ORIGINAL ARTICLE ASIAN JOURNAL OF MEDICAL SCIENCES

Histological and morphometric study of human placenta in hypertensive pregnant women in a tertiary care hospital in West Bengal-a cross-sectional study

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Submission: 11-12-2024 Revision: 03-02-2025 Publication: 01-03-2025

ABSTRACT

Background: The placenta is a vital organ that develops during pregnancy and plays a critical role in fetal growth and development. It acts as a bridge between the maternal and fetal circulations, allowing for the exchange of nutrients, oxygen, and waste products. The placenta also produces hormones and growth factors necessary for fetal development and prepares the fetus for extrauterine life. Hypertensive disorders of pregnancy are a major cause of maternal and fetal morbidity and mortality. **Aims and Objectives:** To study the histological and morphometric changes of human placenta in hypertensive pregnant women in a tertiary care hospital in West Bengal. **Materials and Methods:** A cross-sectional study was conducted with placenta from 60 hypertensive pregnant mothers and 60 pregnant mothers with uncomplicated pregnancy from the Department of Obstetrics and Gynaecology, Jagannath Gupta Institute of Medical Sciences and Hospital, Budge Budge, West Bengal. The gross morphological and histological examination of placentae was done in the Department of Anatomy. **Results:** The mean age of hypertensive mothers was 26.5 ± 3.5295 years, which was slightly higher than that of nonhypertensive mothers (24 ± 3.3446 years). The placental weight, diameter and thickness were reduced in the hypertensive mothers. The hypertensive placentae showed higher incidence of fibrin deposition (33%), syncytial knots (23%), infarction (20%). Stromal fibrosis and villous obstruction were found in hypertensive placenta only. **Conclusion:** During pregnancy significant histomorphological changes in placenta are caused due to hypertensive disorders which lead to harmful and severe fetal outcomes. A valuable insight into the mechanism of placental dysfunction can be achieved through a detailed examination after delivery.

Key words: Placental morphology; Gestational hypertension; Histological changes

Access this article online

Website: https://ajmsjournal.info/index.php/AJMS/index

DOI: 10.71152/ajms.v16i3.4345

E-ISSN: 2091-0576

P-ISSN: 2467-9100

INTRODUCTION

Placental morphology plays a critical role in the health and development of the fetus throughout gestation. The placenta serves as a crucial interface between the maternal and fetal circulatory systems helping in exchange of nutrients and gases and also helping in elimination of metabolites. Structurally it is highly specialized and consists of maternal components, such as decidua, and fetal components, including chorion and villi, which collectively support efficient physiological functions.[1] Histologically, the placenta consists of several key layers: Cytotrophoblast and syncytiotrophoblast layers which are essential for trophoblastic invasion into the maternal endometrium

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during the process of implantation. The study of placental morphology is not only essential for recognizing healthy pregnancies but also for identifying the wide spectrum of pathological conditions, such as hypertensive disorders and intrauterine growth restriction, which can arise from morphological abnormalities.[2] Previous studies have suggested that alterations in the structure and function of the placenta like reduced surface area of villi, along with decreased vascularization, and increased inflammation may lead to the development of hypertensive disorders in pregnancy.[3-5]

Despite the potential role of the placenta in hypertensive disorders of pregnancy, there is a paucity of data on the histological changes that occur in the placenta of hypertensive pregnant women in India. West Bengal has one of the highest burdens of maternal and infant mortality in Eastern India, with hypertensive disorders of pregnancy being one of the major contributing factors.[6] Therefore, understanding the histological changes that occur in the placenta of hypertensive pregnant women in West Bengal may help to improve our understanding of the underlying pathophysiology of these disorders and help in improvement of timely clinical management and prevention feto-maternal morbidity and mortality.

Aims and objectives

Aims

To study the histological and morphometric changes of human placenta in hypertensive pregnant women in a tertiary care hospital in West Bengal.

Objectives

1. To measure the dimensions and weight of the placenta in hypertensive and non-hypertensive women
2. To study the histological changes in human placenta of hypertensive pregnant women
3. To compare the histological changes of the placenta in hypertensive women to nonhypertensive women with uncomplicated pregnancies.

MATERIALS AND METHODS

Approval was taken from Institutional Research and Ethics committee (JIMSH-IEC-05-2021). The study was conducted in the Jagannath Gupta Institute of Medical Sciences and Hospital an over 1 year period (November 1st, 2021-October 31st, 2022) of time. Sixty hypertensive and sixty non-hypertensive pregnant mothers were taken as case and comparison group in the study. The different types of hypertensive disorders were diagnosed following the NICE guidelines,[7] The sample size for the study was determined to ensure sufficient power to detect a difference between hypertensive and non-hypertensive pregnant mothers. The calculation was performed using the formula for two independent groups: $n=(Z\alpha/2+Z\beta)^2/\Delta^2$

Where $Z_{\alpha/2}$ be the Critical value for the significance level (α=0.05, two tailed), $Z\alpha/2$=1.96. $Z\beta$ be the Critical value for the desired power ($1-\beta$=0.80), $Z\beta$=0.84 and Δ be the Standardized effect size, set at Δ=0.36. Substituting these values into the formula: $n=(1.96+0.84)^2/0.362\approx60.5$ Thus, the required sample size per group is approximately 60.5 participants. However, to account for practical considerations and ensure a manageable study size, we rounded the sample size to 60 participants per group, leading to a total sample size of 120 participants. This sample size provides adequate power (80%) to detect a clinically meaningful difference between the two groups at a 5% significance level. This sample size calculation used the same power and level as was in the study by Siva Sree Ranga et al.[8]

Consent was taken from the pregnant women admitted in the Department of Gynecology and Obstetrics of JIMSH for delivery. Detailed antenatal history was taken.

After child birth, specimens from human placenta were collected immediately in 10% formalin containing jar for fixation of tissue to prevent decay and preserve the structures. Specimen was brought to the Anatomy department for examination, processing and staining. The placenta was checked for gross anomalies and the weight and dimensions was taken. Small tissue sections were prepared for processing. The tissues were dehydrated to remove excess water in increasing concentration of alcohol. To make the tissue transparent and ready for embedding, they were dipped in xylene. Tissues were then infiltrated with a molten embedding medium-paraffin wax and then cooled to solidify and form a block. The block is trimmed to expose the tissue surface for sectioning through a rotary microtome. Hematoxylin and Eosin staining was done. First, deparaffinization was done followed by rehydration using decreasing concentration of alcohol. Staining with Hematoxylin was done to stain the nuclei. Then, differentiation was done using acid-alcohol to refine the staining intensity followed by Eosin staining to stain the cytoplasm and extracellular matrix. Finally, dehydration was done using increasing concentration of alcohol followed by mounting on a slide and covering with the help of coverslip and DPX (glue) to make them ready for observation under microscope. Microphotographs were taken. Findings of microscopic examination was tabulated; statistical analysis was done and graphical representations were made.

RESULTS

The study employed a total of 120 participants, including 60 hypertensive and 60 non-hypertensive pregnant mothers taken as case and control. The mean age of hypertensive mothers was 26.5±3.5295 years and that of non-hypertensive mothers (24±3.3446 years) (Figure 1).

The mean placental weight, diameter, and thickness was found be lower in placenta of hypertensive mother in comparison to non-hypertensive cases. The values were statistically significant (P<0.001) (Table 1).

Fibrin deposition (Figure 2) findings was graded into Grade I (normal), Grade II (mild), and Grade III (moderate to severe). 94% of normal placentae showed Grade I fibrin deposition and 6% showed Grade II. In hypertensive cases, 76% was Grade II and 24% was Grade III.

The syncytial knots (Figure 3) found in histological slides of placentae, were divided into three gradings to give a clearer result. Grade I was described as (+) which means <5 syncytial knots/villi grade II as (++) indicating 5–10 knots/villi, whereas Grade III was (+++) indicating >10 knots/villi. It was found that in normal placentae all cases showed syncytial knots of Grade I type whereas the hypertensive placentae demonstrated 90% a Grade II type and 10% Grade III type (Table 2).

The villous stromal fibrosis (Figure 4) in our study was observed in both types of placentae but 60% of hypertensive showed increased fibrosis.

No increased calcium deposition was noted in both normal as well as hypertensive placentae.

DISCUSSION

Hypertension is a common medical condition among pregnant women that affects both the mother and the fetus. Hypertensive disorders of pregnancy are a major cause of maternal and fetal morbidity and mortality, accounting for 14% of all maternal deaths globally.[9] The placenta plays a very vital role in fetal growth and development and has been suggested to be a key factor in the development of hypertensive disorders in pregnancy.[10]

Figure 5 shows the distribution of normotensive and hypertensive pregnant women according to their age groups. The mean age of hypertensive mothers was 26.5±3.5295 years, which was slightly higher than that of non-hypertensive mothers (24±3.3446 years). Statistical analysis revealed a significant difference between the two groups

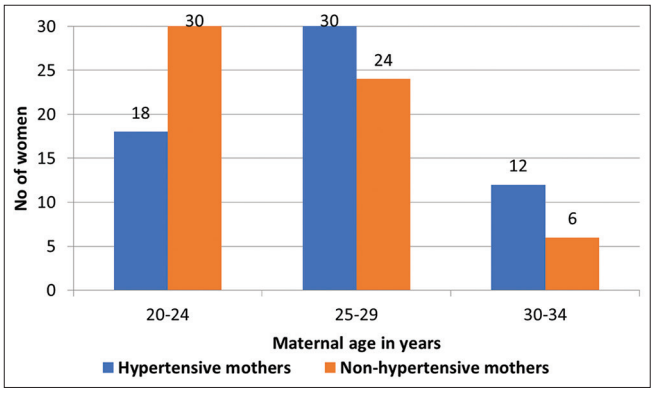

Figure 1: Distribution of normotensive and hypertensive pregnant women according to their age groups

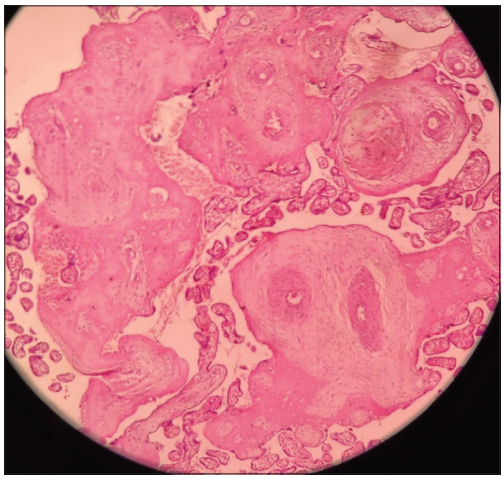

Figure 2: Microphotograph showing fibrin deposition (shown by arrow)

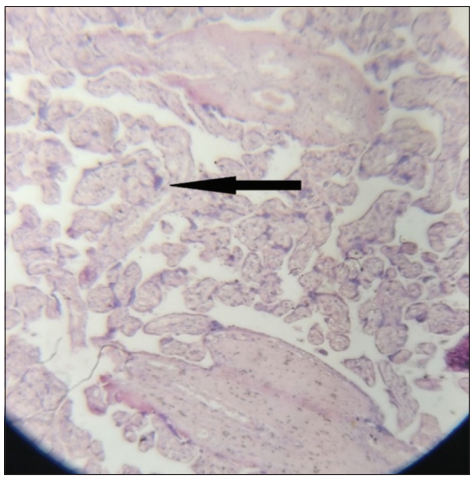

Figure 3: Microphotograph showing increased syncytial knots (shown by arrow)

(t=3.9825, P<0.001. In our study, the highest percentage of (50%) hypertensive mother was found in the age group of 25–29 years while normotensive mothers (50%) were highest in the age group of 20–24 years. This interesting finding may indicate that though the risk of hypertension increases with

Table 1: Placental morphology in hypertensive and non-hypertensive mothers

Variable	HT			Non-HT			Difference of mean	Significance of P
	n	Mean	SD	n	Mean	SD		
Placental weight (gm)	60	507.9	12.1	60	516.7	11.3	4.1172	P<0.001
Placental diameter (cm)	60	17.7	1.7	60	19.1	1.3	5.0672	P<0.001
Placental thickness (cm)	60	2.3	0.12	60	2.4	0.15	4.0324	P<0.001
Faeto-placental ratio	60	5.13	0.37	60	5.6	0.33	7.3432	P<0.0001

Table 2: Distribution of histological findings in placenta of hypertensive and non-hypertensive placenta

S. No.	Histological findings of placenta	Present/Absent	HT		Non-HT		Z-score	Significance
			No.	%	No.	%		
1	Fibrin deposition	Present	20	33.33	8	13.33	2.5900	<0.01
		Absent	40	66.67	52	86.67		
2	Syncytial knot	Present	14	23.33	3	5	2.8797	<0.01
		Absent	46	76.67	57	95		
3	Infarction	Present	11	18.33	2	3.45	2.6434	<0.01
		Absent	49	81.67	58	96.55		
4	Villous obstruction	Present	16	26.67	0	0	4.2967	<0.0001
		Absent	44	73.33	60	100		
5	Stromal fibrosis	Present	7	11.67	0	0	2.7265	<0.01
		Absent	53	88.33	60	100		

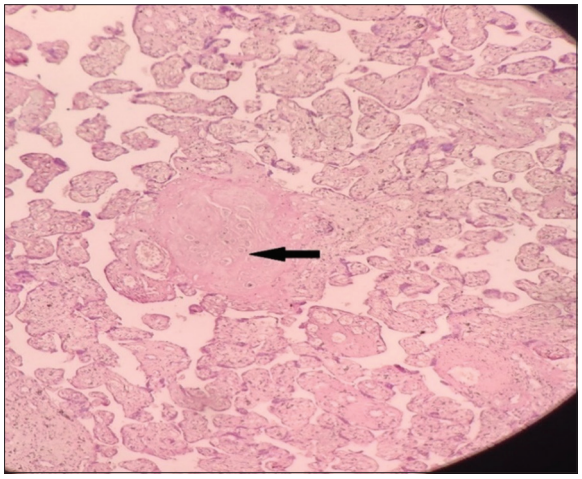

Figure 4: Microphotograph showing placental infarction (shown by arrow)

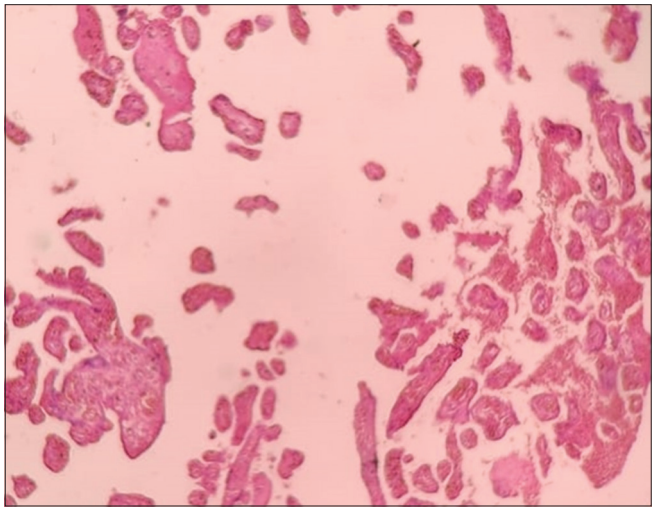

Figure 5: Microphotograph showing villous obstruction

maternal age but there are other important factors which may contribute to developing high blood pressure such as socioeconomic status, ethnicity, pre-existing diseases. The mean maternal age for hypertensive mothers was 28.60 years and controls were 25.23 years in Sharma et al.,[11] Gaur et al.,[12] Sankar et al.,[10] and Saleh and Dkhil[13] also noted similar findings. Gore et al.,[14] along with Saleh and Dkhil[13] and Gaur et al.,[12] found no significant association between maternal age amongst control and pregnancy induced hypertension group unlike our study along with Sharma et al.,[11] and Sankar et al.[10]

The average placental weight in our study was found to be lower for hypertensive mothers (507.9 g) in comparison to non-hypertensive (516.7 g) (Table 1). This was in accordance to the study trends of Sharma et al.,[11] -410.20 g in hypertensive and 480.80 g in non-hypertensive, Porwal et al., -409±88.69 g in hypertensive and 581±91.38 g in non-hypertensive.[15] Hypertension in pregnancy leads to uteroplacental insufficiency resulting in reduced blood flow to the placenta affecting its growth and nutrient transfer capabilities. This in turn affects fetal growth, increasing the risk of intrauterine growth restriction and small for gestational age infants.[16]

The mean placental diameter (17.7 cm) and the thickness (2.3 cm) was found significantly lower in hypertensive mothers in comparison to non-hypertensive mothers (19.1 cm diameter and 2.4 cm thickness) in our study (Table 1). This was in accordance to most of the other studies.[9,17,18] Cibils reported that the placentae from

hypertensive patients were significantly smaller than the normal, suggesting that the pathologic process interferes with the normal placental growth.[19]

In our study, we found 30% cases of fibrin deposition, 23.3% cases of syncytial knots, 13.3% cases of infarction, 26.7% cases of villous obstruction and 6.7% cases of stromal fibrosis in hypertensive placentae (Table 2). No increased calcium deposition was noted in both normal as well as hypertensive placentae in our study unlike the other studies such as Salmani et al.,[9] Samaddar et al.,[17] and Dutta et al.,[20] who reported 45–50% cases of increased calcification in hypertensive placenta.

33.33% of hypertensive and 13.33% of normotensive mothers showed fibrin deposition (Figure 6) similar to Porwar et al.,[15] showing an incidence of 33%. Samaddar et al.,[17] and Kambale et al.,[21] reported an occurrence of 44–50% cases showing fibrin deposition.

In their study, Siva Sree Ranga et al., found[8] found large number (63.3%) of syncytial knots, cytotrophoblastic proliferation, fibrinoid necrosis and villous hyalinization in hypertensive placentae. The purpose and development of syncytial knots is it still unclear but considered to be a part of a degenerative phenomenon, i.e., change due to ageing, a syncytial hyperplasia and trophoblastic ischemia or hypoxia. Reduced perfusion may result in numerous syncytial knots.[14] In our study, 23.3% of hypertensive mothers showed increased syncytial knots (Figure 3). Ahmed et al., reported a percentage of 20.4, 35.97 and 59.77 of syncytial knots in mild, moderate and severe cases of pregnancy induced hypertension.[22]

Increased blood pressure leads to increased vasospasm of the arteries, obliterative endarteritis, all leading to decreased uteroplacental blood flow resulting in increased incidence of placental infarction. 18% of hypertensive placenta presented with infarction in our study (Figure 4). Samaddar et al.,[17] reported an incidence of 46% which Dutta et al.,[20] of 78% cases with infarction.

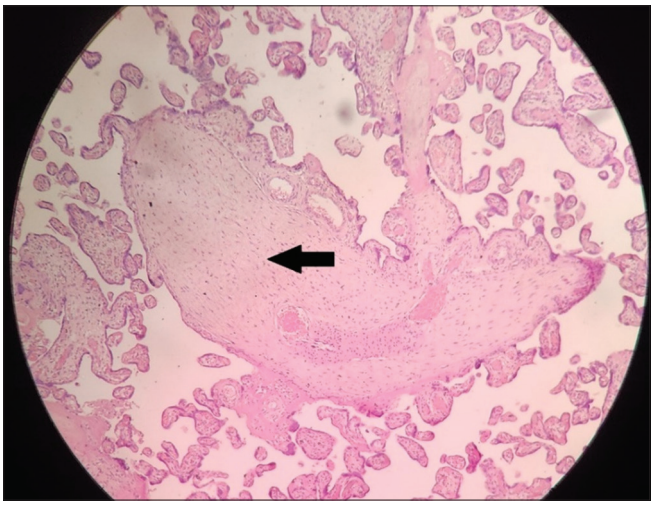

Figure 6: Microphotograph showing villous stromal fibrosis (shown by arrow)

Dhabhai et al., did similar study and found 57% cases of fibrinoid necrosis, 83% cases of syncytial knots, 33% cases of villous fibrosis and 50% cases of hypovascular villi.[23] Our study revealed villous obstruction in 27% (Figure 5) and stromal fibrosis (Figure 6) in 13 % hypertensive placenta similar to the study of Sharma et al.,[11] who reported a stromal fibrosis of 10%. Porwal et al.,[15] reported a much higher percentage of 63% stromal fibrosis. Reduced blood flow through the fetal blood vessels due to increased blood pressure results in villous obstruction and stromal fibrosis.[12]

Limitations of the study

This study encountered some limitations. The sample size was small, and our results might have differed with a larger study sample.

CONCLUSION

The present study was undertaken to provide a comprehensive understanding of variant histology of human placenta in hypertensive pregnancies that could assist the clinicians and surgeons in planning and performing surgical intervention to improve the fetomaternal wellbeing. It will help anatomists in gaining a meticulous knowledge on histology of human placenta.

ACKNOWLEDGMENT

The authors wholeheartedly thank the management, faculties, OT technicians, nurses, dissection hall attendants of Department of Anatomy and Department of Obstetrics and Gynaecology of Jagannath Gupta Institute of Medical Sciences Budge Budge for helping us conduct this study. We thank the Central Research and Ethics committee members for refining our study. Our heartfelt gratitude to the antenatal mothers who served as the participants.

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Authors' Contribution:
NC- Concept and design of the study; prepared first draft of manuscript, preparation of slides; **RC-** Preparation of slides, interpreted the results; reviewed the literature and manuscript preparation; **PP** -Specimen collection, Interpretation of results; **SC**- Statistical analysis and interpretation.

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Source of Support: Nil, **Conflicts of Interest:** None declared.