

Human Placenta Morphology Variations in Gestational Diabetes Mellitus, Hypertension Induced by Pregnancy, and Preterm Labor

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Abstract:

Background: Preterm birth is one of the primary causes of perinatal mortality and morbidity. Pregnancy-related conditions causing preterm labor are associated with gross morphological changes in placenta, the fetomaternal organ which is vital for maintaining pregnancy and for promoting intrauterine growth of the fetus. Aims of this study to the morphological variations of human placenta in preterm labor and compare the findings of the study with the morphology of human placentae of normal pregnancies and correlate the morphologic changes of the placenta in preterm labor with fetal outcome.

Methods: This cross-sectional study was conducted among 695 placentae delivered from the Department of Obstetrics and Gynaecology, Darbhanga Medical College and Hospital, Laheriasarai, Bihar during a period of one year from July 2022 to June 2023. The gross morphological and histological examinations of placentae were performed.

Results: There were 50 preterm placentae including 30 from pregnancy-induced hypertension (PIH), 10 from gestational diabetes mellitus (GDM), and 2 from anemic pregnant mothers. The preterm placentae from PIH showed a significant reduction in placental weight, diameter and thickness and significantly more incidence of infarction, retroplacental hematoma, and calcification. Histologically, placentae in PIH showed significantly large number of syncytial knots, cytotrophoblastic proliferation, fibrinoid necrosis, and villus hyalinization. Newborn babies of mothers with PIH showed significant reduction of birth weight and low Apgar score. 50% of the preterm placentae from GDM were heavier, paler, and thick.

Conclusion: Prominent risk factors of preterm labor were PIH and GDM. PIH showed significant differences in various parameters of placental morphology and histology and fetal outcome.

Keywords: Fetal outcome, Gestational diabetes mellitus, Placenta, Pregnancy induced hypertension, Preterm labor.

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Introduction

The human placenta is the vital organ for maintaining pregnancy and promoting development of the fetus in utero.[1] Placenta is an intrauterine fusion of fetal and maternal tissues for the purpose of physiological transfer of nutrients and oxygen from mother to fetus and transfer of waste products of metabolism from fetus to mother for continuation of fetal life. The intrauterine existence of fetus is dependent on this vital organ. Placenta has been considered as a valuable indicator for fetal and maternal diseases and conditions.[2] Many maternal diseases or disorders are associated with high perinatal morbidity and mortality and gross pathologi-

cal changes in placenta.[1] Abnormal placenta adversely affects the fetal outcome.[3] As placenta is the mirror of maternal and fetal status, complications in pregnancy reflect in the placenta in a significant way both macroscopically and microscopically. [4-6] Preterm birth is the primary cause of perinatal mortality and morbidity.[7] The American College of Obstetricians and Gynaecologists (2016) defined preterm labor or premature labor as regular contractions of the uterus resulting in changes in the cervix that start before 37 weeks of pregnancy.[7] Changes in the cervix include effacement and dilation so that the fetus can enter the birth

canal. Globally, perinatal mortality rate is 49.6 per 1000 live births. [8] One of the major causes of perinatal mortality is preterm birth and it accounts for 6-10% of all births. Preterm labor has become a significant public health issue leading to perinatal mortality in developing countries. [9]

Among the various factors, pregnancy-induced hypertension (PIH) and gestational diabetes mellitus (GDM) are two important high-risk factors for preterm birth. [9] Hypertension in pregnancy is responsible for 5-8% of all maternal deaths.10 Hypertensive disorders of pregnancy are strongly associated with fetal growth retardation and prematurity leading to perinatal morbidity and mortality. [4-6]

GDM is defined as any degree of glucose intolerance with onset or first recognition during pregnancy. [11] In women with average or high-risk (marked obesity, personal history of GDM, glycosuria, or a strong family history of diabetes), the plasma glucose concentration 1 h after a 50 g oral glucose load (glucose challenge test), followed by a diagnostic oral glucose tolerance test on the women exceeding the glucose threshold value (>140 mg/dl) at glucose challenge test confirms the diagnosis. GDM is a pregnancy-related condition causing high maternal morbidity and increased risk of perinatal morbidity and mortality.

Anemia exerts profound changes on the maternal circulatory system and has serious effects on both mother and fetus. Anemia in mother leads to hypoxia which results in low birth weight of baby and premature delivery. The prevalence of these risk factors of preterm labor shows geographical variations.

Materials and Methods

A cross-sectional study was conducted among placentae from 659 pregnant ladies admitted in the labor room, Department of Obstetrics and Gynaecology, Darbhanga Medical College & Hospital, Laheriasarai, Bihar during a period of one year from July 2022 to June 2023. Placentae from those pregnant women who delivered before 37 weeks of pregnancy were considered as the preterm group. Placentae from mothers having normal, uncomplicated pregnancy formed the normal group. All pregnant mothers with a history of

hypertension or diabetes mellitus detected before pregnancy were excluded in this study. Clinical findings of mothers were collected from case sheets, along with recording of their obstetric and medical history. Their investigation reports were noted (blood sugar, urea, creatinine, Hb levels, and urine for albumin, pus cells, and ophthalmic examinations). Mothers were considered to be hypertensive if the blood pressure was 140/90 or above mm of Hg. Mothers with blood sugar levels higher than normal as per definition were considered to be having gestational diabetes. Placentae were collected immediately after vaginal delivery and cesarean section and were washed in running tap water. The placentae along with cord were coded. Any abnormality of cord and membranes was noted and were cut off by sharp scissors. The placentae were cleaned and excess water was removed with blotting paper. Then, placentae were immersed in 10% formalin.

Examination of placenta was done for gross and histological studies. Size, shape, surface area and thickness of placentae, number of cotyledons, and presence of infarction, calcification, and site of insertion of umbilical cord were noted. The placental weight was taken using standard weighing machine. Placental tissues were stained and examined under microscope for number of syncytial knots, fibrinoid necrosis, cytotrophoblastic cell proliferation, calcification, and hyalinization of villi in the preterm group in comparison to normal group.

Neonatal outcome in the form of birth weight, Apgar score, presence of any congenital anomalies, need for neonatal resuscitation, and admission to newborn intensive care unit were noted. Fetal-placental weight ratio was calculated in each case.

Statistical analysis was made using Chi-square test and Student's t-test.

Results and Discussion

Among 695 placentae delivered, 50 placentae were from preterm labor. The gross morphological and histological findings of preterm placentae were compared with a normal group of significantly comparable maternal age and parity. The prevalence of preterm labor was 7.19% in this study (Table 1).

Table 1: Distribution of placentae-based on term of delivery

Category	Number of placentae	Percentage
Term	645	92.806%
Preterm	50	7.194%
Total	695	100%

Prominent risk factors of preterm labor in this study were PIH (60%) and GDM (20%) (Table 2).

Table 2: Distribution of preterm placentae (N=50) and risk factors

Risk factor of preterm labor	Number of cases	Percentage
Pregnancy induced hypertension	30	60%
Gestational diabetes mellitus	10	20%
Low pre pregnancy weight of mother	4	8%
Anemia	2	4%
Multiple (twin) gestation	1	2%
Antepartum hemorrhage	1	2%
Cervical incompetence	1	2%
Hypothyroidism	1	2%
Total	50	100%

In this study, 26.7% hypertensive placentae were irregular. A study conducted by Agarwal et al. did not show a significant variation of shape in hypertension. [13] The incidence of infarction among placentae of the PIH was 36.7% and the same of the nonhypertensives was 6.7% in the

present study. Udaina et al. and Majumdar and Dasgupta and Corrêa et al made similar observation in their study. [4,5,6]

In this study, the presence of infarction was related to low birth weight and intrauterine death (IUD) of fetus. (Table 3)

Table 3: Gross appearance of placentae (normal vs. pregnancy induced hypertension)

Placental features	Component	No. (%)		“Z” value	Significance
		Pregnancy induced hypertension	Normal		
Shape	Discoid	22(73.3%)	30(100%)	5.894	p<0.001
	Irregular	8(26.7%)	0		
Presence of hematoma	Yes	2(6.7%)	0	1.433	p>0.05
	No	28(93.3%)	30(100%)		
Presence of infarction	Yes	11(36.7%)	2(6.7%)	2.821	P<0.01
	No	19(63.3%)	28(93.3%)		
Presence of calcification	Yes	17(56.7%)	7(23.3%)	2.635	P<0.01
	No	13(43.3%)	23(76.7%)		

Placental features such as placental weight, diameter, thickness, and number of cotyledons were significantly less in PIH compared to normal group. (Table 4)

Table 4: Gross morphology of placentae (normal vs pregnancy induced hypertension)

Placental features	Pregnancy induced hypertension		Normal		Difference of Mean	“t” value	df	Significance
	No.	Mean±SD	No.	Mean±SD				
Placental weight	30	455.7±59.9	30	516.7±25.7	60.3	5.073	58	P<0.01
Placental diameter	30	14.1±0.7	30	19.1±0.9	5.0	24.459	58	P,0.001
Placental thickness	30	1.9±0.9	30	2.4±0.1	0.5	3.023	58	P<0.01
Cotyledons	30	16.1±2.5	30	19.1±1.2	3.0	6.080	58	P<0.001
Fetal-placental ratio	30	5.5±1.9	30	5.6±0.7	0.1	0.193	58	P>0.05

Similar findings were reported from other studies [5,6,13] also. In the studies by Udaina et al., [4] Sheetal et al., [14] Virupaxi et al., [15] Dadhich et al., [16] Barker et al., [17] Londhe and Mane, [18] and Eriksson et al. [19] placental weight was seen significantly reduced in the PIH group. Dadhich et al. [16] and Pandure and Ghosh [20] observed that both diameter and thickness of placenta were significantly reduced in the hypertensive placentae.

In the present study, fetal-placental weight ratio was not showing statistically significant relation between the two groups. Another study [21] by Vijayalakshmi and Kittali has reported increased F/P weight ratio in the hypertension complicating pregnancy. In the present study, fetal-placental

weight ratio was not showing statistically significant relation between the two groups. In the PIH group of this study, five placentae showed abnormal insertion of cord. Among them, four placentae showed marginal insertion and one showed velamentous insertion while the placentae of normotensive group showed central insertion of umbilical cord.

There was insignificant association between insertion of umbilical cord and PIH ($P > 0.05$). Placentae in PIH showed significantly large number of syncytial knots, cytotrophoblastic proliferation, fibrinoid necrosis, and villus hyalinization compared to normal group in this study. In this study, Apgar score of new born

babies was found to be significantly low in the hypertensive group ($P < 0.001$). (Table 5)

Table 5: Comparison of pregnancy outcome (normal vs PIH)

Pregnancy outcome	Component	No. (%)		“Z” value	Significance
		PIH = 30	Normal = 30		
Mode of delivery	Vaginal LSCS	18(60%) 12(40%)	27(90%) 3(10%)	2.860	$P < 0.01$
Type of birth	Live IUD	28(93.3%) 2(6.7%)	30(100%) 0	1.468	$P > 0.05$
NICU admissions	Yes No	9(30%) 21(70%)	0 30(100%)	3.586	$P < 0.001$

The means of Apgar score of babies at birth of PIH and non-hypertensive groups were 6.9 ± 1.8 and 9 ± 0 and the same at 5 min were 8.5 ± 0.8 and 10 ± 0 , respectively. There were two cases of IUDs in the PIH group. This study was found that in gestational diabetes; there was increased birth

weight of babies. The placentae of gestational diabetic mothers showed significant increase in size, weight, and volume in the present study.

In this study, the placental weight and volume were reduced in anemia (Hb 9 g/dl) complicating pregnancy.

Table 6: Comparison of fetal outcome (normal vs. PIH)

Variables	PIH = 30		Normal = 30		Difference of Mean	“t” value	df	Significance
	No.	Mean±SD	No.	Mean±SD				
Birth weight	30	2.5 ± 0.7	30	2.9 ± 0.4	0.4	2.973	58	$P < 0.01$
Apgar score at birth	28	6.9 ± 1.8	30	9 ± 0	2.1	6.294	56	$P < 0.001$
Apgar score at 5 min.	28	8.5 ± 0.8	30	10 ± 0	1.5	10.13	56	$P < 0.001$

Conclusion

The prevalence of preterm labor was 7.19% in the present study. Prominent risk factors of preterm labor were PIH and GDM. 60% of preterm placentae from PIH were delivered by early induction for the sake of mother and new born.

PIH showed significant differences in various parameters of placental morphology and histology and fetal outcome. There were two cases of preterm IUD in the PIH group. In GDM, there was increased birth weight of babies. Placentae from pregnancy with combined PIH and GDM were normal in size and volume.

The preterm placentae of gestational diabetic mothers showed significant increase in size, weight, and volume in the present study. Examination of the placenta gives valuable information about the perinatal health of the new born baby and the mother.

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