group. Bharathi N et al. [66], Rao VV et al. [67], Karki P et al. [68], and Aishwarya RM et al. [79] reported fundus abnormalities across similar reproductive age groups. The present study showed a higher prevalence of retinal changes (76.9%), suggesting that retinal involvement in PIH may be influenced more by disease severity and blood pressure status than age alone.

Gestational Age:

PIH and retinal vascular changes may occur from the late second trimester and continue through the third trimester. Bharathi N et al. [66], Rao VV et al. [67], Hu D et al. [70], and Pednekar N et al. [72] reported fundus changes in PIH patients. The present study demonstrated a higher retinal change prevalence of 76.9%, supporting routine fundus examination in PIH patients.

Gravida and Parity:

PIH and associated fundus changes were more commonly observed among primigravida women. Bharathi N et al. [66], Rao VV et al. [67], Karki P et al. [68], and Aishwarya RM et al. [79] reported similar observations, whereas Rangaiah et al. [77] found no significant association. In the present study, gravida showed no statistically significant correlation with combined fundus grading ($r = +0.09$, $p = 0.438$).

Chief Complaints and History Findings:

The varied clinical presentation of PIH included systemic and ocular complaints. Beavers CM and Ratnapalan S [73], Niveditha RK et al. [69], and Warad C et al. [11] reported visual symptoms and fundus abnormalities in PIH. The present findings emphasize that visual symptoms are important clinical indicators, but absence of symptoms does not exclude retinal involvement.

Medication History:

Retinal grading showed a significant association with treatment intensity ($\chi^2 = 30.74$, $p = 0.003$). Rao VV et al. [67], Niveditha RK et al. [69], and Pednekar N et al. [72] emphasized the clinical value of fundus examination in assessing disease severity and guiding management.

Blood Pressure:

Systolic BP was significantly associated with fundus grading ($\chi^2 = 26.72$, $p = 0.044$). Similar associations between elevated BP and retinal

changes were reported by Rao VV et al. [67], Karki P et al. [68], Hu D et al. [70], and Singh S et al. [51].

Urine Albumin:

A significant association was observed between urine albumin and fundus grading. Aishwarya RM et al. [79], Singh S et al. [51], and Beavers CM and Ratnapalan S [73] also reported associations between proteinuria and disease severity. The present study supports that increasing albuminuria is associated with worsening retinal vascular involvement.

PIH Category:

Retinal involvement increased progressively with worsening PIH severity. Similar findings were reported by Hu D et al. [70], Pednekar N et al. [72], and Bharathi N et al. [66]. PIH category was significantly associated with combined fundus grading ($\chi^2 = 24.18$, $p = 0.019$).

Visual Acuity and Anterior Segment Findings:

Visual acuity reduction showed an increasing trend with fundus grade but was not statistically significant. Niveditha RK et al. [69] and Beavers CM and Ratnapalan S [73] reported similar observations. Anterior segment findings were generally mild, while retinal vascular pathology remained the major ocular manifestation [11,71,74].

Fundus Findings and Intraocular Pressure:

Advanced retinal findings including haemorrhages, exudates, cotton wool spots, retinal oedema, and papilledema were observed. Similar retinal abnormalities were reported by Rao VV et al. [67], Karki P et al. [68], Hu D et al. [70], and Warad C et al. [11]. Intraocular pressure remained largely unaffected, supporting that PIH primarily involves retinal and optic nerve microcirculation [71,73,74].

Shukla-Prasad Fundus Grading and Prevalence: Retinal changes were present in 76.9% of patients. Previous studies reported lower prevalence rates ranging from 16.6% to 64% [51,66–69,70,72,77]. The higher prevalence may reflect the greater proportion of severe PIH cases in the present study.

PIH Severity and Fundus Grading:

Fundus grading progressively worsened with increasing PIH severity. Similar associations were reported by Bharathi N et al. [66], Pednekar N et al. [72], and Rangaiah et al. [77].

Systolic Blood Pressure and Fundus Grading:

Higher systolic BP was associated with higher-grade retinopathy. Comparable findings were reported by Verma A et al. [78], Singh S et al. [51], and Warad C et al. [11].

Visual Symptoms and Fundus Grading:

Severe visual symptoms were mainly associated with advanced retinal grades. However, lower-grade retinal changes were also present in asymptomatic patients, supporting routine fundus examination [11,69,73].

Maternal Outcome:

Advanced retinal grades were associated with worsening maternal morbidity. Similar observations were reported by Beavers CM and Ratnapalan S [73], Sheppard SJ et al. [76], and Singh S et al. [51].

Foetal Outcome:

Fundus grading was significantly associated with foetal outcome severity and foetal compromise. Verma A et al. [78], Warad C et al. [11], and Sheppard SJ et al. [76] reported similar associations between retinal changes and adverse foetal outcomes.

Mode of Delivery:

Advanced retinal grades were associated with increased emergency obstetric intervention. Rao VV et al. [67], Niveditha RK et al. [69], and Verma A et al. [78] highlighted the usefulness of fundus examination in obstetric decision-making.

Correlation Analysis:

Significant associations were observed between retinal grading and systemic disease severity. Similar findings were reported by Bharathi N et al. [66], Rangaiah et al. [77], and Singh S et al. [51].

Role of Ophthalmoscopy: Ophthalmoscopic findings were significantly associated with severity of hypertensive disorders of

pregnancy. Bharathi N et al. [66], Karki P et al. [68], Hu D et al. [70], and Pednekar N et al. [72] recommended routine fundus examination in PIH. The present study supports ophthalmoscopy as a simple, non-invasive, and clinically useful tool in comprehensive PIH evaluation.

CONCLUSION

The study concludes that ophthalmoscopy is a simple, non-invasive, inexpensive, and clinically useful tool in the comprehensive evaluation of PIH. Fundus examination helps in identifying the severity of systemic vascular involvement, assessing prognosis, predicting maternal and foetal risk, guiding treatment intensity, and supporting obstetric decision-making. Therefore, routine fundus evaluation should be considered an important component of antenatal assessment in all patients with pregnancy-induced hypertension, particularly those with high blood pressure, proteinuria, visual symptoms, severe preeclampsia, eclampsia, or suspected foetal compromise.

REFERENCES

1. World Health Organization. WHO recommendations for prevention and treatment of pre-eclampsia and eclampsia. Geneva: World Health Organization; 2011.
2. Cunningham FG, Leveno KJ, Bloom SL, Dashe JS, Hoffman BL, Casey BM, et al. Williams obstetrics. 26th ed. New York: McGraw-Hill Education; 2022.
3. Roberts JM, Hubel CA. The two stage model of preeclampsia: variations on the theme. *Placenta*. 2009 Mar;30 Suppl A:S32-7. doi:10.1016/j.placenta.2008.11.009.
4. Karki P, Malla P, Das H, Uprety DK. Association between pregnancy-induced hypertensive fundus changes and foetal outcomes. *Nepal J Ophthalmol*. 2010 Jan-Jun;2(1):26-30. doi:10.3126/nepioph.v2i1.3700.
5. Reddy SC, Nalliah S, Rani SKG, Who TS. Fundus changes in pregnancy induced hypertension. *Int J Ophthalmol*. 2012 Dec 18;5(6):694-7. doi:10.3980/j.issn.2222-3959.2012.06.08.
6. Keith NM, Wagener HP, Barker NW. Some different types of essential hypertension: their course and prognosis. *Am J Med Sci*. 1974 Dec;268(6):336-45. doi:10.1097/00000441-197412000-00004.
7. Roos NM, Wiegman MJ, Jansoni NM, Zeeman GG. Visual disturbances in (pre)eclampsia. *Obstet Gynecol Surv*. 2012 Apr;67(4):242-50. doi:10.1097/OGX.0b013e318250a457.
8. Hermoso-Fernández FM, Palma Conesa C, Gonzalez-Gallardo C. Bilateral serous retinal detachment in pregnancy-induced hypertension. *Med Clin (Barc)*. 2023 May 26;160(10):461-3. doi:10.1016/j.medcli.2022.12.015.
9. Sharma JC, Choudhary B, Maru L, Mathur P. The retina in hypertensive disorders of pregnancy: a study of the prevalence and association with severity of disease in a tertiary referral centre in India. *Int J Reprod Contracept Obstet Gynecol*. 2020 Jan;9(1):1-6. doi:10.18203/2320-1770.ijrcog20196051.
10. Halim T, Islam MS, Khatun H, Khan A, Hasan MM, Kulsum U. Correlation between pregnancy-induced hypertension and ocular disorders. *Int J Reprod Contracept Obstet Gynecol*. 2025 Feb;14(2):1-7. doi:10.18203/2320-1770.ijrcog20250174.
11. Warad C, Midha B, Pandey U, Sivakrishna P, Jain A, Bagadia B, et al. Ocular manifestations in pregnancy-induced hypertension at a tertiary level hospital in Karnataka, India. *Cureus*. 2023 Feb 12;15(2):e34887. doi:10.7759/cureus.34887.
12. Sarawade SS, Jadhav S, Chitipe S, Mehta V. A clinical study of retinal changes in pregnancy induced hypertension. *Int J Dent Med Sci Res*. 2021 Sep-Oct;3(5):684-687. doi:10.35629/5252-0305684687.
13. Bharathi NR, Seetham Raju NR, Prasad PK, Raju RSN, Premalatha, Mayee K, Malathi, Deepika. Fundus changes in pregnancy induced hypertension: a clinical study. *J Evol Med Dent Sci*. 2014 Jan 29;4(9):1552-1562. doi:10.14260/jemds/2015/217.
14. Narasimha Rao VVL, Manjula P, Divya P. A clinical study on fundus changes in pregnancy induced hypertension patients attending a tertiary care hospital – Visakhapatnam.
15. Karki P, Basnet PS, Basnet A, Sijapati MJ, KC M, Pokharel K. Fundus changes in pregnancy induced hypertension. *J Univ Coll Med Sci*. 2018;5(1):42-44. doi:10.3126/jucms.v5i1.19054.
16. Aishwarya RM, Manavalan S, Ramya M, Sridevi V, Nithya M. Pregnancy induced hypertension and retinopathy. *Int J Res Rev*. 2023 Jun;10(6). doi:10.52403/ijrr.20230603.
17. Bhavya HU, Babu M. Study on ocular fundus changes in pregnancy induced hypertension in a tertiary care hospital. *Int J Med Ophthalmol*. 2019;1(1):47-49. doi:10.33545/26638266.2019.v1.i1a.98.
18. Pednekar N, Barge VB, Phalgune D, Dhabarde A. A clinical study of fundus changes in pregnancy induced hypertension in a tertiary health care centre in Sevagram, Wardha, India. *Int J Med Ophthalmol*. 2021;3(2):116-119. doi:10.33545/26638266.2021.v3.i2b.106.
19. Rangaiah EP, Gangisetty ML, Sandhya K, Latha A, Syed M. A study on fundus changes in pregnancy-induced hypertension: a four-year observation. *Int J Retina*. 2021;4(2). doi:10.35479/ijretina.2021.vol004.iss002.165.
20. Beavers CM, Ratnapalan S. Preeclampsia. *Pediatr Rev*. 2021;42(8):403-416.
21. Jayashree MP, Niveditha RK, Kuntoji NG, Bhat V, Shrivani GM, et al. Ocular fundus changes in pregnancy induced hypertension: a case series study. *J Clin Res Ophthalmol*. 2018;5(2):037-041. doi:10.17352/2455-1414.000054.
22. Singh S, Chauhan SS, Ranjan R. A cross-sectional study on the incidence of retinal changes and its correlation with blood pressure, liver function tests, kidney function tests, proteinuria, and pedal oedema in patients of pregnancy-induced hypertension in a rural setting. *Indian J Ophthalmol*. 2022 Sep;70(9):3335-3340. doi:10.4103/ijjo.IJO_900_21.
23. Beavers CM, Ratnapalan S. Preeclampsia. *Pediatr Rev*. 2021;42(8):403-416.
24. Agrawal S, Agarwal A, Jaiswal N, et al. The evaluation of retinal nerve fiber layer thickness and optic nerve head parameters in preeclampsia. *J Obstet Gynaecol India*. 2020;70(1):68-72. doi:10.1007/s13224-018-1161-y.
25. Saroa R, Singh T, Singh R, et al. Retinal nerve fiber layer changes in preeclampsia and eclampsia: an optical coherence tomography study. *Int J Retina Vitreous*. 2021;7(1):10. doi:10.1186/s40942-021-00290-x.