



Morphology and Morphometric Study of Human Placenta in Rural Southern India

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Authors' contributions

This work was carried out in collaboration between all authors. Author ARK examined all the specimens collected, guided in statistical analysis, managed the analysis of the study and wrote the protocol. Author BSC designed the study, guided in carrying out the study and wrote the first draft of the manuscript. Author AM collected the specimens and managed literature searches. Author AM helped in grossing the specimens and compiling the reports. All authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

Aims: To study the morphology and do the morphometric analysis of placenta and to correlate with the foetal parameters, in order to help in the assessment of the state of well being of foetus. To study the histomorphological features of placenta in various conditions complicating the pregnancy.

Study Design: Descriptive type of study.

Place and Duration of Study: Department of Pathology and Department of Obstetrics and Gynaecology, Sri Manakula Vinayagar Medical College, Puducherry, between July 2013 and August 2013.

Methodology: We included 51 fresh placentae. Gross examination including weight, shape, thickness, feto-placental ratio, placental co-efficient was calculated. Later, histo-

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morphological study was done.

Results: Out of the 51 placentae, 48 were circular in shape and 3 were oval in shape. In the present study the mean (\pm SD) diameter of the placenta was 14.65 cm and thickness of the placenta was 1.42 cm. The thickness of placenta was reduced (<1.5 cm) in all cases of Pregnancy induced hypertension (PIH), Isoimmunisation, twin pregnancy, prematurity and anemia. Placental weight was reduced in all cases of PIH, low birth weight baby, prematurity and Increased placental weight was seen in the gestational diabetes. Feto-placental ratio was 5.39:1(both sexes considered together) and placental coefficient was 0.19. In PIH, the average foeto-placental ratio was 5.20:1 and the average placental coefficient was 0.19. Gestational diabetes showed a foeto-placental ratio of 5.30:1, the placental coefficient being 0.18 with a considerable increase in the birth weight and in the placental weight. Anaemia showed a significant reduction in the placental weight, with a foeto-placental ratio of 5:1 and an increase in the number of ill-defined cotyledons. In prematurity, average foeto-placental ratio was 4.43:1, while Rh isoimmunisation did not show any decrease in the foeto- placental ratio.

Conclusion: As anticipated, in case of PIH complicating pregnancies, the morphometric values of the placenta like the diameter, number of cotyledons and the average placental and foetal birth weights were found to be lower than that of the normal, uncomplicated pregnancies. At the same time, all these parameters were increased in cases of diabetes. So morphometric investigation of the placenta will be tremendously useful in the early assessment of placental insufficiency and also the state of foetal well being.

Keywords: Placenta; birth weight; feto-placental ratio; placental co-efficient.

1. INTRODUCTION

The placenta is a mirror which reflects the intrauterine status of the foetus . It is a vital organ for maintaining pregnancy and promoting normal foetal development. It is an organ that connects the developing foetus to the uterine wall, thereby allowing nutrient uptake, waste elimination, and gas exchange via the mother's blood supply. Proper vascular development in the placenta is fundamental to ensuring a healthy foetus and successful pregnancy [1].

Maldevelopment of Placenta is the leading cause of maternal and perinatal mortality and an important factor of foetal growth retardation [2]. Despite the significant achievements made by India in health, maternal mortality rate still remains high in comparison to developed countries and is largely preventable.

Placenta depicts the most accurate record of prenatal experience of an infant. It undergoes different changes in weight, volume, structure, shape and function continuously throughout the gestation to support the prenatal life [3]. Pregnancy complications like hypertension or gestational diabetes are reflected macroscopically and microscopically in the placenta [4]. Babies born with a disproportional large placenta are at a greater risk of developing hypertension in later life.

The examination of placenta in utero as well as postpartum provides much insight into the prenatal health of the baby and the mother [5]. In mothers who have had no previous antenatal check up, a thorough examination of the placenta will help in the early diagnosis of the foetal complications, soon after parturition and thus helps in the early treatment of the

baby by neonatologists especially in a rural setup where even today the mothers land into the labour ward with no prior investigation done.

Hence, this study correlates the morphological parameters of the placenta with the foetal parameters and gives valuable information about the state of foetal well being.

2. MATERIALS AND METHODS

A total of fifty one freshly delivered placentae (including the twin placenta) were collected from the Department of Obstetrics and Gynaecology during the period of July 2013 to August 2013.

Before the study, permission was taken from the Institutional Ethics Committee and Head of Obstetrics and Gynaecology.

In each case, a preliminary history was elicited from the mother regarding her age, parity, the period of amenorrhoea, history of bleeding per vaginum and her present and previous obstetric history with regard to PIH and diabetes mellitus.

The babies whose placentae were utilized in this study were examined for any visible anomalies and sex, weight, maturity of the baby was noted.

All the placentae were collected immediately after delivery, both from normal deliveries and Caesarean sections. The collected placenta was washed under running tap water. The cord and membranes were examined for any abnormalities. The placenta along with the cord were collected in 10% formalin filled wide mouthed plastic containers. All the specimens were tagged with number discs before the commencement of the study for the purpose of identification.

In the collected placenta the following parameters were studied on gross examination:

1. Weight: Measured using electronic weighing machine.
2. Shape: The shape of the placenta and the presence of accessory lobe were recorded after proper inspection. Each placenta was categorised round, oval or irregular in shape.
3. Diameter: The placenta was placed in a flat tray after trimming. At first, the maximum diameter was measured with a metallic scale graduated in centimetres. Then the second maximum diameter was taken at right angles to the first one. The mean of the two measurements is considered to be the diameter of the placenta expressed in centimetres.
4. Thickness: With a long needle, placental thickness was measured at five points of each placenta. Each placenta was placed on the foetal surface. The placenta was divided arbitrarily into three zones of equal parts by drawing two circles on the maternal surface. These circles cut the radius of the placenta into three equal parts. One thickness was measured from the centre of the central zone, two from the middle zone and two from the peripheral zone. The peripheral points were taken within the outer zone on a line perpendicular to the previous imaginary line. Finally, the mean of all five measurements was calculated and considered as the thickness of the placenta.

5. Number of Cotyledons: Each formalin fixed placenta was taken on both the hands. Then gentle pressure was applied on the central part of the foetal surface with thumbs of both the hands while holding the periphery of the placenta with the other fingers. As a result, the cotyledons on the maternal aspect became prominent after separation between them. Then the placenta was put in a flat tray with the maternal surface facing upwards by placing a block of paraffin on the foetal side. Then the counting was started from the left side of one end of the placenta going rightward and again turning back to the left in a manner of loop. This counting procedure was repeated until the other end of the placenta was reached. The total numbers of cotyledons were recorded.
6. The foeto-placental ratio
7. The placental coefficient
8. The colour of the placental membranes
9. The presence of sub chorionic fibrosis.

The presence of the following abnormal placental characteristics were looked for:

1. Placental calcification
2. Amniotic bands
3. Retro-placental lobes.
4. Accessory placental lobes.
5. Placental cysts on the membranes.

Transverse cuts were made through the maternal surface at a distance of 1-2 cm in bread loaf manner and examined for pale areas.

The placenta was grossed by swiss-roll technique. Bits were taken from the maternal surface, membranes, cords and from the representative areas.

The tissues were then processed, embedded and block out with paraffin wax. Haematoxylin and eosin stains were used and the slides were examined under a light microscope.

The microscopic study of the placenta was carried out utilising a set of standard criteria for villous and intervillous lesions. For studying these criteria eight random microscopic fields were chosen and hundred villi were counted in each field and studied for the presence of the following criteria:

2.1 Villous Lesions

1. Syncytial knots > 30 % in one field
2. Fibrinoid necrosis > 5 % in one field
3. Placental infarction > 5% in one field

2.2 Intervillous Space

1. Perivillous fibroid deposition >5% in one field
2. Presence of calcification.

3. RESULTS AND DISCUSSION

A total number of fifty one placentae including one twin placenta were studied and their morphological parameters were recorded and correlated with the observations which were made by other researchers on this title.

Out of 51 cases studied, 26 cases were primigravida and 25 cases were multigravida. Vaginal delivery was conducted in 28 cases and 23 cases were delivered by caesarean section. Gestational age at delivery ranged from 32 weeks to 43 weeks mean age being 30.3 weeks. Maternal age ranged from 19 years to 35 years, average being 26 years. Out of all cases, 47 cases were full term, 3 cases were preterm and 1 case was post term delivery (Tables 1 & 2).

Table 1. Parity, mode of labour and maturity of the baby

Parity Type	Cases	Mode of labour		Maturity	
		Type	Cases	Type	Cases
Primi	26	Vaginal	28	Full Term	47
				Pre term	03
Multi	25	Caesarean	23	Post Term	01

Table 2. Factors complicating pregnancy observed in the study of 51 cases

Factors complicating pregnancy		
Sl. no	Type	Cases
1.	PIH	06
2.	Diabetes Mellitus	01
3.	Anaemia	01
4.	Rh-isoimmunisation	01
5.	Twins	01
6.	Prematurity	03
7.	Post Maturity	01

The following parameters were observed in 51 placentae (including the twin placenta).

3.1 Shape

Out of the 51 cases, 48 were circular in shape and 3 were oval in shape.

3.2 Cord Attachment

Majority of placenta showed central attachment of cord in 90% cases while the remaining 10% had marginal attachment.

3.3 Diameter

In the present study the mean (\pm SD) diameter of the placenta was 14.65 cm.

3.4 Thickness

The mean (\pm SD) thickness of the placenta was 1.42 cm .In the present study the thickness of placenta was reduced (<1.5cm) in all cases of PIH, Isoimmunisation, twin, prematurity and anemia.

3.5 Weight of the Placenta

In this study, the placental weight ranged from 325 gm to 700 gm, with an average of 550.39 gm (Table 3). Decrease in weight of placenta was seen in all cases of PIH, low birth weight baby, prematurity and anaemia. Increase in weight of the placenta was seen in the case of gestational diabetes. Gunapriya Raghunath et al reported the average weight of placenta to be 525.55 grams and Armitage et al study states that the average weight to be 508 grams [6]. Compared to other studies, this study showed an increase in average weight and it could be due to improvement in the antenatal care, follow up and nutritional status of the antenatal mother.

Table 3. The range and average Weight of the placenta in different sex group

Sex of baby	Range of weight of placenta	Average weight of placenta
Both sexes together	325 gm – 700 gm	550.39 gm
Male baby	325 gm – 650 gm	546.53gm
Female baby	450gm – 700 gm	554.40 gm

3.6 Foeto- Placental Ratio and Placental Co-efficient

The ratio of the foetal weight to the placental weight is known as the foeto-placental ratio, which is normally 6:1. In the present study, this ratio was 5.39:1(both sexes considered together. In male babies, it was 5.34:1and in female babies, it was 5.45:1(Table 4).

Placental co-efficient is yet another method to correlate the weight of the baby and the placenta.

Placental coefficient = Placental weight in grams \div Birth weight in grams.

The present study showed a placental coefficient of 0.19.

Table 4. Average birth weight and average placental weight in different sex group

Sex of baby	Average birth weight	Average placental weight
Male	2.95kg (Range 1.10kg – 3.60 kg)	546.53gms (Range 325gm – 650gm)
Female	3.02 kg (Range 2.25kg – 3.75 kg)	554.40gms (Range 450gm–700gm)

In PIH, the average foeto-placental ratio was 5.20:1 and the average placental coefficient was 0.19. Out of the six cases of PIH, four of them showed the presence of placental infarction.

Placenta of diabetic mother showed a foeto-placental ratio of 5.30:1, the placental coefficient being 0.18 with a considerable increase in the birth weight and in the placental weight much similar to Vineeta Tiwari et al. [7] study.

The case of anaemia showed a significant reduction in the placental weight, with a foeto-placental ratio of 5:1 and an increase in the number (25%) of ill-defined cotyledons. The average thickness of the placenta was also found to be grossly reduced.

The cases of prematurity showed a substantial decrease in the placental weight. The average foeto-placental ratio was 4.43:1, while in case of Rh isoimmunisation did not show any decrease in the foeto- placental coefficient. Kotgirwar et al study showed significant reduction in foeto-placental ratio and placental dimensions in case of idiopathic intrauterine growth retardation [8].

The twin pregnancy which was observed in this study showed a foeto-placental ratio of 5.11:1 with a placental coefficient of 0.20 (Table 5).

A subchorionic placental cyst was observed near the umbilical cord insertion in one case and on aspiration, the cyst was found to contain clear, serous fluid. The baby in this case was not associated with foetal growth retardation.

Table 5. Correlation of placental weight with foetal birth weight in cases of factors complicating pregnancy

Factors complicating pregnancy	Average birth weight	Average placental weight	Foeto-placental ratio	Placental coefficient	Average diameter of the placenta	Average thickness of the placenta
PIH (06 cases out of 51 placenta)	2.48 kg	476.67 gm	5.20:1	0.19	13.59 cm	1.23 cm
Anaemia (01 case of 51 placenta)	2.40kg	475 gm	5:1	0.19	14cm	1 cm
Diabetes (01 case out of 51 placenta)	3.75 kg	700 gm	5.30:1	0.18	18.50 cm	2.15 cm
Rh isoimmunisation (01 case out of 51 placenta)	2.90 kg	550 gm	5.27:1	0.19	13.25 cm	1.25 cm
Prematurity (03 cases out of 51 placenta)	1.93 kg	425 gm	4.43:1	0.23	10.75 cm	1.03 cm
Twins (02 cases out of 51 placenta)	2.5 kg	487.5 gm	5.11:1	0.20	13.13 cm	1.08 cm

Histo-morphological features of placenta in complicated pregnancy

3.8 Pregnancy Induced Hypertension (PIH)

The foeto placental unit was adversely affected in PIH. Due to placental insufficiency the foetal growth was affected. In the studies conducted by Thomson et al. and Saigal et al. the

placental weight and birth weight were below average [9,10]. In accordance with these studies the present study recorded the foeto placental ratio of 5.2:1 and placental coefficient of 0.19 in case of PIH. Zek and Assali defined placental infarction as a zone of ischemic necrosis of a group of villi due to complete interference with blood supply in the deciduas or by the thrombosis of spiral arteriole [11]. Fox and Udainia observed placental infarcts in cases of PIH [12].

This study showed placental infarction in four out of 6 cases of PIH (70%) during gross and microscopical examination of placenta [Fig. 1]. It has been further stated that the extent and incidence of infarction increases with increasing severity of toxæmia of pregnancy [3].

3.9 Diabetes Mellitus

One of characteristic feature of placenta in maternal diabetes is increase in weight [13]. The present study showed foeto placental ratio of 5.3:1, the placental coefficient being 0.18 with considerable increase in both birth weight and placental weight.



Fig. 1. Gross specimen of placenta showing extensive infarct in case of PIH

3.10 Anaemia of Pregnancy

The present study showed a significant reduction in the placental weight in case of anaemia [Fig. 2], with a foeto-placental ratio of 5:1 and an increase in the number of ill-defined cotyledons. The average thickness of the placenta was also found to be grossly reduced.

3.11 Prematurity

According to our study, the average foeto-placental ratio was 4.43:1 which correlates well with the findings reported by Gunapriya Raghunath et al. which showed an average foeto-placental ratio of 4.5:1 in cases of premature infants [6].



Fig. 2. Gross specimen showing thinned out placenta in case of anaemia

3.12 Post maturity

According to Burgees and Hutchins, the post maturity was associated with placental calcification and foetal distress [14]. In accordance with the above study, our study showed placental calcification in post maturity too [Fig. 3].

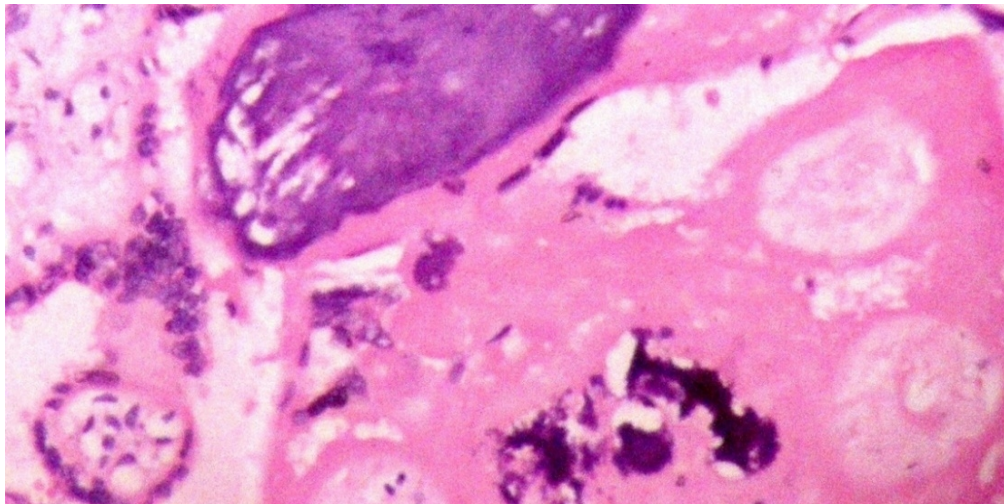


Fig. 3. Photomicrograph 10x(H &E)- showing calcification in postmature placenta

3.13 Twin Pregnancy

Ramos – Arroyo et al reported that dichorionic dizygotic twins were the heaviest and also suggested that the chorionic status is more important determinant of birth weight than zygosity [15]. One case of dichorionic dizygotic twin was observed in the present study and showed an average foeto placental ratio of 5.11:1 with a placental coefficient 0.20 which

coincided with the results of former study. Gunapriya Raghunath et al reported the average birth of dichorionic dizygotic twins to be 1.9 kg while the present study showed an average birth weight of 2.5 kg [6].

3.14 Subchorionic Fibrosis

Subchorionic fibrosis is caused due to subchorionic fibrin deposits which may be seen in all term placenta and is not of clinical significance as stated by Sprit et al. [16].

In accordance with the above study, the present study showed subchorionic fibrosis in all term placenta.

3.15 Cotyledons

A paucity of cotyledons [Fig. 4] was observed in this study in case of PIH, prematurity and low birth weight babies which coincided with findings of Nordenvall et al. and Gunapriya Raghunath et al. [17,6].



Fig. 4. Gross specimen of placenta showing ill defined cotyledons

3.16 Placental Cysts

Rega et al reported that subchorionic placental cysts are ominous finding and that they can be associated with growth retardation and intra uterine asphyxia due to umbilical cord constriction if they are found near the umbilical cord insertion [18]. One case of subchorionic placental cyst was observed in this study too and the baby in this case was not associated with foetal growth retardation [Fig. 5]. This is not in accordance with the study mentioned above.



Fig. 5. Gross specimen of placenta showing cyst near the insertion of cord

3.17 Microscopic Examination of the Placenta

The significant microscopic findings are depicted in Table 6. In a study by Vineeta Tewari et al. the diabetic placentae showed increased syncytial knots, fibrinoid necrosis, trophoblastic basement membrane thickening, villous stromal fibrosis, crowding of villi with thickening of vessel wall and fibrin deposition [7]. This is well comparable to the findings in this study where the microscopic examination of the diabetic placenta divulged fibrinoid necrosis and perivillous deposits with the narrowing of the intervillous space [Fig. 6].

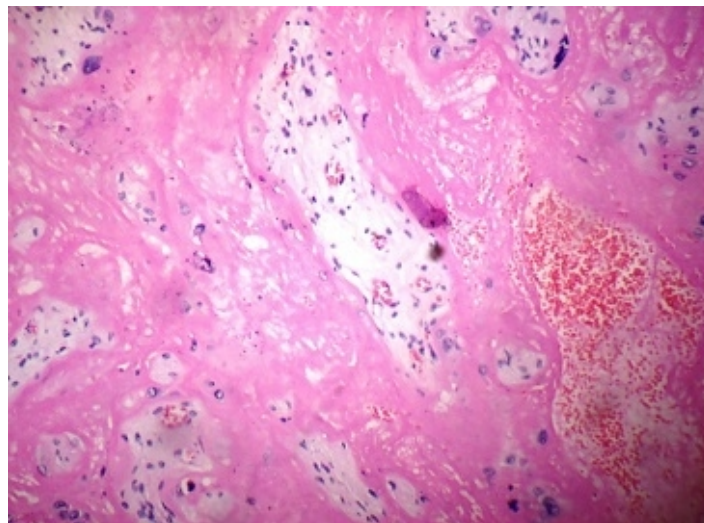


Fig. 6. Photomicrograph 10X(H & E)- showing necrosis of placenta in PIH

Table 6. Microscopic features of placenta in normal and complicated pregnancy

Sl.no	Pathology	No of cases of PIH (out of 6 cases)	No of cases of diabetes (of the 1 case)	No of cases
1	Syncytial knots >30% in one field	6		
2	Fibrinoid necrosis >5% in one field	6	1	
3	Placental infarction >5% in one field	4	1	
4	Perivillous fibrous deposits >5% in one field	6	1	
5	Narrowing of the intervillous space	6	1	
6	Presence of calcification			1 case of post maturity
7	Hemorrhage	4		
8	Sub chorionic cyst (lined by simple cuboidal epithelium)			1
9	Sub chorionic fibrosis			All cases of term placenta (47)
10	Normal histology			Rest of the number of placentae

Stromal and villous pathological changes like increase in the syncytial knots (>30% per field) and fibrinoid necrosis (>5% per field), placental infarction and perivillous deposits (>5% per field) were observed by the microscopic examination of the placenta in cases of PIH complicating pregnancy [Fig. 7]. This finding correlated well with the findings of Majumdar S et al study which showed changes like the stromal fibrosis, medial coat proliferation of medium sized blood vessels and mean number of calcified and hyalinised area per low power field [19].

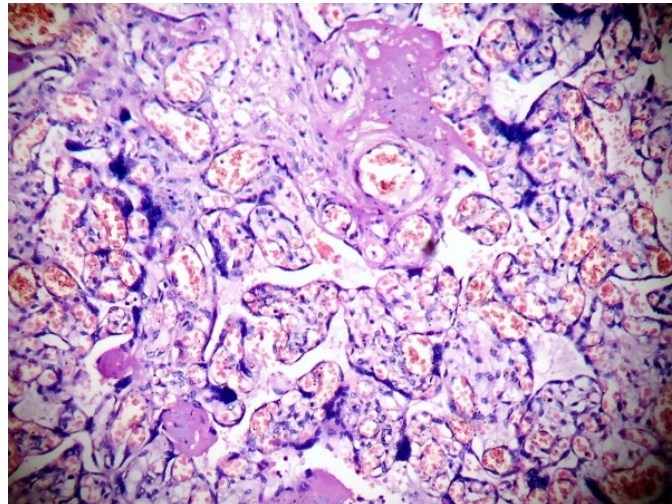


Fig. 7. Photomicrograph 10X (H & E) showing syncytial knots and fibrin in placenta

4. CONCLUSION

As anticipated, in case of PIH complicating pregnancies, the morphometric values of the placenta like the diameter, number of cotyledons and the average placental and foetal birth weights were found to be lower than that of the normal, uncomplicated pregnancies. The values of the average birth weight and the foeto-placental ratio were lower in the preterm cases as compared to the normal full term pregnancies.

The morphometric values of the placenta and the average birth weight were found to be appreciably increased in case of the placenta collected from a diabetic mother.

There was distinct histo-morphological changes in the placenta collected from the PIH and diabetic mothers which connote degenerative changes that are detrimental to the outcome of pregnancy. Developing markers, histological and histochemical factors for the foetal well being in diabetic and PIH mothers would be of immense help in addressing these grave diseases with potential negative outcomes in pregnancy.

Thus, in addition to the advanced investigative techniques such as Gray scale ultrasound and other modern radio-imaging techniques, an adequate knowledge about the morphology and the various morphometric investigations of the placenta will be tremendously useful in the early assessment of placental insufficiency and also the state of foetal well being.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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