A Cross-Sectional Study on a Structured Histopathological Scoring System for Placental Changes in Normal and Hypertensive Disorders of Pregnancy

1. **Dr. Nafisa Parveen (Corresponding Author)**

Postgraduate, Upgraded Department of Pathology, Osmania Medical College, Hyderabad, Telangana State

2. **Dr. B. S. Nithyananda**

Professor, Department of Pathology, Niloufer Hospital, Osmania Medical College, Hyderabad, Telangana State

3. **Dr. Naval Kishore Bajaj**

Professor and HOD, Upgraded Department of Pathology, Osmania Medical College, Hyderabad, Telangana State

4. **Dr.Swetha Annaram**

Assistant Professor, Upgraded Department of Pathology, Osmania Medical College, Hyderabad, Telangana State

ABSTRACT

Background: Hypertensive disorders of pregnancy (HDP) are a leading cause of maternal and perinatal morbidity and mortality. Placental histopathology reflects the severity of uteroplacental insufficiency; however, lack of standardized reporting limits its clinical utility.

Aim

To evaluate placental histopathological changes in hypertensive disorders of pregnancy using a structured scoring system and correlate these findings with fetal outcomes.

Materials and Methods

This cross-sectional observational study included 214 placentae, comprising 107 normotensive and 107 hypertensive pregnancies, collected over two years at a tertiary care centre in Hyderabad. Placentae were examined grossly and microscopically using hematoxylin and eosin staining. A semi-quantitative scoring system assessed fibrin deposition, maternal floor infarction, syncytial knots, calcification, and villous basement membrane thickening. Statistical analysis was performed using SPSS v27.

Results

Placentae from hypertensive pregnancies showed significantly higher histopathological scores compared to normotensive controls ($p < 0.05$). Increased syncytial knots and fibrin deposition were the most frequent lesions. Higher lesion scores correlated significantly with prematurity, low birth weight, increased NICU admissions, and stillbirths, particularly in severe pre-eclampsia and eclampsia.

Conclusion

A structured histopathological scoring system provides an objective and reproducible method for placental reporting in hypertensive disorders of pregnancy and demonstrates strong correlation with adverse fetal outcomes.

Keywords: Placenta, Hypertensive disorders of pregnancy, Histopathology, Scoring system, Fetal outcome

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Introduction

The placenta is a vital organ responsible for maternal-fetal exchange and reflects intrauterine events affecting pregnancy outcomes [1]. Hypertensive disorders of pregnancy complicate 5–10% of pregnancies and are strongly associated with abnormal trophoblastic invasion and defective spiral artery remodelling, resulting in uteroplacental ischemia [2]. These changes manifest as characteristic histopathological lesions including increased syncytial knots, fibrin deposition, infarction, and villous maturation abnormalities [2].

Despite its diagnostic value, placental examination often remains descriptive and subjective. Standardized histopathological scoring systems allows objective evaluation and improved clinico-pathological correlation [3]. This study evaluates placental histopathological changes using a structured scoring system and correlates them with fetal outcomes.

Materials and Methods

Study Design and Setting

A cross-sectional observational study conducted over two years in the Department of Pathology, Niloufer Hospital and Modern Government Maternity Hospital, Hyderabad.

Study Population

- Total placentae: 214
- Normotensive pregnancies: 107
- Hypertensive disorders of pregnancy: 107
  (Chronic hypertension, gestational hypertension, non-severe pre-eclampsia, severe pre-eclampsia, eclampsia)

Inclusion Criteria

- Singleton pregnancies
- Diagnosed hypertensive disorders of pregnancy
- Normotensive pregnancies as controls

Exclusion Criteria

- Multiple gestation
- Gestational diabetes mellitus
- Chronic renal or cardiovascular disease
- Congenital fetal anomalies

Placental Examination

Placentae were fixed in 10% neutral buffered formalin. Gross examination included placental weight, umbilical cord length and insertion, and membrane characteristics. Multiple sections were processed and stained with hematoxylin and eosin.

Histopathological Scoring System

Lesions assessed included:

- Fibrin deposition (FDS).
- Maternal floor infarction (MFI).
- Syncytial knots (SK).
- Calcification
- Villous basement membrane thickening (V BMT).
- Each parameter was graded semi-quantitatively (Score 0–2).
- Clinical records including patient history, gestational age & fetal birth weight were taken.

Score	Fibrin Deposition	Maternal Floor Infarction	Syncytial Knots	Calcification	Villous Basement Membrane Thickening
0	Histological absence	Absent or <5% infarction	Absent	Absent	Absent or <3% involvement
1	~10% intravillous or perivillous fibrin	>5% in a single area	Present in one low power field	Present in one field	>3% thickening
2	≥30% of both fibrin types	>5% in multiple areas	—	Multiple fields/sections	Hyalinization present

TABLE 1: SCORING SYSTEM

Statistical Analysis

Data were analysed using SPSS v27. Chi-square and t-tests were applied. A p-value <0.05 was considered statistically significant.

Observations & Results

Age Group (years)	Normal	HDP				
		Chr HTN	Gest HTN	NSPE	SPE	Eclampsia
<19	2	0	1	1	0	0
20-24	44	3	6	35	5	1
25-29	52	0	1	31	6	3
30-34	8	0	2	7	2	1
>35	1	0	1	1	0	0
Total	107	3	11	75	13	5

Table 2: Standard demographic representation

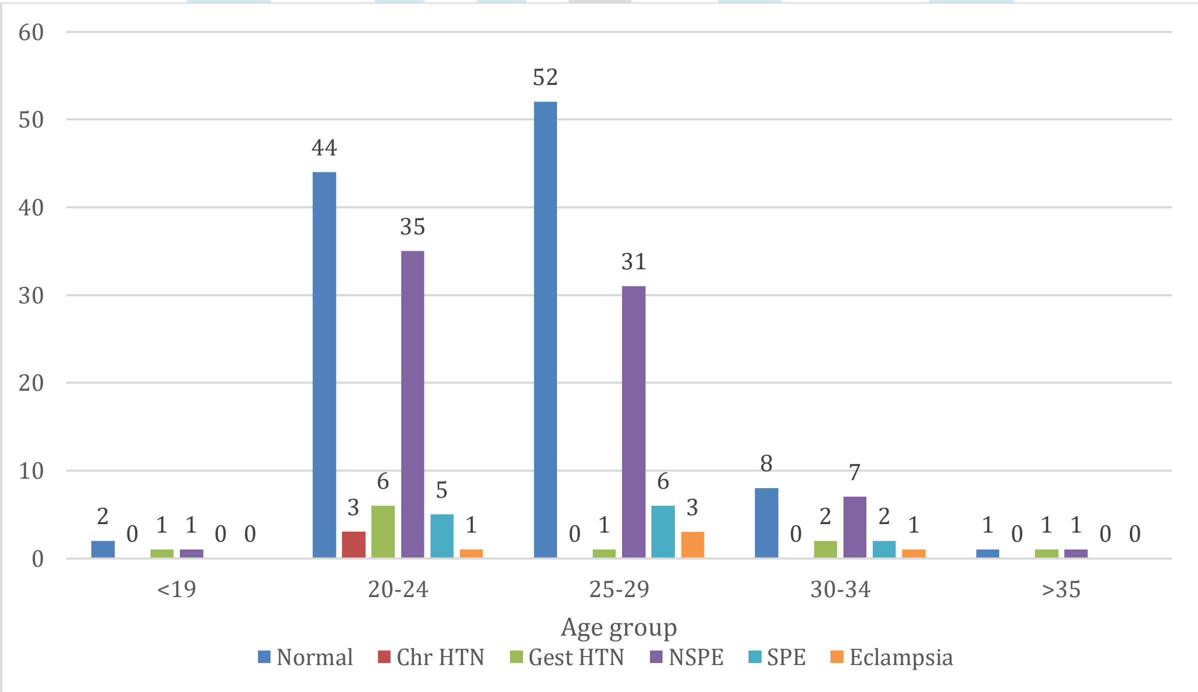

Chart 1: Age distribution

- The majority of HDP occurred in the 20–29 years age group, with non-severe preeclampsia (NSPE) being the most prevalent subtype across all age categories.

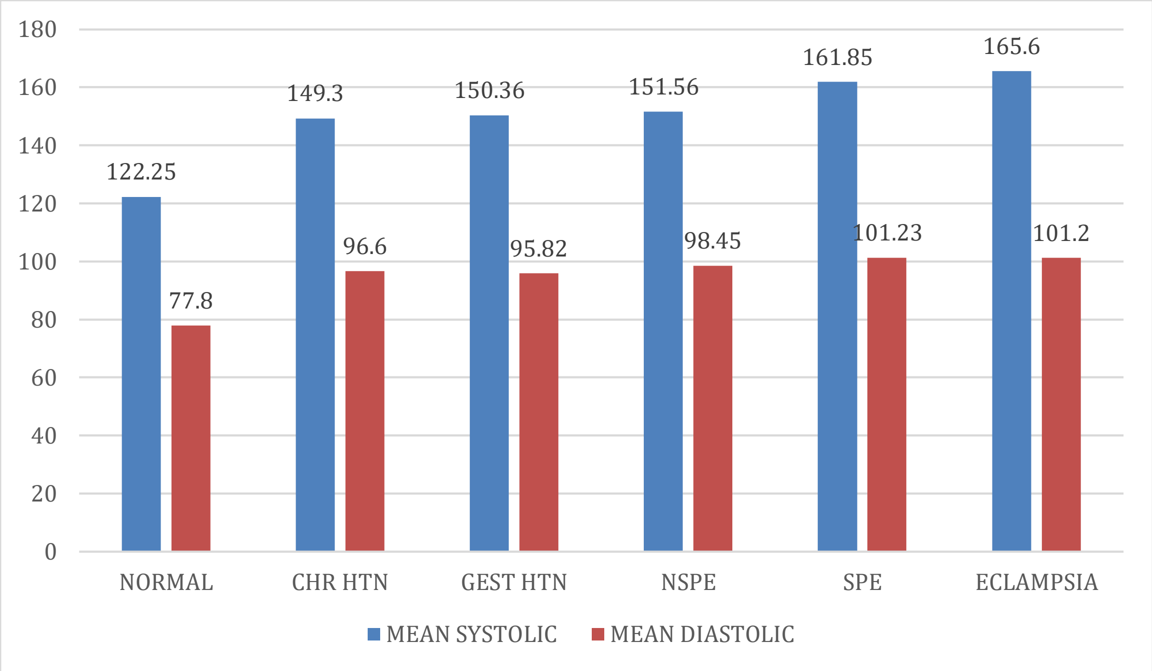

Chart 2: Mean blood pressure of normal and HDP groups

	Diagnosis												P value
	Normal		NSPE		SPE		Chr HTN		Gest HTN		Eclampsia		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Maternal Age (years)	25.2	2.8	22.7	1.5	24.7	5.7	25.0	3.1	25.8	3.3	26.6	3.4	0.594
Gestational Age (weeks)	37.3	1.5	33.7	3.5	35.1	4.7	35.6	2.9	32.6	3.3	29.0	7.0	0.001
Birthweight (Kgs)	2.90	0.36	2.20	0.26	2.32	0.76	2.33	0.47	1.92	0.43	1.84	0.83	0.002
Placenta Weight (gms)	369.1	32.9	306.7	51.3	324.5	67.7	355.5	79.7	301.5	71.7	300.0	127.5	0.001
UC length (cms)	28.8	3.2	23.3	6.5	30.6	10.8	24.9	5.9	25.8	6.1	22.1	3.7	0.002

Table 3: Comparison of Maternal and Fetal Parameters Across Normal & HDP

- Maternal age did not differ significantly across diagnostic groups.

- Gestational Age at delivery was significantly lower in hypertensive groups, especially in eclampsia (29.0 weeks) and gestational hypertension (32.6 weeks), indicating a strong association with preterm birth.
- Birthweight showed a marked decrease in hypertensive pregnancies with normal pregnancies averaging 2.90 kg, while eclampsia cases averaged just 1.84 kg reflecting fetal growth restriction.
- Placental Weight was also significantly reduced in hypertensive disorders.
- Umbilical Cord Length was shorter in hypertensive pregnancies.

Fetal Outcome		HISTOPATHOLOGICAL SCORING													
		FDS			MFI			SK		CALCIFI-CATION			V BMT		
		0	1	2	0	1	2	0	1	0	1	2	0	1	2
Prematurity	Normal	18	2	0	20	0	0	16	4	20	0	0	20	0	0
	Chr HTN	1	0	1	0	2	0	1	1	2	0	0	2	0	0
	GHTN	0	2	3	5	0	0	3	2	2	3	0	5	0	0
	NSPE	11	18	8	30	7	0	11	26	27	10	0	36	1	0
	SPE	3	4	5	8	4	0	1	11	8	4	0	12	0	0
	Eclampsia	0	1	3	2	2	0	2	2	4	0	0	3	1	0
Birth weight/ IUGR	Normal	7	1	0	8	0	0	6	2	8	0	0	8	0	0
	Chr HTN	2	0	1	1	2	0	1	2	2	1	0	3	0	0
	GHTN	0	2	3	5	0	0	3	2	2	3	0	5	0	0
	NSPE	16	27	5	43	5	0	13	35	32	16	0	47	1	0
	SPE	3	4	5	8	4	0	1	11	8	4	0	12	0	0
	Eclampsia	0	1	3	2	2	0	2	2	4	0	0	3	1	0
NICU admission	Normal	18	2	0	20	0	0	16	4	20	0	0	20	0	0
	Chr HTN	1	0	1	0	2	0	1	1	2	0	0	2	0	0
	GHTN	0	2	3	5	0	0	3	2	2	3	0	5	0	0
	NSPE	11	18	8	30	7	0	11	26	27	10	0	36	1	0
	SPE	3	4	5	8	4	0	1	11	8	4	0	12	0	0
	Eclampsia	0	1	3	2	2	0	2	2	4	0	0	3	1	0
Still birth	Normal	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Chr HTN	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GHTN	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	NSPE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SPE	1	2	2	3	2	0	0	5	4	1	0	5	0	0
	Eclampsia	0	1	1	1	1	0	1	1	2	1	0	2	1	0

TABLE 4: Correlation of fetal outcomes with histopathological scoring

- Histopathological scores increase in relation to severity of the disease i.e, higher scores are seen with NSPE, SPE, Eclampsia in terms of fibrin deposition score, MFI, syncytial knots, calcifications.
- Majority of the HDP cases showed high syncytial knots score, which are usually rare in healthy pregnancies.
- MFI nearly absent in patients of chronic hypertension found in eclampsia, SPE, NSPE indicating MFI could be a sign for severe placental ischaemia.
- In SPE, Eclampsia VBMT is more.
- All stillbirths are observed only in SPE & Eclampasia concluding that poor placental reserve.Eclampsia, SPE, NSPE account for majority of NICU admissions.

Fetal outcome	**Normal (n=107) (%)**	**Hypertensive Disorders of Pregnancy**				
		Chr HTN (n=3) (%)	**Gest HTN (n=11) (%)**	**NSPE (n=75) (%)**	**SPE (n=13) (%)**	**Eclampsia (n=5) (%)**
NICU	28 (26%)	3 (100%)	6 (55%)	49 (65%)	8 (62%)	3 (60%)
Prematurity	20 (18%)	2 (67%)	5 (45%)	37 (49%)	12 (92%)	4 (80%)
p-value	NICU admission (N/ HDP)= p<0.00001, **Highly significant** Prematurity(N/HDP)= p<0.0000001, **Highly significant**					

Table 5: Association between HDP and fetal outcome

Histopathological Scoring		**Normal**	**Hypertensive Disorders in Pregnancy**					
			Chr HTN	**Gest HTN**	**NSPE**	**SPE**	**Eclampsia**	**p value**
Fibrin deposition	0	104 (97.2%)	2 (8.0%)	0 (0.0%)	20 (80.0%	3 (12.0%)	0 (0.0%)	p<0.0001 Significant
	1	3 (2.8%)	0 (0.0%)	3 (6.4%)	39 (83.0%)	4 (8.5%)	1 (2.1%)	
	2	0 (0%)	1 (2.9%)	8 (22.9%)	16 (45.7%)	6 17.1%	4 (11.4%)	
Maternal floor infarction	0	107 (100%)	1 (1.2%)	10 (11.8%)	63 (74.1%)	8 (9.4%)	3 (3.5%)	p<0.0002 Significant
	1	0 (0%)	2 (9.1%)	1 (4.5%)	12 (54.5%)	5 (22.7%)	2 (9.1%)	
Syncytial knots	0	76 (71%)	1 (4.0%)	5 (20.0%)	16 (64.0%)	1 (4.0%)	2 (8.0%)	p<0.0002 Significant
	1	31 (29%)	2 (2.4%)	6 (7.3%)	59 (72.0%)	12 (14.6%)	3 (3.7%)	
Calcification	0	107 (100%)	2 (2.5%)	8 (10.0%)	57 (71.3%)	8 (10.0%)	5 (6.3%)	p<0.0001 Significant
	1	0 (0%)	1 (3.7%)	3 (11.1%)	18 (66.7%)	5 (18.5%)	0 (0.0%)	
Villous BM thickening	0	107 (100%)	3 (2.9%)	11 (10.6%)	73 (70.2%)	13 (12.5%)	4 (3.8%)	p=0.609 Not significant
	1	0 (0%)	0 (0.0%)	0 (0.0%)	2 (66.7%)	0 (0.0%)	1 (33.3%)	

Table 6: Distribution of placental histopathological features across hypertensive disorders of pregnancy

- Maternal Floor Infarction is more common in hypertensive disorders, particularly in severe pre-eclampsia and eclampsia.
- Syncytial Knots show a higher frequency in gestational hypertension and eclampsia.

- Calcification is more prevalent in severe pre-eclampsia while villous BM thickening is found in eclampsia.
- Fibrin Deposition increases with the severity of hypertension, with grade 2 fibrin deposition being widespread in severe preeclampsia and eclampsia, indicating it may be a key pathological marker for severe hypertensive disorders.

MICROSCOPY

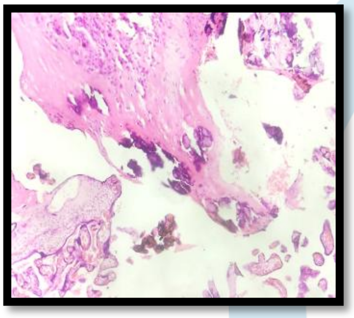

Figure 1: CALCIFICATION (H&E, 100X)

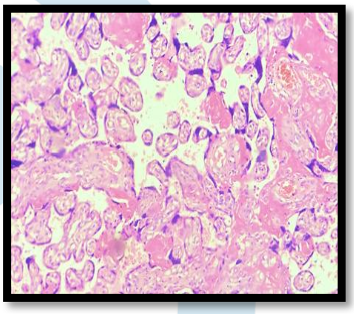

Figure 2: INCREASED SYNCYTIAL KNOTS, FIBRIN DEPOSITION (H& E, 100X)

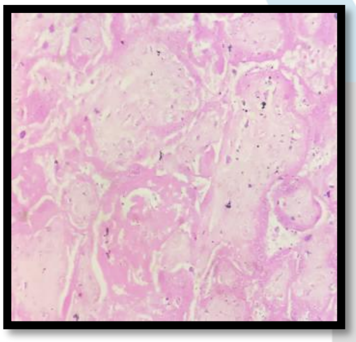

Figure 3: MATERNAL FLOOR INFARCTION (H& E, 400X)

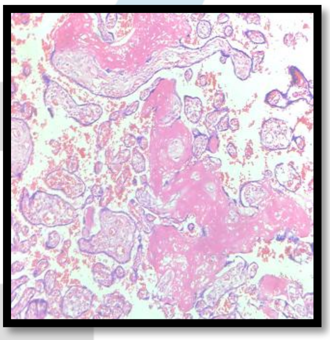

Figure 4: FIBRIN DEPOSITION (H&E, 100X)

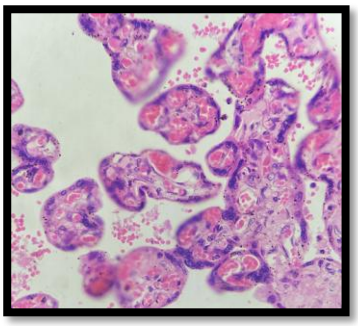

Figure 5: VILLOUS BM THICKENING (H&E, 400X)

Study	Fibrin Deposition (%)	Syncytial Knots (%)	Maternal Floor Infarction (%)	Calcification (%)	Low Birth Weight Incidence	Still Birth (%)	Scoring
Current Study	74.7%	69.1%	21.5%	24.3%	61.68%		Done
Samaddar et al [4]	50%	-	46%	44%	-	6%	-
Verma et al. (2021) [5]	69%	71%	24%	25%	63%	-	-
Kovo et al. (2013) [6]	76%	75%	23%	28%	65%	-	-
Redline et al. (2015) [3,7]	71%	68%	22%	26%	62%	-	-
Nahar et al. (2020) [8]	80%	95%	85%	Marked	-	7.5%	-
Chhatwal et al[9]	83.3%	90.5%	16.9%	45.2%	-	-	-
Deepak Donthi et al[10]	77%	73.3%	55%	35%	-	-	Done

Table 7: Comparison of Histopathological Findings with previous studies

Discussion

- This cross-sectional study was carried out in a tertiary care hospital to assess the morphological and histological characteristics of placentae in normal and HDP using a standardized scoring system. The overall sample size was 214 placentae, split evenly between the normotensive (n = 107) and HDP groups (n = 107).
- The mean maternal age was in the HDP groups was 24.8 ± 3.5 years and in the normal group it was 25.10 years.
- The mean gestational age at delivery was substantially lower in HDP patients (34.81 weeks) than in normal pregnancies (37.34 weeks), indicating a higher prevalence of preterm deliveries in the hypertensive group.
- The mean systolic BP is 150 ± 10 mmHg and the mean diastolic BP 100 ±8 mmHg. BP readings fall within the expected range for HDP, consistent with other studies.
- NICU admission rates are in line with other studies, reflecting the increased neonatal morbidity associated with HDP. Furthermore, preterm and NICU admissions occurred in 22.06% of HDP patients compared to 6.87% in the normotensive group.
- In our study, the mean placental weight in HDP was substantially lower (341.78 g) than in normal pregnancies (369.07 g).
- In HDP patients, 74.7% had fibrin deposition compared to 2.8% in normals, with 32.7% having a score of 2.
- 69.1% of HDP cases had syncytial knots, compared to 28.9% in normals.
- MFI was found in 21.5% of HDP patients in our study but was completely absent in the control group.
- In our analysis, cases with MFI had a greater prevalence of NICU admissions, which supports the clinical significance of this finding.

- The Chi-square test showed significant relationships ($p < 0.0001$) for all measures except villous basement membrane thickness, suggesting limited diagnostic usefulness when employed alone.
- 24.3% of HDP placentae revealed calcification (compared to 0% in normals).
- Only two HDP cases (1.87%) demonstrated villous BM thickening, while the lesion was absent in normotensive individuals.
- Hypertensive pregnancies demonstrated significantly reduced gestational age, placental weight, birth weight, and umbilical cord length compared to normotensive pregnancies. Syncytial knots and fibrin deposition showed a progressive increase with severity of hypertension. All stillbirths occurred in severe pre-eclampsia and eclampsia groups.
- Higher composite histopathological scores correlated strongly with prematurity, NICU admission, and fetal growth restriction ($p < 0.001$).

Lesion	**Most Common in**	**Significance**
Fibrin deposition	HDP (74.7%)	Indicates ischemic response
Syncytial knots	HDP (69.1%)	Marker of hypoxia, maturity
MFI	HDP (21.5%)	Associated with IUGR, stillbirth
Calcification	HDP (24.3%)	Sign of premature placental aging
BM thickening	Rare	Limited clinical value alone

Table 8: Summary of Key Lesions

Conclusion

- This cross-sectional study highlights the importance of placental histopathology in understanding the pathophysiological alterations associated with hypertensive disorders of pregnancy (HDP).
- A systematic analysis of 214 placentas using a structured scoring system revealed that gross and microscopic changes, particularly fibrin deposition, syncytial knotting, maternal floor infarction, and calcification, occur significantly more frequently in hypertensive pregnancies than in normotensive controls.
- These lesions were discovered to be strongly associated with fetal outcomes like prematurity, low birth weight, and NICU admissions, making them valid indicators of placental insufficiency and fetal impairment.
- The histopathological checklist scoring framework used in this study provided an effective, reliable, and clinically useful tool for quantifying placental damage and stratifying risk in effected pregnancies and their outcome.
- Comparative research with existing literature confirmed the findings and underlined the worldwide consistency of these pathogenic patterns, while also emphasizing the need of context-specific adaptations in Indian healthcare settings.
- The implementation of a semi-quantitative scoring system:
  - Provide objective histopathology reporting.
  - improves Consistency among institutions and observers.

• Effective communication between obstetricians and pathologists.

- This study provides the framework for bigger, multi-centric validations and recommends incorporating structured scoring systems into routine placental reporting to improve maternal-fetal care outcomes. With further refining and technology integration, such scoring models have the potential to be useful diagnostic, prognostic and teaching tools in obstetrics and pathology.

REFERENCES

1. Herrick EJ. Embryology, Placenta. In: StatPearls . Treasure Island (FL): StatPearls Publishing; 2023.

2. Roberts JM, Cooper DW. Pathophysiology of hypertensive disorders of pregnancy. Placenta. 2001;22(7):566–571.

3. Redline RW. *Placental pathology and clinical utility: survey of providers.* J Matern Fetal Neonatal Med. 2016;29(10):1608-12.

4. Samaddar A, Ghosh S, Dasgupta H, Dey R**.** Histomorphological changes of placenta in hypertensive disorders of pregnancy and its correlation with fetal outcome. *Int J Res Med Sci*. 2018;6(3):768–72.

5. Verma V, Nanda S, Rani K. Role of structured placental scoring in HDP: A tertiary care experience. Int J Reprod Contracept Obstet Gynecol. 2021;10(2):612–617.

6. Kovo M, Schreiber L, Ben-Haroush A, Bar J, Lerner-Geva L, Golan A, et al. The placental component in fetal growth restriction—analysis of a novel combined scoring system. *Placenta*. 2013 Aug;34(8):693–7.

7. Redline RW, Boyd TK, Roberts DJ, et al. Amsterdam criteria for placental lesions. Arch Pathol Lab Med. 2015;139(5):698–713.

8. Nahar K, Afroza S, Begum K, et al. Study of placental histopathological changes in hypertensive disorder of pregnancy. J Bangladesh Coll Phys Surg. 2020;38(3):126–132.

9. Chhatwal J, Chaudhary DN, Chauhan N. Placental changes in hypertensive pregnancy: a comparison with normotensive pregnancy. *Int J Reprod Contracept Obstet Gynecol*. 2018 Sep;7(9):3620-5.

10. Donthi D, Shilpa PS, Kiran S, Karuna R**.** Histopathological scoring system of placenta in diagnosis of preeclampsia and eclampsia: a tertiary hospital-based study. *Indian J Pathol Oncol*. 2019;6(2):192–7.