Section: Pathology

Original Research Article

HISTOMORPHOLOGICAL ANALYSIS OF PLACENTAL CHANGES IN PREGNANCY INDUCED HYPERTENSION

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Received *: 15/12/2025*
Received in revised form *: 20/01/2026*
Accepted *: 05/02/2026*

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DOI:10.70034/ijmedph.2026.1.430

Source of Support: Nil,
Conflict of Interest: Nonedeclared

Int J Med Pub Health
2026; 16 (1); 2489-2494

ABSTRACT

Background

Pregnancy-induced hypertension (PIH) is a major obstetric complication associated with significant maternal and perinatal morbidity and mortality. Placental abnormalities play a central role in the pathophysiology of PIH. Histomorphological examination of the placenta provides valuable insight into the underlying vascular and hypoxic changes that contribute to adverse pregnancy outcomes. **Aim:** To analyze the histomorphological changes in placentae of pregnancies complicated by pregnancy-induced hypertension and compare them with placentae from normotensive pregnancies.

Materials and Methods: This prospective observational case-control study was conducted over 12 months at a tertiary care center. A total of 74 placentae were studied, including 44 from PIH cases and 30 from normotensive controls matched for gestational age. Gross examination was performed to assess placental weight, dimensions, infarction, calcification, and retroplacental clots. Histopathological evaluation was carried out on hematoxylin and eosin-stained sections to assess syncytial knots, villous infarction, chorangiosis, and other microscopic features. Statistical analysis was performed using SPSS version 27.0, with $p < 0.05$ considered statistically significant.

Results: Placental weight (334.09 ± 50.73 g vs 382.00 ± 50.20 g, $p < 0.001$) and neonatal birth weight (2.16 ± 0.38 kg vs 2.75 ± 0.22 kg, $p < 0.001$) were significantly lower in the PIH group compared to controls. Gross calcification was significantly more common in hypertensive placentae (26.7%, $p = 0.001$). Histopathological examination revealed a significantly higher frequency of syncytial knots in cases (65.0%, $p < 0.001$). Villous infarction (8.3%) and chorangiosis (10.0%) were observed exclusively in the PIH group. Low birth weight (68.2%), proteinuria (75.0%), and edema (72.7%) were significantly associated with hypertensive pregnancies ($p < 0.001$).

Conclusion: Pregnancy-induced hypertension is associated with significant gross and microscopic placental alterations indicative of maternal vascular malperfusion and chronic hypoxia. These changes correlate strongly with adverse maternal and fetal outcomes. Routine placental histopathological examination can serve as an important adjunct in understanding disease severity and improving perinatal risk assessment.

Keywords: Pregnancy-Induced Hypertension. Placenta. Histomorphology.

INTRODUCTION

Pregnancy is a unique physiological state that requires dynamic adaptations in the maternal body to support fetal growth and development. Among the many organs involved, the placenta holds central importance as the interface between the maternal and fetal circulations, ensuring oxygenation, nutrition, waste removal, and endocrine support. The placenta not only facilitates materno-fetal exchange but also plays a pivotal role in regulating vascular homeostasis, immune tolerance, and fetal programming. Any compromise in placental function can lead to adverse maternal and neonatal outcomes. Pregnancy-induced hypertension (PIH), a group of hypertensive disorders that develop during gestation, profoundly affects placental morphology and function, making histomorphological analysis an indispensable tool for understanding its pathophysiology.

Hypertensive disorders of pregnancy, which include gestational hypertension, pre-eclampsia, and eclampsia, are among the leading causes of maternal and perinatal morbidity and mortality worldwide. According to the World Health Organization, hypertensive disorders complicate 5-10% of pregnancies globally, with preeclampsia accounting for a substantial proportion of maternal deaths in low- and middle-income countries. In India, PIH remains one of the "deadly triad" along with hemorrhage and infection, contributing significantly to maternal mortality. The pathogenesis of PIH is complex and multifactorial, involving abnormal trophoblastic invasion of the spiral arteries, endothelial dysfunction, imbalance between angiogenic and antiangiogenic factors, and heightened systemic inflammation. These pathophysiological processes are reflected in placental architecture and histomorphological patterns, which serve as a window into the disease process.[1]

The placenta in PIH typically shows a spectrum of changes, ranging from macroscopic alterations such as reduced weight and size to microscopic abnormalities such as increased syncytial knots, villous infarctions, fibrinoid necrosis, atherosis of spiral arteries, cytotrophoblastic proliferation, and intervillous fibrin deposition. These changes impair utero-placental perfusion, leading to chronic hypoxia and oxidative stress. As a result, fetal growth restriction, intrauterine hypoxia, and stillbirth are more frequent in pregnancies complicated by hypertension compared to normotensive pregnancies. Thus, systematic evaluation of placental morphology and histology not only aids in understanding the disease mechanism but also provides insight into predicting perinatal outcomes.

Previous studies have shown that the placenta in hypertensive pregnancies often weighs less and has reduced surface area, which correlates with poor neonatal outcomes such as low birth weight and prematurity. Histologically, maternal vascular malperfusion (MVM) lesions are prominent. Syncytial knots, which represent nuclear aggregates formed due to accelerated villous maturation, are significantly increased in PIH and are considered markers of hypoxic stress. Other features such as intervillous fibrin deposition, villous agglutination, and perivillous fibrinoid necrosis indicate impaired intervillous circulation. Decidual arteriopathy, characterized by fibrinoid necrosis and acute atherosis of spiral arteries, reflects defective remodeling of uterine arteries. Such vascular pathology underlies the ischemic changes observed in villous structures.[2]

Comparative studies between normal and hypertensive pregnancies demonstrate a clear association between severity of hypertension and degree of placental histopathological changes. For instance, in mild gestational hypertension, only subtle alterations such as focal fibrin deposition may be noted, whereas in severe preeclampsia and eclampsia, massive infarction, villous hypoplasia, and widespread fibrinoid necrosis predominate. Hence, histomorphological analysis provides a continuum of pathological events linked to disease severity. Moreover, correlation of placental findings with neonatal outcomes highlights their clinical significance in prognostication.[3]

The importance of such studies is twofold: (1) scientific-as they enhance understanding of placental pathology in hypertensive disorders, shedding light on the underlying pathogenesis, and (2) clinical-since placental examination in PIH can help predict adverse maternal and fetal outcomes, thereby emphasizing the need for timely interventions. Furthermore, recognizing consistent histopathological patterns can also assist in differentiating PIH from other causes of maternal and perinatal morbidity. In regions with limited access to advanced biochemical or imaging markers, placental histology remains a cost-effective and reliable method for postnatal assessment of PIH severity.[4]

Aim

To analyze the histomorphological changes in placentae of pregnancies complicated by pregnancy-induced hypertension and compare them with placentae from normotensive pregnancies.

Objectives

1. To study the gross morphological changes of placentae in hypertensive and normotensive pregnancies.
2. To evaluate the histopathological features of placentae in cases of pregnancy-induced hypertension.
3. To compare and correlate the placental changes between hypertensive and normotensive groups in relation to maternal and fetal outcomes.

MATERIALS AND METHODS

Source of Data: Placentae were collected from women admitted and delivered in the Department of Obstetrics and Gynaecology at Tertiary care hospital. Cases were selected from hypertensive pregnancies (gestational hypertension, preeclampsia, eclampsia), and controls were from normotensive women delivering at same gestational age.

Study Design: This was a prospective observational, case-control study.

Study Location: The study was carried out at the Department of Pathology in collaboration with the Department of Obstetrics and Gynaecology at Tertiary care hospital.

Study Duration: The study was conducted over a period of 12 months.

Sample Size: A total of 74 placentae were examined:

- **Cases (PIH group):** 44 placentae
- **Controls (Normotensive group):** 30 placentae

Inclusion Criteria

- Cases: Pregnant women diagnosed with pregnancy-induced hypertension (gestational hypertension, preeclampsia, or eclampsia) after 20 weeks of gestation.
- Controls: Pregnant women with normotensive pregnancies delivering at similar gestational ages.

Exclusion Criteria

- Pregnancies with pre-existing chronic hypertension, diabetes mellitus, renal disease, or other systemic disorders.
- Multiple pregnancies (twins/triplets).
- Placentae from mothers with intrauterine infections, congenital anomalies, or history of smoking/drug abuse.

Procedure and Methodology:

After delivery, placentae were collected immediately, washed in running water to remove blood clots, and examined grossly for size, weight, shape, and surface characteristics. Measurements of placental weight, diameter, and thickness were recorded. The maternal and fetal surfaces were inspected for infarcts, hematomas, calcifications, and cord abnormalities. Representative tissue samples were taken from different regions including central, peripheral, and cord insertion sites.

Sample Processing: Tissue samples were fixed in 10% neutral buffered formalin, processed routinely, and embedded in paraffin blocks. Sections of 4-5 µm thickness were prepared and stained with Hematoxylin and Eosin (H&E). Special stains were used whenever required (e.g., Masson's trichrome for fibrosis, PAS for basement membrane changes). Microscopic examination was done under light microscopy to assess villous morphology, syncytial knots, intervillous fibrin deposition, infarcts, cytotrophoblastic proliferation, decidual vessel changes, and other histopathological features.

Statistical Methods: Data were entered into Microsoft Excel and analyzed using SPSS software (version 27.0). Quantitative variables such as placental weight and thickness were expressed as mean ± standard deviation (SD) and compared using Student's t-test. Categorical variables such as presence of infarcts or syncytial knots were analyzed using Chi-square or Fisher's exact test. A p-value of <0.05 was considered statistically significant.

Data Collection: Clinical details such as maternal age, parity, blood pressure records, gestational age, and perinatal outcomes (birth weight, APGAR score, NICU admissions) were recorded from case sheets and delivery records. Placental gross and microscopic findings were systematically documented and compared between the two groups.

RESULTS

Table 1: Baseline Characteristics of Cases and Controls

Variable	Cases Mean (SD)	Controls Mean (SD)	t-value	95% CI (Difference)	p-value
Age (years)	26.55 (3.89)	27.00 (3.84)	-0.50	-1.35 to 0.44	0.621
Gestational Age (weeks)	33.30 (2.70)	34.77 (2.33)	-2.50	-2.08 to -0.86	0.015
Birth Weight (kg)	2.16 (0.38)	2.75 (0.22)	-8.49	-0.69 to -0.49	<0.001
Placental Weight (g)	334.09 (50.73)	382.00 (50.20)	-4.01	-60.77 to -35.05	<0.001
Systolic BP (mmHg)	151.32 (6.72)	117.47 (3.89)	27.35	29.75 to 37.95	<0.001
Diastolic BP (mmHg)	92.68 (4.48)	78.00 (3.11)	16.64	12.77 to 16.60	<0.001

The baseline characteristics showed that the mean maternal age was comparable between cases (26.55 ± 3.89 years) and controls (27.00 ± 3.84 years), with no statistically significant difference ($p = 0.621$). However, gestational age at delivery was significantly lower among hypertensive pregnancies (33.30 ± 2.70 weeks) compared to normotensive controls (34.77 ± 2.33 weeks; $p = 0.015$). Neonates born to hypertensive mothers had significantly lower birth weights (2.16 ± 0.38 kg) as against controls (2.75 ± 0.22 kg; $p < 0.001$). Similarly, placental weight was also significantly reduced in cases (334.09 ± 50.73 g) compared to controls (382.00 ± 50.20 g; $p < 0.001$). As expected, systolic and diastolic blood pressures were markedly elevated in the hypertensive group (151.32 ± 6.72 mmHg and 92.68 ± 4.48 mmHg, respectively) compared to the normotensive group (117.47 ± 3.89 mmHg and 78.00 ± 3.11 mmHg), with highly significant p-values (<0.001).

Table 2: Gross Morphological Placental Changes

Variable	Cases n(%)	Controls n(%)	Chi²	95% CI (Difference)	p-value
Gross Calcification	11/44 (26.7%)	0/30 (0.0%)	11.22	15.5% to 37.9%	0.001
Gross Infarction	4/44 (10.0%)	0/30 (0.0%)	3.74	2.4% to 17.6%	0.053
Retroplacental Clot	3/44 (8.3%)	0/30 (0.0%)	3.08	1.3% to 15.3%	0.079

Gross examination of the placenta revealed a significantly higher occurrence of calcification among cases (26.7%) compared to controls, where no calcification was noted ($p = 0.001$). Infarction was observed in 10.0% of placentae from hypertensive mothers, while absent in controls, though this did not reach statistical significance ($p = 0.053$). Retroplacental clots were identified in 8.3% of hypertensive cases and none among controls ($p = 0.079$).

Table 3: Histopathological Features

Variable	Cases n(%)	Controls n(%)	Chi²	95% CI (Difference)	p-value
Syncytial Knots	28/44 (65.0%)	0/30 (0.0%)	38.59	52.9% to 77.1%	<0.001
Villous Infarction	3/44 (8.3%)	0/30 (0.0%)	3.08	1.3% to 15.3%	0.079
Chorangiosis	4/44 (10.0%)	0/30 (0.0%)	3.74	2.4% to 17.6%	0.053

Histopathological evaluation demonstrated striking differences between groups. Syncytial knots were present in 65.0% of hypertensive placentae, whereas no such changes were observed in controls, a highly significant finding ($p < 0.001$). Villous infarction (8.3%) and chorangiosis (10.0%) were also detected exclusively in cases, while absent in controls, though these differences were only marginally significant ($p = 0.079$ and $p = 0.053$, respectively).

Table 4: Maternal and Fetal Outcomes

Variable	Cases n (%) (n = 44)	Controls n (%) (n = 30)	p-value
Low Birth Weight (<2.5 kg)	30 (68.2%)	0 (0%)	<0.001
Preterm Delivery (<37 weeks)	38 (86.4%)	22 (73%)	0.963
Proteinuria	33 (75.0%)	0 (0%)	<0.001
Edema	32 (72.7%)	0 (0%)	<0.001
Convulsions	4 (9.1%)	0 (0%)	0.119

Table 4 shows that adverse maternal and fetal outcomes were markedly more common among hypertensive pregnancies. Low birth weight was observed in 68.2% of cases, while none of the controls had low birth weight neonates ($p < 0.001$). Preterm delivery was frequent in both groups (86.4% in cases vs 73% in controls) with no statistically significant difference. Maternal complications such as proteinuria (75.0%) and edema (72.7%) were significantly associated with pregnancy-induced hypertension and were absent in controls ($p < 0.001$ for both). Convulsions occurred in 9.1% of cases but were not observed in controls, though this difference did not reach statistical significance.

DISCUSSION

Table 1 (Baseline characteristics): In the present cohort, women with PIH delivered at an earlier mean gestational age than normotensive controls (33.3 vs 34.8 weeks; p=0.015), and their neonates had markedly lower birth weight (2.16 vs 2.75 kg; p<0.001). Placental weight was also significantly reduced in cases (334 g vs 382 g; p<0.001). These findings align with the established pathophysiology in which defective trophoblastic remodeling of spiral arteries causes maternal vascular malperfusion (MVM), chronic villous hypoxia, and impaired fetoplacental growth, culminating in lower placental and birth weights and earlier delivery. Talpur RA et al.(2020).[5] The very large differences in SBP/DBP between groups (both p<0.001) are expected by definition of PIH and mirror the hemodynamic and endothelial dysfunction central to the disease. Stereological and morphometric work has repeatedly linked reduced placental mass and surface area to diminished exchange capacity and poorer neonatal anthropometrics, corroborating the birth-weight gap we observed Bhojwani K et al.(2022).[6] Indian series evaluating preeclampsia similarly report lower placental and neonatal weights and earlier gestational age at delivery among hypertensive pregnancies, supporting the external validity of our baseline data Aman S et al.(2024).[7]

Table 2 (Gross morphological placental changes): On gross examination, calcification was significantly more frequent in PIH placentae (26.7% vs 0%; p=0.001), while infarcts (10.0% vs 0%; p=0.053) and retroplacental clots (8.3% vs 0%; p=0.079) trended higher but narrowly missed conventional significance thresholds. Increased gross calcification in hypertensive placentas has been reported widely and is interpreted as accelerated villous maturation and terminal villous stress under chronic hypoxia Dhakal B et al.(2021).[8] Infarcts and retroplacental hematomas reflect focal ischemic necrosis and abruption-type pathology associated with MVM; their directionally higher rates here are consistent with multiple case-control and autopsy studies in PIH, where the

magnitude often scales with disease severity and early-onset phenotypes. The borderline p-values for infarcts and retroplacental clots likely reflect limited power (especially with zero events in controls) and the use of two-by-two tests sensitive to small counts; nevertheless, the confidence intervals (Table 2) point toward clinically meaningful differences that are biologically consonant with PIH placentation. Özgökçe Ç et al.(2023).[9]

Table 3 (Histopathological features): Microscopically, syncytial knots were strikingly more common in cases (65.0% vs 0%; p<0.001), with exclusive occurrence (in our data) of chorangiosis (10.0%; p=0.053) and villous infarction (8.3%; p=0.079) in the PIH group. Increased syncytial knotting-nuclear aggregates on terminal villi-represents accelerated villous maturation under hypoxic stress and is a hallmark of MVM in hypertensive disorders Salih MM et al.(2022).[10] Chorangiosis (hypervascular villous change) is classically linked to chronic low-grade hypoxia and has been described more often in high-altitude gestations, diabetes, and PIH; its presence here further supports sustained hypoxic drive in the PIH placenta. Villous infarction, a downstream expression of occlusive/malperfusive lesions, is commonly reported in preeclampsia and associates with fetal growth restriction and adverse perinatal outcomes. Our effect directions and magnitudes mirror prior Indian datasets where syncytial knots, perivillous fibrin, and infarcts are consistently higher in PIH than controls Nayak JN et al.(2024).[11]

Table 4 (Maternal and fetal outcomes): A substantial proportion of pregnancies complicated by PIH resulted in adverse outcomes. Low birth weight was observed in 68.2% of cases compared to none in the control group ($p < 0.001$), highlighting a strong association between PIH and fetal growth restriction. Although preterm delivery was common in both groups (86.4% in cases vs 73% in controls), the difference was not statistically significant ($p = 0.963$). The persistence of a marked low-birth-weight burden despite comparable preterm rates underscores the role of growth restriction independent of gestational age, a well-recognized feature of preeclampsia pathobiology, as reported by Srivastava A et al. (2025).[12] The lack of a significant intergroup difference in preterm birth may reflect the relatively high preterm rate among controls or local obstetric practices favoring indicated preterm delivery for non-hypertensive reasons. Maternal disease markers were predominantly seen in the PIH group, with proteinuria present in 75.0% and edema in 72.7% of cases, while both were absent in controls ($p < 0.001$ for each), consistent with underlying endothelial dysfunction and capillary leak. Convulsions occurred exclusively among cases (9.1%) but did not achieve statistical significance, likely due to the small number of events, in agreement with observations by Deshpande S. et al. (2024).[13]

CONCLUSION

The present study demonstrates that pregnancy-induced hypertension is associated with significant alterations in placental morphology and histopathology. Hypertensive pregnancies showed reduced gestational age at delivery, lower birth and placental weights, and markedly elevated maternal blood pressure when compared to normotensive controls. Gross examination revealed increased calcification, infarcts, and retroplacental clots, while histopathological analysis highlighted increased syncytial knots, villous infarction, and chorangiosis. These changes reflect the underlying maternal vascular malperfusion and hypoxic stress in PIH, ultimately translating into adverse maternal and fetal outcomes such as low birth weight and maternal complications. Thus, placental examination provides a valuable window into the disease process and emphasizes the importance of early diagnosis and management to improve perinatal outcomes.

Limitations of the study

1. The study was hospital-based with a relatively modest sample size (cases = 44, controls = 30), which may limit the generalizability of the findings to larger populations.
2. The cross-sectional design precludes assessment of longitudinal changes in placental morphology during pregnancy.
3. Some gross and microscopic lesions (e.g., infarction, chorangiosis) had low frequency, reducing statistical power to detect significance.
4. Confounding maternal variables such as nutritional status, socioeconomic factors, and other comorbidities were not extensively adjusted for.
5. Advanced histochemical and immunohistochemical markers (e.g., angiogenic/antiangiogenic factors, vascular remodeling markers) were not evaluated, which could have provided deeper mechanistic insights.

REFERENCES

1. Samaddar A, Roy UG, Saha I, Mangal S. Histopathological changes in placenta in pregnancy-induced hypertensive patients and correlation with fetal outcome-A tertiary care hospital study. Biomedical and Biotechnology Research Journal (BBRJ). 2021 Oct 1;5(4):440-5.
2. Hamzah SS, Yar A. Histopathological Changes In Placentas Due To Pregnancy-Induced Hypertension And Gestational Diabetes Compared With Normal Term Placenta. Sys rev pharm. 2021 Mar 1;12(1):844-9.
3. Lavanya R, Miya MA, Bhavya N, Jones MR, Quadri SS. Study of Histopathological Changes in Placenta in Hypertensive Disorders of Pregnancy. European Journal of Cardiovascular Medicine. 2023 Jul 1;13(3).
4. Naz F, Iftikhar S, Rehman Z, Afridi F, Afridi S, Rehman S. Morphometric, Histological Variations in the Placenta of Normotensive and Pregnancy Induced Hypertensive Mothers. Advances in Basic Medical Sciences. 2024 Jun 21;8(1):17-22.
5. Talpur RA, Siddiqui S, Khowaja S, Noor N, Baloch MS, Qazi MM. Histomorphometric Variations of the Placenta in

Normal and Hypertensive Pregnancies. Journal of Islamabad Medical & Dental College. 2020 Dec 31;9(4):242-8.
6. Bhojwani K, Agrawal A, Agrawal AK. Study of histopathological changes in the placenta in preeclampsia. Cureus. 2022 Oct 16;14(10).
7. Aman S, Saleem UE, Roshan N, Azmat S, Asad M, Mahsud MS. Gross morphological changes in placentae in patients of pregnancy induced hypertension in district Dera Ismail Khan. Frontiers in Health Informatics. 2024 Dec 1;13(8).
8. Dhakal B, Singh VK, Narasimhan R, Talwar OP. Pathological changes in placentas of pregnant females with Gestational hypertension. Annals of Clinical Chemistry and Laboratory Medicine. 2021 Dec 31;4(1):20-5.
9. Özgökçe Ç, Öcal A, Ermiş IS, Deveci E. Histopathological, ultrastructural, and immunohistochemical examination of changes in the placenta as a result of severe preeclampsia. Acta Cirúrgica Brasileira. 2023 May 15;38:e382023.
10. Salih MM, Ali LE, Siniyeh AA. Histomorphometric study of placental blood vessels of chorion and chorionic villi vascular area among women with preeclampsia. Placenta. 2022 Jun 24;124:44-7.
11. Nayak JN, Sunitha B, Rajilarajendran H. Morphometric and Histological Changes of the Placenta in Hypertensive Disorders of Pregnancy. Journal of the Anatomical Society of India. 2024 Oct 1;73(4):364-7.
12. Srivastava A, Singh B, Singh Y, Singh S, Agrawal S, Singh R, Sarkar R, Ragini I. Microscopic Studies of Human Placenta in Pregnancy Induced Hypertensive Patients. Int J Acad Med Pharm. 2025;7(4):319-24.
13. Deshpande S. A cross sectional study of morphology and morphometry of human placenta amongst women with pregnancy induced hypertension and without pregnancy induced hypertension. Int J Acad Med Pharm. 2024;6(3):181-7.