Section: Anatomy

Original Research Article

A CROSS SECTIONAL STUDY OF MORPHOLOGY AND MORPHOMETRY OF HUMAN PLACENTA AMONGST WOMEN WITH PREGNANCY INDUCED HYPERTENSION AND WITHOUT PREGNANCY INDUCED HYPERTENSION

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Abstract

Background: The placenta, vital during pregnancy, provides nutrition, hormones, and records the infant's prenatal experience. Studies reveal significant pathology, including pregnancy-induced hypertension, which can reduce placenta weight and impact fetal growth. Understanding these changes can improve maternal and fetal health. The study aims to compare the placental thickness of hypertensive and normal placentas, investigate the shape and morphometry of hypertensive placentas, and determine the difference between the two groups. **Materials and Methods:** The study collected 114 placentae from patients with normal blood pressure and oedema, including those with pregnancy-induced hypertension, to examine their morphology and morphometry, providing a comprehensive understanding of placentae. **Result:** The study analyzed human placenta morphology and morphometry in women with and without pregnancy-induced hypertension, comparing normal and hypertensive groups. This study examines morphological and morphometric changes in placentas due to pregnancy-induced hypertension, highlighting the importance of early diagnosis and potential life-saving interventions in rural settings like India. **Conclusion:** The study examined 114 placentae, revealing oval-shaped and round-shaped ones in normal and pregnancy-induced hypertensive groups, highlighting the impact of pre-eclampsia and eclampsia on foetal growth.

INTRODUCTION

The placenta, derived from the Latin word for cake and Greek plakóenta, is an organ that connects the fetus to the mother's uterine wall. It is crucial in pregnancy as it provides nutrition, thermoregulation, waste elimination, and hormones that support pregnancy. The placenta also serves as an accurate record of the infant's prenatal experience.[1-5]

Placenta studies are increasingly important in modern obstetrics due to significant pathology that often affects the placenta before affecting the foetus. Placental abnormalities can serve as an early warning system for foetal problems. Examinations of the placenta after delivery can provide valuable information for the mother and infant, including the size, shape, completeness, weight, presence of haemorrhage, accessory lobes, placental infarcts, nodules, and tumors.[6-10]

Pregnancy-induced hypertension, which occurs after 20 weeks of gestation, is one of the leading causes of maternal and foetal morbidity and mortality. This condition significantly impacts the placenta by reducing its weight and dimensions, potentially leading to placental insufficiency. Pregnancy-induced hypertension has a significant influence on the morphology and histology of the placenta, affecting the growth of the foetus.[11-14]

This study focuses on studying structural changes in the placenta in women with pregnancy-induced hypertension. By understanding the structural changes in the placenta, researchers can better manage high-risk pregnancies and improve maternal and fetal health.

Aims and Objectives

1. To determine the variation in placental thickness between those who have pregnancy-induced hypertension and those who do not.
2. To investigate the normal placenta's shape and morphometry.
3. To compare the morphometry and morphology of hypertensive and normal placentas.

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MATERIALS AND METHODS

The study was conducted in the Department of Anatomy at a medical college and hospital for 18 months, after approval from the synopsis and ethical committee approval. The sample size was calculated using a formula from a study by Sabita Singh and TS Gugapriya.[1]

$$n = \frac{2S2\ (Z1 + Z2)2}{(M1 - M2)2}$$

where S = pooled Standard deviation M1 = Mean in first group = 2.77
M2 = Mean in second group = 2.39 SD1 = 0.51
SD2 = 0.54
S (pooled SD) = 0.525
Z1 = Z value associated with 99% confidence interval = 2.575 Z2 = Z value associated with 90% power = 1.281
∝ error = 0.01
We obtain the sample size 57 for one group by entering these numbers into the formula. There will be 57 placentae in the other group as well, for a total sample size of 114.
The placentae to be selected for the study were subjected to the following criteria:-

Inclusion criteria

Placenta are delivered by normal vaginal or caesarean section to women without any maternal abnormalities or pregnancy-induced hypertension, either through normal or caesarean methods.

Exclusion criteria

Placenta from women with co-morbidities like gestational diabetes, heart abnormalities, chronic hypertension, thyroid abnormalities, infections, multifetal pregnancies, and patients/relatives not willing to give consent.
A total of 114 placentae were collected from the Department of Obstetrics and Gynecology, with 57 from patients without co-morbidities and 57 from those with pregnancy-induced hypertension, forming the control and PHI groups, respectively.
The study involved pregnant women with normal blood pressure and oedema, while those with pregnancy-induced hypertension (PIH) had blood pressure readings over 140/90mmhg twice after 20 weeks of gestation, requiring a detailed history to confirm hypertension before 20 weeks.
Placentae were collected from patients who delivered a live newborn between 36-42 weeks of gestation. They were washed, blotted dry, and examined for morphology and morphometry. Results were compared among pregnancy-induced hypertension (PIH) and non-PIH groups. Materials used for studying placentae were calibrated for accurate measurement. The findings were compared among PIH and non-PIH groups. The study aimed to provide a comprehensive understanding of placentae.

Material

1. Scalpel and scissors.
2. Measuring tape and measuring scale.
3. Weighing machine.
4. Forceps.
5. Rubber gloves.
6. Strip of graph paper and Filter paper.
7. Vernier caliper.
8. Magnifying glass and metal probe.
9. Plastic tag.
10. Permanent marker.

Method:

The placentae were studied according to the following parameters:

Morphology:

The parameters for morphologic study:-

1. Shape of placenta
2. Site of umbilical cord insertion
3. Calcification

Morphometry:

The parameters for morphometric study:

- Thickness of the placenta
- Diameter of the placenta
- Number of cotyledons
- Weight of the placenta
- Circumference of the placenta

1. Shape of the Placenta:

The placenta's shape was recorded after inspection on a flat surface, and it was categorized as oval, round, or irregular.

2. Site of umbilical cord insertion:

The insertion percentage was determined by utilizing the following formula to determine the site of umbilical cord insertion.
Here,
d = minimum distance between the site of insertion of the umbilical cord and the margin of the placenta
r = radius of the placenta.
On the basis of insertion percentage, the site of umbilical cord insertion were then categorized as follows:

Insertion percentage	Site of umbilical cord insertion
0-25	Marginal
26-75	Eccentric
76 and above	Central

3. Calcification:

The placenta's maternal surface was meticulously examined for any signs of calcification.

4. Thickness of the placenta:

Placentae were pierced through a sharp metal probe, and the thickness was measured by marking the point where the probe touched the table surface, and the distance between the probe and marked point was recorded in centimeters.

5. Diameter of the placenta:

Maximum diameter of the placentae was measured using vernier calipers.

6. Number of cotyledons:

The cotyledons were identified by blotting the maternal surface, applying gentle pressure, and counting them in a looped manner.

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7. Weight of the placenta

The placenta was washed, trimmed, and blood clots removed before being blotted dry and weighed on a standard scale in kilograms.

8. Circumference of the placenta

A 2cm graph paper strip was used to measure the circumference of the placenta, marking the point of overlapping. The strip was straightened and measured using a scale, and the data was analyzed using SPSS/PC Window version 21.0 software, with graphs and tables created using Microsoft Word and Excel.

RESULTS

The study aimed to compare the morphology and morphometry of human placentas in women with and without pregnancy-induced hypertension. 114 placentae were collected from a tertiary care center, divided into normal and pregnancy-induced hypertensive groups. The findings were analyzed statistically using appropriate analytical tests.

Morphology

The parameters for morphologic study:

- Shape of placenta
- Site of umbilical cord insertion
- Calcification

Morphometry

The parameters for morphometric study:

- Thickness of the placenta
- Diameter of the placenta
- Number of cotyledons
- Weight of the placenta
- Circumference of the placenta

Table 1: Distribution of women in Normal and Pregnancy induced hypertension (PIH) group.

Sr. No	Group	Frequency	Percentage
1.	Normal	57	50
2.	PIH	57	50
Total		114	100

Out of 114 pregnant women, 57 are normal and 57 are in the pregnancy induced hypertension (PIH) group.

Table 2: Distribution of pregnant women according to age in normal and pregnancy induced hypertension (PIH) groups.

Sr. No	Age of patients in years	Normal		PIH		Total
		No.	%	No.	%	
1.	19 to 21	26	59.09	18	40.91	44 (100)
2.	22 to 24	22	47.83	24	52.17	46 (100)
3.	25 to 27	08	36.36	14	63.64	22 (100)
4.	28 to 30	01	50	01	50	02 (100)
Total		57	50	57	50	114 (100)

The table shows 57 women in the normal group and 57 in the pregnancy induced hypertension (PIH) group. The normal group consisted of 26 women aged 19-21, 22-24, 8-25, and 1-30 years, while the PIH group had 18-19, 24-24, 25-27, and 1-30 years old women.

Table 3: Association between parity and pregnancy induced hypertension (PIH).

Sr. No	Gravida	Group		Total
		Normal	PIH	
1.	Primigravida	37 (45.68)	44 (54.32)	81 (100)
2.	Multigravida	20 (60.61)	13 (39.39)	33 (100)
Total		57	57	114

X2= 2.09, df = 1, p = 0.15.

The study found that pregnancy-induced hypertension was more prevalent in primigravida women, with 44 out of 57 hypertensive women being primigravida, despite the finding being not statistically significant.

Table 4: Association between shape (oval, round, irregular) of the placenta in normal and pregnancy induced hypertension (PIH) groups.

Sr. No	Group	Shape of Placenta			Total
		Irregular	Oval	Round	
1.	Normal	00	35	22	57
2.	PIH	02	37	18	57
Total		02	72	40	114

p = 0.4956, p > 0.05, (columns of oval and round placentae were pooled together).

The study found that out of 57 normal placentae, 35 were oval and 22 were round, while in the pregnancy-induced hypertensive group, 37 were oval and 18 were round. The difference in placentae shapes was not statistically significant.

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Table No.5: Association between site of umbilical cord insertion on the placenta in normal and pregnancy induced hypertension (PIH) groups.

Sr. No	Group	Site of umbilical cord insertion			Total
		Central	Eccentric	Marginal	
1.	Normal	13	43	01	57
2.	PIH	13	38	06	57
Total		26	81	07	114

X2 = 0.05, df= 1, p = 0.82 (Columns of eccentric and marginal were pooled together)

The study found that both groups had an eccentric common site for insertion of the umbilical cord, but the difference was not statistically significant ($p > 0.05$).

Table 6: Showing presence of calcification on the placenta in normal and pregnancy induced hypertensive (PIH) groups.

Sr. No	Group	Calcification of Placenta		Total
		Absent	Present	
1.	Normal	41 (71.93)	16 (28.07)	57 (100)
2.	PIH	15 (26.32)	42 (73.68)	57 (100)
Total		56	58	114

X2= 21.94, df = 1, p< 0.001.

The study found that in both normal and pregnancy-induced hypertensive groups, placenta calcification was more frequent in the pregnancy-induced group, with 73.68% of placentae showing calcification, a finding statistically significant using the Chi square test.

Table 7: Comparison of mean thickness of placenta in normal and pregnancy induced hypertension (PIH) groups.

Sr. No.	Parameter	Normal		PIH		't' value at df=112	'p' value	Significance
		Mean	SD	Mean	SD			
1.	Thickness of placenta	2.88	0.23	2.34	0.28	11.38	0.001	Significant

The study found that the mean thickness of the placenta in the normal group was 2.88 + 0.23 cm, while in the pregnancy-induced hypertension group it was 2.34 + 0.28 cm.

Table 8: Comparison of Mean Diameter of placenta between normal and pregnancy induced hypertension (PIH) groups.

Sr. No.	Parameter	Normal		PIH		't' value at df=112	'p' value	Significance
		Mean	SD	Mean	SD			
1.	Diameter of placenta	17.40	1.07	15.68	0.93	9.18	0.001	Significant

The normal group had a significantly higher mean diameter than the pregnancy-induced hypertension group, as indicated by a statistically significant difference in unpaired 't' test analysis.

Table 9: Comparison of Mean number of cotyledons in placenta of normal and pregnancy induced hypertension (PIH) groups.

Sr. No.	Parameter	Normal		PIH		't' value at df=112	'p' value	Significance
		Mean	SD	Mean	SD			
1.	Number of cotyledons	17.02	1.3	13.95	1.8	10.44	0.001	Significant

The study found that the normal group had a higher mean number of cotyledons than the pregnancy-induced hypertension group, with a statistically significant difference observed after applying the unpaired 't' test. The mean number of cotyledons was 17.02 + 1.3.

Table 10: Comparison of mean weight of placenta between normal and pregnancy induced hypertension (PIH) groups.

Sr. No.	Parameter	Normal		PIH		't' value at df=112	'p' value	Significance
		Mean	SD	Mean	SD			
1.	Weight of placenta	442.63	61.08	313.68	85.31	9.41	0.001	Significant

The mean placental weight in normal and pregnancy-induced hypertension groups was 442.63 + 61.08 gm and 313.68 + 85.31 gm, respectively, with a significantly lower mean in the pregnancy-induced hypertension group.

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Table 11: Comparison of Mean circumference of placenta between normal and pregnancy induced hypertension (PIH) groups.

Sr. No.	Parameter	Normal		PIH		't' value at df=112	'p' value	Significance
		Mean	SD	Mean	SD			
1.	Circumference of placenta	51.21	3.93	46.45	2.62	7.61	0.001	Significant

The study found that the mean circumference of the placenta in the normal group was 51.21 + 3.93 cm, while in the pregnancy induced hypertension group it was 46.45 + 2.62 cm.

Table 12: Association between presence of calcification in primigravida belonging to normal and pregnancy induced hypertensive (PIH) groups.

Sr. No.	Group	Calcification of placenta in primigravida		Total
		Absent	Present	
1.	Normal	27 (72.97 %)	10 (27.03%)	37 (100%)
2.	PIH	11 (25 %)	33 (75%)	44 (100%)
Total		38	43	81

X2 = 16.7, df =1, P<0.001, significant

Calcification is more common in primigravida placenta in pregnancy-induced hypertension group, with a strong association ($p < 0.001$), as indicated by Chi square test analysis.

Table 13: Comparison of mean thickness of placenta in primigravida and multigravida.

Sr. No.	Parameter	Primigravida		Multigravida		't' value at dF= 112	'p' value	Significance
		Mean	SD	Mean	SD			
1.	Thickness of placenta	2.59	0.38	2.65	0.35	0.39	0.4	Not significant

The study found no significant difference in placenta thickness between primigravida and multigravida, indicating a unique finding not found in previous research.

Table 14: Comparison of mean diameter of placenta in primigravida and multigravida.

Sr. No.	Parameter	Primigravida		Multigravida		't' value at dF= 112	'p' value	Significance
		Mean	SD	Mean	SD			
1.	Diameter of placenta	16.45	1.3	16.75	1.38	1.12	0.85	Not significant

The study found no significant difference in placenta diameter between primigravida and multigravida, indicating a unique finding not found in previous research.

Table 15: Comparison of mean weight of placenta in primigravida and multigravida.

Sr. No.	Parameter	Primigravida		Multigravida		't' value at dF = 112	'p' value	Significance
		Mean	SD	Mean	SD			
1.	Weight of placenta	373.58	94.5	389.39	105.03	0.78	0.43	Not significant

The study found no significant difference in placenta weight between primigravida and multigravida, indicating a unique finding not found in previous research.

Table 16: Comparison in shape (oval, round, irregular) of the placenta in normal and pregnancy induced hypertensive (PIH) groups in the present study and other studies.

Studies	Normal group				PIH group			
	No. of cases	Oval	Round	Irregular	No. of cases	Oval	Round	Irregular
Sengupta et al (2009),[3]	30	10	13	07	30	12	10	08
Dadhich et al (2012),[4]	25	06	14	05	25	16	06	03
Goswami and Shah (2016),[5]	50	18	32	00	50	08	20	22
Kantha et al (2017),[6]	100	12	87	00	100	21	79	00
Tiruneh et al (2018), [7]	150	27	103	14	50	27	09	12
Tale et al (2018),[8]	50	24	18	08	50	22	17	11
Akshara et al (2018)	46	16	28	02	40	12	21	5
Puthuraj et al (2018),[9]	147	60	84	00	15	00	15	00
Dadhich et al (2019),[4]	100	54	36	10	100	14	70	16
Present study	57	35	22	00	57	37	18	02

Table 17: Comparison of site of insertion of umbilical cord (central, eccentric, marginal) on the placenta in normal and pregnancy induced hypertensive (PIH) groups in the present study and other studies.

Studies	No. Of controls	Central	Eccentric	Marginal	No. Of cases	Central	Eccentric	Marginal
Dadhich et al (2012)	25	06	17	02	25	04	16	05

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Das et al(2015)	10	08	02	00	40	18	16	02
Goswami and Shah (2016)	50	41	08	01	50	20	22	08
Mohol et al (2016)	130	14	73	43	100	11	56	33
Akshara et al (2018)	46	22	18	02	40	15	22	02
Puthuraj et al (2018)	147	39	75	30	15	00	15	00
Kantha et al (2018)	50	30	08	11	50	18	10	22
Karmakar et al (2018)	50	15	19	16	50	16	15	19
Present study	57	13	43	01	57	13	38	06

Table 18: Comparison of mean thickness (cm) of placenta in normal and pregnancy induced hypertensive (PIH) groups in the present study and other studies.

Studies	Normal group		PIH Group	
	No. of cases	Mean Placental thickness (cm)	No. of cases	Mean Placental thickness (cm)
Sengupta et al (2009)	30	1.59 + 0.39	30	1.51 + 0.37
Fahima et al (2011)	22	1.36 + 0.53	22	1.60 + 0.34
Dadhich et al (2012)	25	2.10 + 0.60	25	1.79 + 0.27
Singh and Gugapriya (2014)	50	2.77 + 0.51	50	2.39 + 0.54
Nafees et al (2015)	30	2.3 + 0.4	30	2.8 + 0.6
Harsha and AtulKeche (2015)	50	1.96 + 0.17	50	1.57 + 0.19
Shevade et al (2015)	50	2.3 ± 0.43	50	1.8 ± 0.49
Goswami and Shah (2016)	50	2.60	50	2.2
Kantha et al (2017)	100	2.9 + 0.25	100	2.09 + 0.22
Wubale et al (2017)	50	1.96 + 0.20	50	1.72 + 0.11
Tale et al (2018)	50	1.86 + 0.52	50	1.48 + 0.49
Chhatwal et al (2018)	42	2.10 + 0.52	42	1.91 + 0.47
Karmakar et al (2018)	50	1.68	50	1.54
Tiruneh et al (2018	150	2.43 + 1.34	50	1.99 + 0.39
Abhilasha Dadhich et al (2019)	100	2.13 + 0.46	100	1.66 + 0.49
Present Study	57	2.88 + 0.23	57	2.34 + 0.28

DISCUSSION

The intrauterine existence of foetus is dependent on one vital organ – "the Placenta".

The placenta is crucial for a foetus' growth and development, but many physicians overlook its examination, especially in rural settings like India, which can lead to early diagnosis and potentially save lives.[2]

The human placenta is a flattened discoid mass, weighing around 500gm and 22cm in diameter. It undergoes changes in weight, volume, structure, and shape during gestation to support prenatal life and prepare the foetus for extrauterine life. The placenta is increasingly studied in modern obstetrics due to significant pathology, such as pregnancy-induced hypertension, gestational diabetes, and anemia, which can cause undernutrition and growth restriction, leading to various morphological changes.

This study examines morphological and morphometric changes in placentas due to pregnancy-induced hypertension, examining 57 normal and 57 hypertensive placentae. Data is analyzed and compared with previous research, comparing results.

The study found that oval-shaped placentae were prevalent in both normal and pregnancy-induced hypertension groups, with 71% in normal and 74% in hypertension groups. This finding is consistent with previous studies. Two irregularly shaped placentae were found in the pregnancy-induced hypertension group. Abnormal shapes of placenta are associated with reduced placental efficiency, which impairs placental development and influences foetal development. Abnormal shapes are associated with reduced efficiency and long-standing pathology.

The study found that oval-shaped placentae were more prevalent in pregnancy-induced hypertension groups than in normal groups. The presence of irregularly shaped placentae was only found in the pregnancy-induced hypertension group. Abnormal shapes of placentae are associated with reduced placental efficiency, which impairs placental development and influences foetal development. The site of umbilical cord insertion was found to be central in 13 (22.8%) of normal pregnancies, eccentric in 43 (75.4%), and marginal in 1 (1.7%) placentae in the pregnancy-induced hypertension group. Marginal cord insertions were 2.11 times more in pre-eclamptic pregnancies compared to normal pregnancies. Marginal cord insertion has been associated with fetal growth restriction and preterm delivery. Variations in the site of umbilical cord insertion can be explained by two theories: placental migration theory or trophotropism, which suggests the placenta migrates towards vascularized areas with advancing gestation, and blastocyst polarity theory, which suggests abnormal cord insertion results from malposition during implantation.

The study found that calcification was more prevalent in hypertensive placentae (72.7%) than normal placentae (28%). It also revealed a correlation between placental calcification and primigravidity. In a normal group, 37 primigravidas were present, while 75% of those in the pregnancy-induced hypertension group had calcification. This

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suggests that calcification is an aging process near the end of pregnancy, potentially causing premature aging in cases of pregnancy-induced hypertension. Calcification is more common in first pregnancies and is linked to low maternal age, high socio-economic status, and summer delivery.

The current study found that the pregnancy-induced hypertension group (2.34 + 0.28) had considerably lower mean placental thickness than the normal group (2.88 + 0.23). Fahima et al,[10] (2011)found that the group with pregnancy-induced hypertension had a non-significantly increased mean placental thickness value. David Barker et al,[11] (2010) and Nafees et al,[12] (2015) both noted these results. According to Michael Yampolsky's 2009 theory, placentas with distorted chorionic surface vascular trees and decreased functional efficiency may also have uneven vascular arborization, which could explain the placental thickness variability and lower mean thickness.[13]

CONCLUSION

The study examined 114 placentae, divided into normal and pregnancy-induced hypertensive groups. The morphology and morphometry of the placentae were analyzed, revealing that the majority were oval-shaped, with 22 and 18 round-shaped placentae in the normal and pregnancy-induced hypertension groups, respectively. The site of umbilical cord insertion was eccentric in both groups.

The presence of calcification was significantly higher in placentae from the pregnancy-induced hypertension group. The mean thickness of placenta was higher in the normal group (2.88 cm) than the pregnancy-induced hypertension group (2.34 cm). The mean diameter of placenta was higher in the normal group (17.40 cm) than the pregnancy-induced hypertension group (15.68 cm). The number of cotyledons in the pregnancy-induced hypertension group (13.95) was lower than in the normal group (17.02).

Placental morphologic changes vary significantly in pre-eclampsia and eclampsia, affecting the growth of the foetus. Pregnancy-induced hypertension adversely affects both foetal and placental outcomes, with higher incidence of eclampsia due to malnutrition, ignorance, lack of adequate health education, and medical care. Proper medical care during antenatal period and labor can reduce further risks to mother and foetus.

The placenta is a paradox as it is one of the most readily available organs for examination but one of the least known. Placental examination helps understand the specific etiologies of adverse outcomes, leading to specific treatment and preventive measures for those at risk for recurrence in subsequent pregnancies.

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