Research Article

Morphometric differentiation between placenta in PIH and normal pregnancy

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Abstract

Background: Placenta is like a diary of gestational life. It is the vital organ for developing fetus, and it is also the most accessible organ of human body. Pregnancy complications such as hypertension, diabetes, and anemia are reflected in a significant way. Placental examination is helpful to plan a safe pregnancy and a healthy baby outcome at its end.

Objective: To study morphometric differences of placenta in normal pregnancy and pregnancy-induced hypertension (PIH).

Materials and Methods: A total of 100 placentas (50 from normal pregnancy and 50 from PIH group) were collected. Parameters such as weight, volume, thickness, diameter, and area were noted and their means were calculated. These parameters were divided into different ranges. From the weight of the baby and that of the placenta, fetoplacental weight ratio and placental coefficient were calculated.

Results: The mean placental weight, area, volume, diameter, and thickness were lower in the PIH group. Weight, volume, area, diameter, and thickness in control group range from 420 to 560 g, 380 to 550 cc, 204.4 to 346 cm^2, 17 to 21 cm, 1.7 to 2.3 cm, respectively, and those in PIH group range from 200 to 510 g, 190 to 500 cc, 132.7 to 247.3 cm^2, 13 to 18 cm, and 1.2 to 2 cm, respectively.

Conclusion: The range of morphometric parameters is comparatively lower in PIH group than in control group. The mean birth weight and fetoplacental weight ratio is higher in control group. The placental coefficient was significantly higher in PIH group.

KEY WORDS: Pregnancy-induced hypertension, morphometry, placenta

Introduction

Placenta is a mirror that reflects the intrauterine status of the fetus and postnatal fetal outcome.[1] It is the most accurate record of the infants' prenatal experience. The human placenta is typified as villous, deciduate, discoid, hemochorial, chorioamniotic, and chorioallantoic. The formation of placenta has bestowed a special status to the animals to develop a separate class known as eutheria. Human placenta is an intrauterine fusion of embryonic or fetal and maternal tissues for the purpose of physiological transfer of nutrients and oxygen from mother to embryo and waste products of the metabolism from embryo to mother for continuation of fetal life.

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Hypertension is a sign of an underlying pathology that may be preexisting or appears for the first time during pregnancy. Pregnancy-induced hypertension (PIH) is divided into three clinical types: pre-eclampsia, eclampsia, and gestational hypertension. It has been recorded that the maternal uteroplacental blood flow decreases in pre-eclampsia[2] because of maternal vasospasm.[3] Reduced maternal uteroplacental blood flow leading indirectly to constriction of fetal stem arteries[4] has been associated with the changes seen in the placentas of women with pre-eclampsia. Maternal vasospasm leads to fetal hypoxia. The agent responsible for vasospasm has still not been isolated precisely, but it seems certain to be humoral in origin.[5]

The placenta is a vital organ for developing fetus, and it is also the most accessible organ of human body, still it is often neglected. After delivery if the placenta is examined minutely it provides much insight into the prenatal health of the baby and the mother.[6] Pregnancy complications are reflected in the placenta in a significant way. PIH is not an exception to this. Placental examination in such cases gives valuable information and answers to the questions concerning pregnancy management. This helps to plan a safe pregnancy and a healthy baby outcome at its end.

Materials and Methods

This study was undertaken in the Department of Anatomy, Jawaharlal Nehru Medical College, Sawangi (Meghe), Wardha, Maharashtra, India. Freshly delivered placentas were collected from the Department of Obstetrics and Gynaecology, ABVR Hospital, Sawangi (Meghe), Wardha, Maharashtra, India. Informed consent was taken before collecting the placentas. Altogether 100 placentas were collected, of which 50 belonged to women with history of normal pregnancies and 50 to those with history of PIH.

Placentas were washed with normal saline and were examined per proforma by Yetter.[7] Following parameters of each placenta were noted after gross examination: weight of each placenta was measured using a weighing scale; diameters were recorded along the two axes, perpendicular to each other using a measuring tape; thickness of each placenta was measured with the help of a vernier caliper; and area was estimated in cm^2 using the formula described by Davies and Beazley.[8]

$$\text{Placental area} = \pi \times \frac{\text{miximum diameter (cm)}}{2} \times \frac{\text{minimum diameter (cm)}}{2}$$

The volume of placenta was derived using the formula "X - Y".[9] The metrical data for normal pregnancy and PIH were analyzed statistically. The probability level of significance for the entire statistical test was arbitrarily set as $p = 0.05$.

Results

In our study, in the control group the mean placental weight, the mean placental area, the mean placental volume, the mean placental diameter, and the mean placental thickness were found to be 464.80 ± 40.21 g, 270.89 ± 27.47 cm^2, 452.20 ± 44.01 cc, 18.53 ± 0.87 cm, and 1.96 ± 0.17 cm, respectively [Table 1].

In the PIH group the mean placental weight, the mean placental area, the mean placental volume, the mean placental diameter, and the mean placental thickness were found to be 387.00 ± 72.54 g, 194.85 ± 23.86 cm^2, 374.40 ± 72.18 cc, 15.72 ± 0.98 cm, and 1.57 ± 0.19 cm, respectively. The values of all these parameters were found higher in the control group than in the PIH group, and the difference was found to be statistically significant.

In our study, the mean birth weight of babies in the control group was found to be 2813.60 ± 258.06 g (ranged from 2500 to 3500 g) whereas in the PIH group it was 2141.00 ± 439.69 g (ranged from 1000 to 3000 g), and the difference was statistically significant [Figure 1, Table 2].

The mean fetoplacental weight ratio in our study in the control group was 6.05 ± 0.07 and that in the PIH group was

Figure 1: Fetal surface of normal full-term placenta

Table 1: Comparative results of placental morphometry

Parameters	Control group	PIH group	*z*-Value	*p*-Value
Mean placental weight (g)	464.80 ± 40.21	387.00 ± 72.54	6.63	0.000
Mean placental area (cm^2)	270.89 ± 27.47	194.85 ± 23.86	14.77	0.000
Mean placental volume (cc)	452.20 ± 44.01	374.40 ± 72.18	6.50	0.000
Mean placental diameter (cm)	18.53 ± 0.87	15.72 ± 0.98	14.97	0.000
Mean placental thickness (cm)	1.96 ± 0.17	1.57 ± 0.19	10.41	0.000

p-Value < 0.05 is considered to be significant.

Table 2: Mean birth weight of babies in control and PIH groups

Parameter	Control group	PIH group	*z*-Value	*p*-Value
Mean birth weight of babies (kg)	2813.60 ± 258.06	2141.00 ± 439.69	9.32	0.000

p-Value < 0.05 is considered to be significant.

Table 3: Mean fetoplacental weight ratio in control and PIH groups

Parameter	Control group	PIH group	*z*-Value	*p*-Value
Mean fetoplacental weight ratio	6.05 ± 0.07	5.51 ± 0.18	18.81	0.0000

p-Value <0.05 is considered to be significant.

5.51 ± 0.18, and the difference was found statistically significant [Table 3].

In our study, we calculated the placental coefficient, which is the ratio between placental weight (g)/fetal weight (g). In the control group, the mean placental coefficient was 0.16 (range 0.16–0.17) and in the PIH group, it was 0.18 (range 0.17–0.20). The placental coefficient in the PIH group was significantly higher.

In the comparative macroscopic study of normal placentas and PIH placentas, the weight of the placentas in control group ranged from 420 to 560 g, 80% of the placentas belonged to 401–500 g category. Area of the placentas ranged from 240.4–346 cm^2, 86% of the placentas belonged to 201–300 cm^2 category. Placental volume in control group ranged from 380 to 550 cc, 68% of the placentas ranged between 401 and 500 cc. Placental diameter and thickness ranged from 17 to 21 cm and 1.7 to 2.3 cm, respectively. Majority of the placentas had diameter 17.1–19 cm (78%) and thickness 2–2.5 cm (60%).

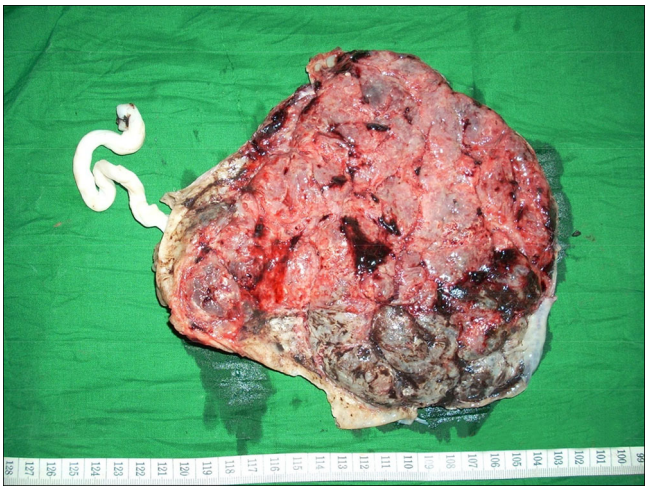

Figure 2: Maternal surface of normal full-term placenta

In the PIH group, weight of the placentas ranged from 200 to 510 g, 36% of the placentas belonged to 401–500 g category. Area of the placentas ranged from 132.7 to 247.3 cm^2, 50% of the placentas belonged to 201–300 cm^2 category and 50% had placental area less than 200 cm^2. Placental volume in PIH group ranged from 190 to 500 cc, 36% of the placentas ranged between 401 and 500 cc. Placental diameter and thickness ranged from 13 to 18 cm and 1.2 to 2 cm, respectively. In PIH group, 6% of placentas had diameter 17.1–19 cm and thickness 2–2.5 cm. The comparison between different ranges of placental weight, area, volume, diameter, and thickness of normal and PIH [Figure 3, Table 5] placentas were found to be statistically significant.

Discussion

In our study, the mean placental weight was 464.80 g (420–560 g) in control group and 387 g (200–510 g) in PIH group. Weight of 80% normal placentas and 36% PIH placentas belong to 401 – 500 gm. Majumdar et al.[6] and Kurdukar et al.[10] noted the placental weight in control group to be 485.85 and that in PIH group to be 399 g. Dutta and Dutta[11] found decreased placental weight in the PIH group and also commented that the weight of the placenta decreases with the increasing grades of PIH. Das et al.[12] observed reduction in placental weight in hypertensive disorders; of 80 cases with hypertension, weight of 25 placentas was less than 300 g. It is considered that the weight of the placenta is functionally significant because it is related to villous surface area and to total fetal weight. A study commented that the margin of placental adequacy may be narrow with regard to oxygen supplies and the hazard may be greater if the placenta is unusually small. Great variations are commonly observed in placental weights. Variations in placental weights have a genetic origin because there are some differences in the genes that regulate fetal and placental weight.[13]

Mean placental area in control group was 270 cm^2 (240–346 cm^2) and 194 cm^2 (132–247.3 cm^2) in PIH group.

Table 4: Comparative results of placental coefficient of control and PIH groups

Group	No. of cases	Mean placental weight (g)	Range of placental weight (g)	Mean fetal weight (g)	Range of fetal weight (g)	Mean placental coefficient	Range	*z*-Value	*p*-Value
Control	50	464.80 ± 40.21	420–560	2813.60 ± 258.06	2500–3500	0.16	0.16–0.17	17.57	0.000
PIH	50	387.00 ± 72.54	200–510	2141.00 ± 439.69	1000–3000	0.18	0.17–0.20		

p-Value <0.05 is considered to be significant.

Figure 3: Fetal surface of PIH placenta

Area of 86% normal placentas and 50% PIH placentas belonged to 201–300 cm^2 category. Browne and Veall[2] found that placental surface area is significantly less in PIH group. Majumdar et al.[6] noted mean placental area to be 265 cm^2 in normal group and 202 cm^2 in PIH group. Davies and Beazley[8] opined that the placental size assessed by area, weight, and volume showed a highly significant correlation to the weight of neonates in cases of normal delivery. The growth of the fetus depends on its nutrition coming from maternal blood as well as surface area of the placenta available for diffusion of nutrients from mother to fetus.

We recorded a lower placental volume of 374.40 cc (190–500 cc) in PIH group compared to that of 452.20 cc (380–550 cc) in control group. Volume of 68% normal and 36% PIH placentas belonged to 401–500 cc category. Majumdar et al.[6] recorded placental volume of 395.99 cc in PIH group and 612 cc in control group. Biswas et al.[14] found volume of placenta associated with intrauterine growth retardation (IUGR) ranged from 120 to 400 ml (mean of 268.92 ml), which were comparatively lower than the volume of placentas in control group, ranged from 260 to 450 mL (mean 343.86 ml).

We recorded mean placental diameter to be 18.53 cm (17–21 cm) in control group and 15.72 cm (13–18 cm) in PIH group. Diameters of 78% placentas in control group and 6% in PIH were between 17.1 and 19 cm. Das et al.[12] in their study noted that the diameter decreased in PIH group than in the control group. We recorded mean thickness of placenta to be 1.96 cm (1.7–2.3 cm) in control group and 1.57 cm (1.2–2.1 cm) in PIH group. We recorded thickness of placentas to be 2–2.5 cm in 60% cases in control group and 6% in PIH group. Younoszai and Haworth[15] recorded the mean placental thickness in normal term infants was significantly greater than that in preterm infants. They concluded that placental weight and thickness increase from 28 to 30 weeks of gestation by cell multiplication. Taking into consideration Collaborative Perinatal Study, all risk factors and unusually thin placenta increased the risk for both fetal

Table 5: Comparative results of placental morphometry in different ranges of parameters

Parameters	Control group	PIH group	χ^2 -value	*p*-Value
Placental weight (g)				
⩽300	0	7 (14%)	46.71	<0.00001, significant
301–400	0	24 (48%)		
401–500	40 (80%)	18 (36%)		
>500	10 (20%)	1 (2%)		
Placental area (cm^2)				
<200	0	25 (50%)	36.76	<0.0001, significant
201–300	43 (86%)	25 (50%)		
301–400	7 (14%)	0		
Placental volume (cc)				
<300	0	8 (16%)	26.74	<0.0001, significant
301–400	9 (18%)	24 (48%)		
401–500	34 (68%)	18 (36%)		
501–600	7 (14%)	0		
Diameter (cm)				
<15	0	8 (16%)		
15.1–17	0	39 (78%)		
17.1–19	39 (78%)	3 (6%)		
>19	11 (22%)	0		
Thickness (cm)				
<1.5	0	12 (24%)	38.18	<0.0001, significant
1.5–1.9	20 (40%)	35 (70%)		
2–2.5	30 (60%)	3 (6%)		

growth retardation and neonatal death, raising the possibility that very thin placentas are sometimes functionally insufficient. In preterm infants, placental weight and thickness vary directly with the duration of gestation.[16]

Mean birth weight of babies was 2813.60 g in control group and 2141 g in PIH group in our study. We also found that newborn babies of mothers with poorly controlled PIH were small for date and few of them had birth asphyxia. Younoszai and Haworth[15] found birth weight in preterms to be 2035 g, in terms 3313 g, and in IUGR 2295 g. They further concluded that in the preterm and term infants, birth weight varied directly with placental decidual area and placental weight. Majumdar et al.[6] recorded mean birth weight of babies in control group as 2800 g and that in hypertensive group 2040 g. Shah et al.[16] stated that weight of placenta and birth weight are more marked in preeclampsia with edema than that without edema but in severe preeclampsia both will decrease probably due to marked proteinuria. Rath and Garg[17] stated that in hypertension, arrangement of the intracotyledons vasculature is altered resulting in low birth weight of the babies.

Naeye[18] explained that the metabolic abnormality in the placenta may potentiate the effects of low uteroplacental blood flow. Low oxygen consumption, poor glucose utilization, and impairment in glycolytic pathways had been reported in placentas from eclamptic and preeclamptic pregnancies. This may reflect impaired nutrient synthesis that could add to the fetal growth retardation that is often associated with preeclampsia and eclampsia.

In this study, fetoplacental weight ratio in the control group was 6.05 and that in PIH group was 5.51. Younoszai and Haworth[15] calculated mean fetoplacental weight ratio in preterm infants as 6.2, which was significantly less than that in the normal term infants (7.9). Shah et al.[16] stated that F/P ratio for preterm is lower than that for full-term babies. They further stated that F/P ratio almost remains the same and does not increase with parity. Damania et al.[19] calculated fetoplacental weight ratio for control group as 6.13 and that for PIH group as 5.71. They also commented that F/P ratio decreases with increase in toxemia. According to Macpherson,[20] F/P ratio was an additional means of evaluating placental weight deviation.

Mean placental coefficient in control group was 0.16 (range 0.16–0.17) and that in the PIH group was 0.18 (range 0.17–0.20). The placental coefficient in PIH group was significantly higher. Davies and Beazley[8] commented that decrease in placental weight and the ratio of placenta to fetal weight (P/F ratio) has been considered as possible indication of functional inadequacy. They found P/F ratio of 0.16 in premature babies and 0.14 in normal babies. Teasdale[21] calculated placental coefficient in control group to be 0.14 and that in preeclampsia to be 0.17. He stated that the high P/F weight ratio in preeclampsia was also a reflection of higher ratios for significant parameters of placental function to fetal weight, such as parenchymal weight, total trophoblast nuclei content, and all surface areas of exchange between mother and fetus.

Conclusion

In morphometric study, the mean placental weight, volume, area, diameter, and thickness were comparatively less than those in PIH group. Mean birth weight of babies and F/P ratio were also less in PIH group. P/F ratio was significantly higher in PIH group. PIH adversely affects both fetal and placental outcome. Higher incidence of eclampsia is mostly due to malnutrition, ignorance, lack of adequate health education, and medical care. If proper medical care is given during antenatal period and labor, then further risk to mother and fetus can be reduced.

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