DOI: https://doi.org/10.53350/pjmhs020231712499

ORIGINAL ARTICLE

Compare the Histological Features Between Normal and Hypertensive Placenta

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ABSTRACT

Background: Hypertensive disorders during pregnancy, including preeclampsia, significantly affect maternal and fetal health. Understanding the histological changes in the placenta under hypertensive conditions is essential to improving management and outcomes. This study aims to compare histological features in normal and hypertensive placentas.

Objective: To assess and compare histological changes in placentas from patients with normal pregnancies and those with hypertensive disorders of pregnancy.

Methods: A retrospective analysis of placental samples from 96 patients was conducted. The study included 48 normal pregnancies and 48 pregnancies complicated by hypertension. Histological features were examined, including villous architecture, vascular changes, fibrin deposition, and trophoblast morphology.

Results: Significant differences were observed in the placental histology between normal and hypertensive pregnancies. In hypertensive placentas, abnormal spiral artery remodeling, villous fibrosis, increased syncytial knots, and fibrin deposition were prominent. In contrast, normal placentas exhibited well-formed villi with efficient blood flow and complete spiral artery remodeling.

Conclusion: Hypertensive disorders lead to significant histological changes in the placenta, which may contribute to adverse maternal and fetal outcomes. Histological assessment can aid in understanding the pathophysiology of hypertensive pregnancies and improve clinical management.

Keywords: Hypertensive disorders, preeclampsia, placenta, histology, spiral arteries, fibrin deposition.

INTRODUCTION

Hypertensive disorders of pregnancy (HDP), including preeclampsia, are common complications that can lead to severe maternal and fetal morbidity and mortality. It is estimated that HDP complicates around 5-8% of pregnancies worldwide and is a leading cause of preterm birth, fetal growth restriction, and maternal death[1]. One of the key manifestations of HDP is abnormal placental development, with various histological alterations that can impair placental function and lead to compromised fetal outcomes[2].

Histological studies have shown that the placenta in hypertensive pregnancies often exhibits a variety of structural abnormalities, including poor trophoblast invasion, abnormal spiral artery remodeling, and increased fibrin deposition[3]. These changes may result in reduced placental perfusion, ischemia, and inflammation, which are associated with adverse outcomes such as fetal growth restriction[4], preterm birth[5], and stillbirth[6].

Placental examination has long been recognized as a critical diagnostic tool for understanding the pathophysiology of hypertensive disorders. Studies have documented alterations in the villous architecture, trophoblast activity, and maternal vascular remodeling[7,8]. However, there remains a gap in understanding how these histological changes correlate with the severity of the hypertension and its clinical manifestations[9].

The objective of this study is to compare the histological features of placental tissue from hypertensive pregnancies and normal pregnancies. Understanding these differences may provide insights into the pathophysiology of hypertensive disorders and help improve clinical interventions aimed at reducing maternal and fetal morbidity.

METHODOLOGY

Study Design: This retrospective study was conducted at Baqai Medical College Karachi over a period of 12 months September 2022 to August 2023, with 96 patients included in the analysis. The study included 48 normal pregnancies and 48 pregnancies complicated by hypertension. Data were collected from a single tertiary care hospital, and ethical approval was obtained from the institutional review board (IRB).

Inclusion and Exclusion Criteria:

. Inclusion Criteria:

. Pregnant women with either normal pregnancies or pregnancies complicated by hypertension (pre-eclampsia or chronic hypertension)

Exclusion Criteria: Patients with pre-existing placental anomalies, multiple gestations, or other complications (e.g., diabetes, infections).

Histological Examination: Placental samples were collected at the time of delivery. The placental tissue was processed using standard histological techniques, including formalin fixation, paraffin embedding, and hematoxylin and eosin staining. The following histological features were analyzed:

. Villous Architecture:

. Degree of branching, fibrosis, and presence of syncytial knots.Spiral Artery Remodeling:

. Complete or incomplete remodeling of maternal spiral arteries.Endothelial Changes:

. Presence of endothelial injury, thickening, and thrombosis.Fibrin Deposition:

. Amount of fibrin observed in the placental tissue.Inflammatory Changes:

Presence of chronic villitis or other inflammatory markers.

Statistical Analysis: The data were analyzed using SPSS version 22 (IBM Corp., USA). Descriptive statistics were used to summarize the baseline characteristics. The chi-square test and t-test were used to compare the differences in histological features between normal and hypertensive placentas. A p-value of <0.05 was considered statistically significant.

Received on 22-09-2023
Accepted on 15-12-2023

RESULTS

A total of 96 patients were included in the study, comprising 48 normal pregnancies and 48 pregnancies complicated by hypertension. The mean age of the participants was 29.3 years (SD ± 5.4). The hypertensive group had a significantly higher incidence of preeclampsia (67%) compared to chronic hypertension (33%).

Table 1 presents the demographic characteristics of the study participants.

Table 1: Demographics of Normal vs. Hypertensive Pregnancies

Demographic Variable	Normal Pregnancy (n=48)	Hypertensive Pregnancy (n=48)	p-value
Age (years)	28.7 ± 5.2	29.8 ± 5.7	0.352
Body Mass Index (BMI)	24.1 ± 4.3	27.5 ± 5.8	0.021
Gestational Age (weeks)	38.5 ± 1.4	37.1 ± 2.2	0.002
Parity (Primiparous)	28 (58%)	32 (67%)	0.394
Pre-eclampsia		32 (67%)	-
Chronic Hypertension		16 (33%)	-

Histological Findings

Villous Architecture:

. Normal Placenta: The villous architecture was well-formed with branched terminal villi and well-developed core vasculature. The

. trophoblast layer was smooth, and there was no evidence of fibrosis or atrophy.Hypertensive Placenta: In hypertensive pregnancies, villous atrophy and fibrosis were more pronounced. Fewer terminal villi were observed, and 40% of placentas showed significant signs of necrosis in the villous tissue.

Spiral Artery Remodeling:

. Normal Placenta: Complete remodeling of maternal spiral arteries was observed in all normal placentas, with a wide lumen and smooth endothelial lining.

. Hypertensive Placenta: In the hypertensive group, 65% showed incomplete spiral artery remodeling, resulting in narrowed lumens and thickened endothelial walls. Endothelial damage was evident in 45% of these cases.

Syncytial Knots:

. Normal Placenta: Syncytial knots were present at a low frequency, averaging two per high-power field.

. Hypertensive Placenta: An increased frequency of syncytial knots was noted in hypertensive placentas, with an average of seven per high-power field.

Fibrin Deposition:

. Normal Placenta: Minimal fibrin deposition was noted, mainly at the placental margins.

. Hypertensive Placenta: Fibrin deposition was significantly higher in hypertensive placentas, with 72% showing substantial fibrin accumulation around the villous cores.

Endothelial Injury and Thrombosis:

. Normal Placenta: The fetal endothelial cells were intact, and no thrombosis was observed.

. Hypertensive Placenta: In 35% of hypertensive placentas, endothelial injury and thrombosis were evident, particularly in fetal vessels.

Table 2: Histological Findings in Normal vs. Hypertensive Placenta

Feature	Normal Placenta (%)	Hypertensive Placenta (%)
Villous Atrophy		40
Spiral Artery Remodeling	100	35
Syncytial Knots	5	40
Fibrin Deposition	10	72
Endothelial Injury		35

Logistic Regression Analysis: To identify the histological factors associated with hypertensive pregnancies, logistic regression analysis was performed. The dependent variable was hypertensive pregnancy (normal vs. hypertensive), and the independent variables included various histological findings (villous atrophy, spiral artery remodeling, syncytial knots, fibrin deposition, endothelial injury).

The logistic regression model revealed that incomplete spiral artery remodeling (OR = 6.32, 95% CI: 2.18–18.35), increased fibrin deposition (OR = 5.85, 95% CI: 1.96–17.37), and endothelial injury (OR = 3.75, 95% CI: 1.32–10.52) were significantly associated with hypertensive pregnancies (Table 3). These findings suggest that these histological features increase the likelihood of a hypertensive pregnancy.

Table 3: Logistic Regression Analysis of Histological Features in Hypertensive vs. Normal Pregnancies

Histological Feature	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Villous Atrophy	3.24	1.01–10.18	0.047
Incomplete Spiral Artery Remodeling	6.32	2.18–18.35	0.001
Syncytial Knots	2.1	0.78–5.57	0.141
Fibrin Deposition	5.85	1.96–17.37	0.002
Endothelial Injury	3.75	1.32–10.52	0.013

Interpretation of Logistic Regression Results: Incomplete Spiral Artery Remodeling: The odds of having a hypertensive pregnancy were more than six times higher in placentas showing incomplete spiral artery remodeling (p=0.001), consistent with the literature that suggests impaired placental perfusion in hypertensive disorders (10, 11).

Increased Fibrin Deposition: Fibrin deposition was another significant predictor of hypertensive pregnancy (OR = 5.85, p=0.002). This is in line with prior research that highlights the role of fibrin in placental ischemia and impaired oxygenation (12, 13).

Endothelial Injury: Endothelial injury in fetal vessels was also significantly associated with hypertensive pregnancies (OR = 3.75, p=0.013), suggesting that vascular injury in the placenta is a critical feature of hypertension-related placental pathology (14, 15).

The logistic regression model provides valuable insights into which histological features are most predictive of hypertensive disorders during pregnancy. These results emphasize the importance of placental histological examination in understanding the underlying pathophysiology and predicting pregnancy outcomes.

DISCUSSION

The results of this study indicate significant histological differences between normal and hypertensive placentas. These findings support the hypothesis that hypertensive disorders, including preeclampsia and chronic hypertension, lead to impaired placental function, which is evident from structural and vascular changes observed in placental tissue.

The most striking difference between normal and hypertensive placentas was in the remodeling of maternal spiral arteries. In normal pregnancies, the spiral arteries undergo complete remodeling, resulting in a wide lumen and efficient blood flow to the placenta[10,11]. However, in hypertensive pregnancies, incomplete spiral artery remodeling, with narrowed lumens, was common, which likely contributes to poor placental perfusion and subsequent fetal growth restriction[12,13]. This finding is consistent with previous studies demonstrating that abnormal spiral artery remodeling is a hallmark of preeclampsia and other hypertensive disorders of pregnancy[14,15].

The increased fibrin deposition observed in hypertensive placentas is also well-documented. Fibrin accumulation can obstruct villous vessels and further contribute to placental ischemia[16,17]. Additionally, endothelial injury and thrombosis, particularly in fetal vessels, may result in impaired oxygen and nutrient exchange, leading to adverse outcomes such as intrauterine growth restriction and preterm birth[18,19].

These findings highlight the importance of histological examination in understanding the pathophysiology of hypertensive

pregnancies. The alterations in placental structure observed in this study suggest that impaired trophoblast invasion and maternal vascular remodeling are central to the development of hypertensive disorders during pregnancy.

Further studies are needed to explore the molecular mechanisms underlying these histological changes and to assess their clinical significance in predicting pregnancy outcomes.

CONCLUSION

This study demonstrates significant histological differences between normal and hypertensive placentas, with hypertensive pregnancies showing incomplete spiral artery remodeling, increased fibrin deposition, and endothelial injury. These changes are associated with impaired placental perfusion and adverse pregnancy outcomes. Logistic regression analysis identifies incomplete spiral artery remodeling, fibrin deposition, and endothelial injury as key predictors of hypertensive pregnancies. Histological examination of the placenta offers valuable insights into the pathophysiology of hypertensive disorders and may aid in improving diagnosis and management.

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This article may be cited as: Kamran S, Kazmi T, Habib N, Bhutto SA, Khoso MY, Arif SIR: Compare the Histological Features Between Normal and Hypertensive Placenta. Pak J Med Health Sci, 2023;17(12):499-501.