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Dr. Poonam TM
Assistant Professor, Department of Obstetrics and Gynaecology, S. Nijalingappa Medical College and HSK Hospital and Research Centre, Bagalkot, Karnataka, India

Dr. Sangameshwarayya Salimath
Associate Professor, Department of Ophthalmology, S. Nijalingappa Medical College and HSK Hospital and Research Centre, Bagalkot, Karnataka, India

Anju Ravindran
Junior Resident, Department of Ophthalmology, S Nijalingappa Medical College, Bagalkot, Karnataka, India

Corresponding Author:
Dr. Poonam TM
Assistant Professor, Department of Obstetrics and Gynaecology, S. Nijalingappa Medical College and HSK Hospital and Research Centre, Bagalkot, Karnataka, India

Fundoscopic changes in pregnancy-induced hypertension and their correlation with disease severity and fetal outcomes: A cross-sectional study

Dr. Poonam TM, Dr. Sangameshwarayya Salimath and Dr. Anju Ravindran

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Abstract
Introduction: Pregnancy-Induced Hypertension (PIH), encompassing preeclampsia, eclampsia, and HELLP syndrome, significantly contributes to maternal and perinatal morbidity. Retinal changes observed through fundoscopy provide a non-invasive window into systemic vascular health and may correlate with the severity of PIH. Despite their clinical significance, these evaluations are often underutilized in routine antenatal care.
Objective: To evaluate the prevalence and pattern of fundoscopic changes in patients with PIH and assess their association with disease severity and fetal outcomes.
Methodology: A cross-sectional study was conducted over six months (July-December 2024) at a tertiary hospital in North Karnataka. Eighty pregnant women aged 18-40 years diagnosed with PIH underwent detailed ophthalmologic assessments, including dilated fundoscopy. Retinal findings were graded using the Keith-Wagener-Barker classification. Data on blood pressure, gestational age, PIH category, and fetal outcomes were analyzed using Epi Info and MedCalc software.
Results: Of 80 participants, 55% had severe preeclampsia, and 28.75% had non-severe preeclampsia. Retinal changes were observed in 43.75%, with Grade 1 hypertensive retinopathy being most common. Serous retinal detachment and choroidal effusion were noted in HELLP syndrome cases. A statistically significant correlation (p<0.001) was observed between higher grades of retinopathy and both the severity of PIH and poor fetal outcomes, including all nine cases of intrauterine death (IUD). Cesarean delivery was more frequent (58.75%) among patients with abnormal fundoscopic findings.
Conclusion: Fundoscopic examination in PIH is a valuable, non-invasive tool for assessing disease severity and predicting fetal outcomes. Its incorporation into routine antenatal care may facilitate earlier intervention and better maternal-fetal prognosis.

Keywords: Pregnancy induced hypertension, hypertensive retinopathy, fetal outcome

Introduction

Pregnancy-Induced Hypertension (PIH) is a hypertensive disorder that develops as a result of pregnancy, typically after 20 weeks of gestation, and includes conditions such as gestational hypertension, preeclampsia, and eclampsia. It complicates 2-8% pregnancies worldwide and is a major contributor to maternal and perinatal morbidity and mortality, particularly in developing countries [1, 2].

Gestational hypertension is defined as a systolic blood pressure of 140 mm Hg or more or a diastolic blood pressure of 90 mm Hg or more, or both, on two occasions at least 4 hours apart after 20 weeks of gestation in a woman with a previously normal blood pressure [2].

Preeclampsia is characterized by elevated blood pressure (systolic > 140 mmHg or diastolic > 90 mmHg on two occasions, at least 4 hours apart) after 20 weeks of gestation in a previously normotensive woman. While proteinuria was a classic sign, the revised definition includes cases where it's absent but other organ dysfunction (renal, hepatic, or hematological) is present [2]. Preeclampsia when complicated with grandmal seizures (generalized tonic-clonic convulsions) and/or coma is called eclampsia [3].

Eclampsia in India remains prevalent (1.5% incidence) with no decline over decades. Maternal deaths declined (14%→2-9%) but perinatal mortality remains high (25-48%) [4]. Pathogenesis begins with abnormal cytotrophoblast invasion, leading to inadequate spiral artery remodeling. This results in placental ischemia and hypoperfusion. The ischemic placenta releases antiangiogenic and inflammatory factors into maternal circulation, causing widespread

endothelial dysfunction and vasospasm, which may lead to multiorgan involvement, including the kidneys, liver, brain, and eyes [5].

The eye, being the only organ where blood vessels can be directly visualized, offers a unique opportunity for assessing systemic vascular health through fundoscopy. Retinal changes in PIH, such as arteriolar narrowing, hemorrhages, exudates, and papilledema, reflect the severity of hypertension and can correlate with disease progression [6]. Reddy *et al*. studied retinal changes in pregnancy-induced hypertension and found that fundus abnormalities correlate with the severity of hypertension. Common findings included arteriolar narrowing, hemorrhages, and exudates. These retinal findings, when identified early, may help in stratifying risk, guiding treatment decisions, and anticipating complications such as eclampsia or fetal growth restriction [7].

Despite its clinical relevance, routine fundoscopic examination is often overlooked in antenatal care, especially in resource-limited settings. Incorporating fundoscopy into standard PIH evaluation protocols may enhance maternal and fetal outcomes by facilitating timely intervention [8].

This study aims to investigate the prevalence and pattern of fundoscopic changes in women with PIH and their association with disease severity.

Materials and Methods

This study was a hospital based cross sectional study conducted at tertiary care hospital in North Karnataka, over a period of 6 months (from July 2024 to December 2024). It was approved by the Institutional Ethics Committee on Human Research Subjects. A total of 80 pregnant women diagnosed with PIH were included in the study.

Inclusion Criteria

All patients diagnosed with pre-eclampsia or eclampsia or HELLP syndrome, admitted to the obstetrics ward aged 18-40 years and who consented to participate in the study, were included.

Exclusion Criteria

Women with a pre-existing history of hypertension or any other cardiovascular disease or anemia.

Methods

All patients diagnosed with PIH underwent a detailed ophthalmological examination. It included Visual Acuity checking using Snellen's chart. Bedside vision was assessed in severe cases. A dilated fundus examination was conducted to evaluate the retinal changes using indirect ophthalmoscopy. Blood pressure and gestational age and was recorded at each visit to correlate the severity of PIH and retinal changes. Mode of delivery was recorded.

The retinal findings were classified into different stages of hypertensive retinopathy based on the Keith-Wagener-Barker grading system, which includes Grade 1: Mild arteriolar narrowing, Grade 2: Moderate arteriolar narrowing with arteriovenous nicking, Grade 3: Retinal hemorrhages, exudates, and cotton-wool spots, Grade 4: Optic disc edema (papilledema).

Sample size estimation

Considering the prevalence of fundus changes in pregnant females with Pregnancy Induced Hypertension from the study "Fundoscopic changes in preeclampsia and eclampsia and their association with fetal outcome" by Nataraju *et al*. [9] as 48% and, with a confidence interval of 95% CI and acceptable difference of 12%, the minimum sample size calculated was 67. However, in this study we have included 80 participants. The software used is WinPepi version 11.38.

All data was entered in Microsoft Excel 2021 (Part of Microsoft Office Professional Edition) [computer program]. Microsoft; 2021) format and analyzed using, Epi Info v7.2.5 and MedCalc v18.2.1

Results

A total of 80 pregnant women diagnosed with pregnancy-induced hypertension (PIH), including preeclampsia and eclampsia, were evaluated for fundoscopic changes and associated maternal-fetal outcomes.

The mean age was 27.5 ± 6.5 years. Elevated systolic and diastolic blood pressures were observed in 83.75% and 63.75% of patients, respectively. Elevated SBP was noted in 83.75% of cases, highlighting its dominance as a diagnostic and prognostic marker. Elevated DBP was present in 63.75%, indicating substantial vascular resistance and severity (Table 1, 2).

Table 1: Descriptive statistics of the study population showing the mean, standard deviation, median with interquartile range (IQR), and minimum-maximum values for age, systolic blood pressure (SBP), and diastolic blood pressure (DBP)

Parameter	Mean (SD)	Median (IQR)	Min- Max
Age	27.50 (6.51)	27 (21-32) *	18-40
SBP	152.20 (10.78)	150 (144-160) *	140-200
DBP	100.80 (11.15)	100 (90-110) *	90-130

Table 2: Distribution of systolic and diastolic blood pressure categories among participants, showing frequency and percentage of elevated and normal values along with their respective 95% confidence intervals (CI)

Category	SBP N (%)	95% CI (SBP)	DBP N (%)	95% CI (DBP)
Elevated	67 (83.75%)	73.82 - 91.05	51 (63.75%)	52.24 - 74.21
Normal	13 (16.25%)	8.95 - 26.18	29 (36.25%)	25.79 - 47.76
Total	80 (100%)	—	80 (100%)	—

Among the participants, 62.5% were primigravida (Table 3) and 70% presented at term gestation (Table 4).

Table 3: Gravida status distribution among study participants, indicating the proportion of primigravida and multigravida cases along with their respective 95% confidence intervals (CI).

Gravida	N (%)	95% CI
Primigravida	50 (62.50)	50.96 - 73.08
Multigravida	30 (37.50)	26.92 - 49.04
Total	80 (100)	

Table 4: Distribution of gestational age at presentation among participants, showing the percentage of term and preterm cases along with their respective 95% confidence intervals (CI)

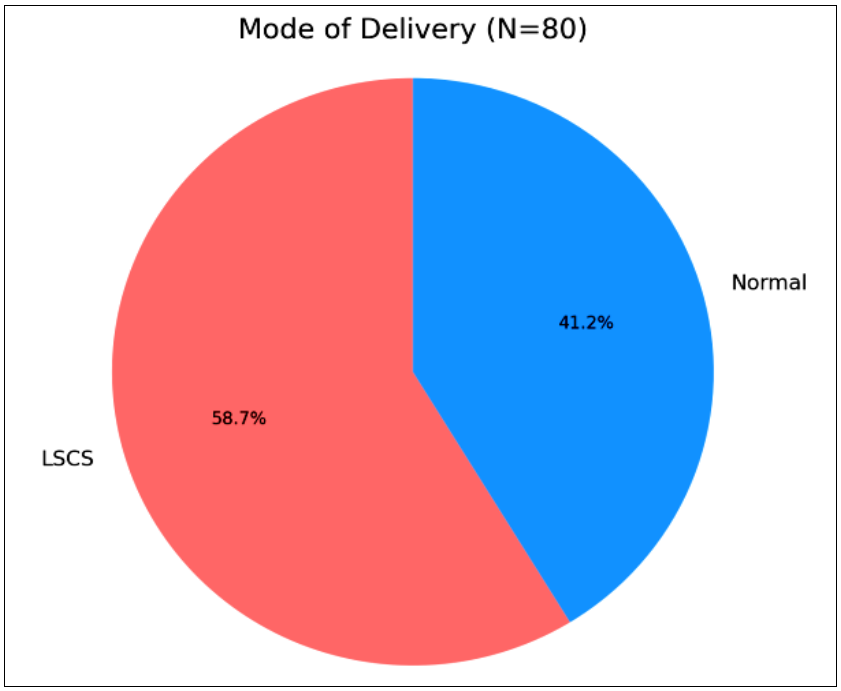
Gestational Age at Presentation	N (%)	95% CI
Term	56 (70)	58.72 - 79.74
Preterm	24 (30)	20.26 - 41.28
Total	80 (100)	

Severe preeclampsia was most common (55%), followed by non-severe PE (28.75%). Eclampsia (12.5%) and HELLP (3.75%) highlight the spectrum and severity of PIH complications (Table 5).

Table 5: Distribution of pregnancy-induced hypertension (PIH) categories among study participants, including the proportions of non-severe and severe preeclampsia (PE), eclampsia, and HELLP syndrome, along with their respective 95% confidence intervals (CI)

PIH category	N (%)	95% CI
PE Non-severe	23 (28.75)	19.18 - 39.95
PE Severe	44 (55)	43.47 - 66.15
Eclampsia	10 (12.50)	6.16 - 21.79
HELLP	3 (3.75)	0.78 - 10.57
Total	80 (100)	

In this study, higher grades of retinopathy were associated with increasing severity of PIH and a greater need for cesarean section (LSCS rate: 58.75%).



Graph 1: Mode of Delivery - shows the proportion of LSCS (58.75%) vs. normal delivery (41.25%).

Ocular changes were identified in 43.75% of patients. Hypertensive retinopathy was graded using the Keith-Wagener classification: Grade 1 was most common (32.5%), followed by Grade 2 (3.75%) and Grade 3 (1.25%). Serous retinal detachment was observed bilaterally in 5% of patients (Figure 1,2), and choroidal effusion (Figure 3,4) in 1.25%. Notably, 56.25% had normal fundus findings (Table 6).

Fig 1: Showing serous retinal detachment in right eye.

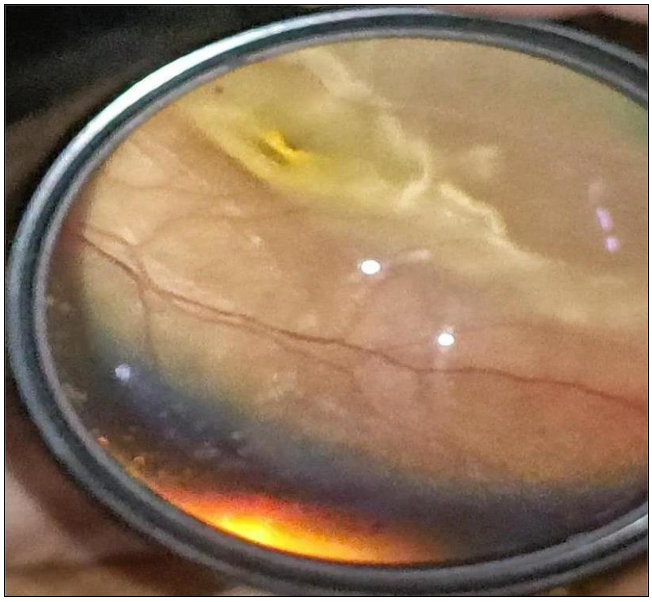


Fig 2: Showing serous retinal detachment in left eye

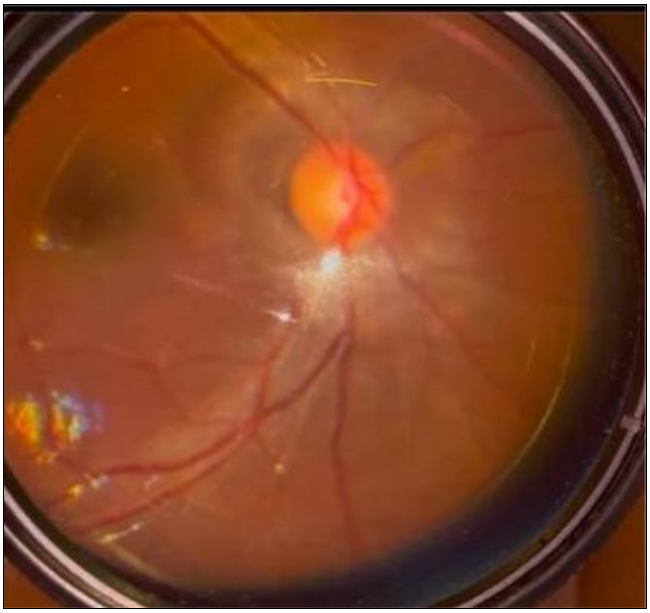


Fig 3: Showing choroidal effusion in right eye

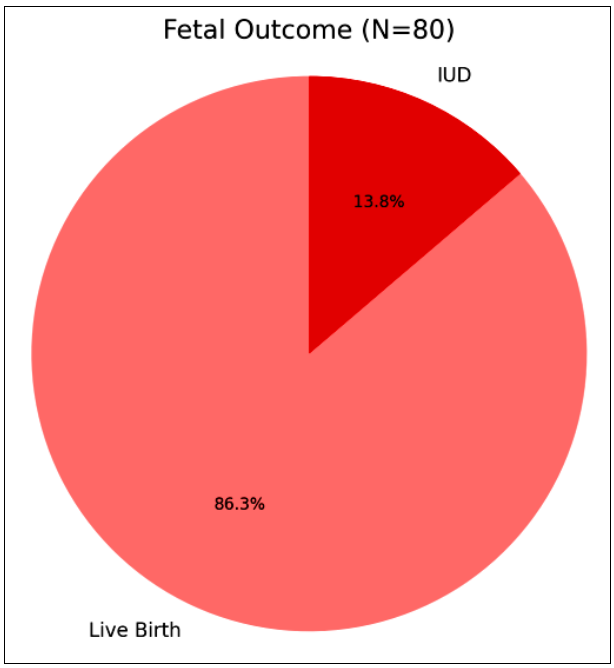
Fig 4: Showing choroidal effusion in left eye

Table 6: Distribution of ocular fundus changes in participants with pregnancy-induced hypertension (PIH), including normal findings and various grades of hypertensive retinopathy, serous retinal detachment (RD), and choroidal effusion, along with their respective 95% confidence intervals (CI)

Ocular Changes	N (%)	95% CI
Normal	45 (56.25)	44.70 - 67.32
Grade 1	26 (32.50)	22.45 - 43.89
Grade 2	3 (3.75)	0.78 - 10.57
Grade 3	1 (1.25)	0.03 - 6.77
Serous RD Both Eye	4 (5)	1.38 - 12.31
Choroidal Effusion Both Eye	1 (1.25)	0.03 - 6.77
TOTAL	80 (100)	

Severe preeclampsia and eclampsia were significantly associated with higher grades of retinopathy ($p < 0.001$). All three patients with HELLP syndrome showed bilateral serous RD.

A significant correlation was noted between ocular changes and adverse pregnancy outcomes. All nine cases of antepartum intrauterine death (AP-IUD) occurred in patients with abnormal fundus findings, with none in the normal fundus group ($p < 0.001$).



Graph 2: Fetal outcomes, with 86.25% resulting in live births and 13.75% intrauterine deaths (IUD), emphasizing the prognostic value of fundus changes

Discussion

This study highlights the importance of fundoscopic evaluation in the management of pregnancy-induced hypertension (PIH), including preeclampsia and eclampsia.

Visual disturbances occur in up to 25% of preeclamptic patients and nearly all eclamptic cases however complete blindness remains uncommon, occurring in only 1-3% of cases. Symptoms range from blurred vision and photopsia to more severe manifestations like scotomas, diplopia, and transient or permanent blindness [10]. Historically, blindness was primarily linked to retinal issues such as vascular changes, edema, detachment, or ischemic optic neuropathy caused by reduced blood flow to the optic nerve. However, current understanding increasingly highlights the role of cortical involvement specifically, occipital cortex dysfunction as a significant contributor to vision loss in these conditions [11-14].

A study done by Uma *et al*. showed visual loss in 72% of eclampsia cases and 12% of pre-eclampsia cases, indicating a significant association between ocular changes and disease severity ($P = 0.03$) similar to our study in which higher grades of hypertensive retinopathy were significantly associated with adverse fetal outcomes, including intrauterine death ($P < 0.001$, Fisher's Exact Test). Both studies underscore the prognostic value of fundus examination in assessing disease severity and predicting outcomes [15].

Study done by Samra etal. highlights retinal arteriolar narrowing, hemorrhages, and edema as common in PIH similar to our study [16].

A study done by Warad *et al*. observed Grade 1 as most common change. Our study also reported a similar prevalence of fundus changes in PIH patients 43.75% in our study and 40% in the study by Warad *et al*. highlighting the consistency of hypertensive retinopathy among this population. Arteriolar narrowing was the most frequently observed retinal finding in both studies, corresponding to Grade 1 hypertensive retinopathy, indicating that early vascular changes are common [17].

In comparison to study done by Jaffe etal. findings on severe ocular involvement in preeclampsia, our study reaffirms the significance of retinal changes in PIH. Both studies demonstrate a strong link between hypertensive retinopathy and disease severity. Fundoscopic findings, especially higher-grade changes, is associated with adverse maternal and poor fetal outcomes, including low birth weight and intrauterine death, highlighting their prognostic value in clinical management [13].

Bilateral Serous retinal detachment is a rare cause of vision loss typically seen in severe cases or eclampsia, often without retinal breaks. It occurs when the neurosensory retina separates from the retinal pigment epithelium (RPE) and is considered an ophthalmic emergency [18]. This was particularly notable in HELLP syndrome. These ocular symptoms are not isolated findings but reflections of widespread systemic endothelial dysfunction, vasospasm and cerebral autoregulation failure, hallmark features of severe preeclampsia and eclampsia [10].

Hayreh *et al*. proposed that in preeclampsia, serous retinal detachment may result from choroidal ischemia triggered by rapidly elevated blood pressure presents with sudden bilateral vision loss [19].

It usually resolves postpartum with good visual recovery, though severe cases may cause lasting damage with variable prognosis.

A study done by Nataraju etal. demonstrates a strong association between fundoscopic abnormalities and adverse fetal outcomes in hypertensive pregnancies similar to our study. Both studies reported high LSCS rates, with retinal findings associated with more surgical deliveries due to fetal distress or poor maternal condition [9].

The study done by Yang *et al*. highlights the importance of monitoring and managing common pregnancy complications, especially postpartum hemorrhage and hypertensive disorders, to reduce the incidence of severe maternal morbidity. Regular prenatal care and timely interventions are crucial for improving maternal health outcomes [20].

In our study higher grades of hypertensive retinopathy is associated with adverse fetal outcomes, including intrauterine death (IUD), showing strong statistical significance ($p<0.001$, Fisher's Exact Test), supporting fundoscopy as a vital tool in risk stratification and outcome prediction.

The onset of visual symptoms often precedes other severe complications, making them valuable clinical indicators for early intervention. This study advocates for prompt evaluation of visual complaints in pregnant women with hypertension, as they

often signal life threatening complications requiring immediate obstetric and neurologic attention. It underscores the importance of multidisciplinary care in managing such high-risk pregnancies.

The exact pathophysiology of hypertension during pregnancy remains incompletely understood. However, current evidence suggests that defective trophoblast differentiation and invasion, influenced by dysregulated production of cytokines, adhesion molecules, major histocompatibility complex proteins, and metalloproteinases, plays a central role in the onset of gestational hypertensive disorders. These molecular abnormalities impair the remodeling of spiral arteries within the myometrium, resulting in placental ischemia and reduced perfusion.

The study done by Levine *et al*. investigated the role of circulating angiogenic factors soluble fms-like tyrosine kinase-1 (sFlt-1) and placental growth factor (PlGF) in predicting the development of preeclampsia. Recent studies also implicate the release of antiangiogenic factors from placental tissue, which contributes to widespread endothelial dysfunction and the development of systemic hypertension. This dysfunction leads to reduced perfusion in key organs, including the eyes, kidneys, liver, lungs, and peripheral vasculature. Most researchers agree that the etiology is multifactorial [21, 22].

Our study supports that fundoscopic findings in PIH reflect systemic vascular compromise and may serve as early, noninvasive predictors of adverse fetal outcomes. The retinal vascular changes is associated with the severity of systemic hypertension in pregnancy [23], particularly at higher grades or with bilateral involvement, warrant close monitoring and timely obstetric intervention to optimize maternal and fetal prognosis.

Further studies are required to determine ideal blood pressure targets during pregnancy, enhance the use of pregnancy complication history in risk assessment models, and evaluate the efficacy of preventive strategies [24].

Conclusion

Fundoscopic examination serves as a valuable, noninvasive tool in assessing the severity of pregnancy-induced hypertension. Our study emphasizes the clinical importance of blood pressure monitoring and regular ocular evaluation in PIH and its direct impact on obstetric decision-making, particularly the higher rate of LSCS to ensure maternal and fetal safety.

Given the potential for visual impairment in severe cases of PIH, ophthalmologists should play a critical role in the management of these patients.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient (s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial Disclosures

None.

Conflict of Interest

None.

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