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Variable placental attachment of umbilical cords and its effects on placental outcomes

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Abstract

Introduction: Growth of the fetus is dependent on the development and function of the placenta. Therefore, any pathological condition which affects the function of placenta, will also affects the fetal outcomes. The aim of the present study was to assess the effects of non-central cord insertions on placental outcomes.

Materials and Method: 120 placentae divided into sixty each of normotensive and pre-eclamptic pregnancies were studied. After delivery, the weight of the placenta was taken by using weighing machine. The shape of the placenta and umbilical cord insertion on placenta was observed.

Results: In this study, abnormal cord insertions were found 2.57 times more in pre-eclamptic pregnancies as compared to normal pregnancies. Altered shaped placentae were found 2.6 times more in pre-eclamptic pregnancies as compared to normal pregnancies. We found that 28.57% and 55.56% placentae with abnormal cord insertion were associated with altered placental shapes in normal and pre-eclamptic pregnancies respectively. We also observed that 57.14% and 77.78% placentae with abnormal cord insertion were associated with low placental weight in normal and pre-eclamptic pregnancies respectively.

Conclusion: The incidence of abnormal cord insertions were more in pre-eclamptic pregnancies and these abnormal cord insertions were significantly associated with altered shaped placentae and lower placental weight. Conclusively, placenta with abnormal cord insertion may be associated with alteration in the function of the placenta, which ultimately affects the fetal outcomes.

Keywords: Cord insertion, Pre-eclampsia, Placenta, Placental shape, Placental weight.

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Introduction

During intrauterine life, placenta and umbilical cord act as a connecting link between fetus and mother. All the essential nutrients needed for fetal growth and development comes from the mother's blood and fetal waste products pass back to the mother's blood through the placenta and umbilical cords; hence an examination of the placenta and umbilical cord gives a clear idea about the fetal outcomes when it was in the mother's womb.

The placenta is a discoidal organ, which has fetal and maternal surfaces. The fetal surface is covered by an amnion and umbilical cord is attached to the center of this fetal surface. The maternal surface is finely granular and has 15-30 lobes. These lobes correspond to the major branches of distribution of the umbilical vessels.(1) Placenta regulates the growth and survival of the fetus during intrauterine life. The growth of the placenta is not uniform in intrauterine life. It undergoes different changes in shape, weight, and function continuously.(2) In the early gestational period, the shape of the placenta is not round, but irregularly-regular with a few large branches and gaps between them. In a normal course of development of placental vasculature, the main branches of the placental vascular tree grow first, then smaller branches fills the gaps between main branches. Thus the placental shape becomes round from irregular. Any disease which affects the utero-placental vascular pathology may also alter the placental angiogenesis. Thus the overall placental shapes remain irregular in these diseases(3) and these irregular shaped placentae are associated with reduced placental efficiency which impacts negatively on the fetal development.(4)

Abnormalities in the site of insertion of umbilical cord on placenta can produce a number of complications in pregnancies i.e. preterm labour, vasa previa.(5,6) These complications have potential to affect the fetal health and well-being. Low birth weight, IUGR (intrauterine growth retardation), low APGAR (appearance, pulse, grimace, activity and respiratory rate) score, and increased rate of fetal malformation has been associated with abnormal cord insertions.(7-9)

The aim of present study was to compare the distribution of variable placental attachment of umbilical cord and placental shapes in normal and pre-eclamptic pregnancies; and to evaluate the effects of variable cord insertions on placental shapes and weight.

Materials and Method

The study was conducted in the Department of Anatomy, Gandhi Medical College, Bhopal (M.P.). After permission from the institutional ethics committee, a total of 120 placentae were collected from

the labour room of Sultania Zanana Hospital associated to G.M.C. Bhopal. All mothers were properly explained about the study and their written consent was taken. Pre-eclampsia was diagnosed when women had proteinuria after the 20th week of gestation, with systolic BP ≥ 140 mmHg and diastolic BP ≥ 90 mmHg, measured on two or more occasions at least 4 hrs apart. The presence of proteinuria was conformed when a urine dipstick value was 1+ (>30 mg/dL) on two different occasions at least 6 hours apart.[10] On this basis, subjects were divided into two groups. Group I consist of placentae obtained from normal pregnant women (n=60) with gestational age 37-40 weeks. Group II consist of placentae obtained from pre-eclamptic women (n=60) of similar gestational age. Pregnancies with anemia, essential hypertension, gestational diabetes, hepatic disorders, renal disorders, multiple pregnancies and other illness associated with pregnancies were excluded from the study.

A special code number was given to each mother's and her neonates. The placenta was collected soon after their expulsion and washed in the running tap water to clear all blood. The weight of the placenta was recorded by using weighing machine. Distance from the margin of placental to the point of umbilical cord insertion was measured. The umbilical cord which was inserted within 2 cm from the edge of the placenta, classified as marginal cord insertion. Whereas insertion of the cord into chorio-amniotic membranes was classified as velamentous cord insertion. Both marginal and velamentous cord insertions were considered as abnormal cord insertion (ACI). Remaining central and eccentric cord insertions were considered as normal cord insertion (NCI). The shape of the placenta was noted visually. Oval and discoidal shaped placentae were considered as normal shaped placentae, whereas triangular, square and irregular shaped placentae were considered as altered shaped placentae.

Statistical analysis of data was performed by using Statistical Package for Social Sciences (SPSS) version 15.0 (Chicago, IL). The statistical significance was analyzed by using Chi-square test for categorical data. The significance of differences between group parameters was considered significant if $p < 0.05$.

Results

The present study revealed that normal cord insertion (NCI) was found in 88.33% placentae and abnormal cord insertion (ACI) was found in 11.67% placentae of normal pregnancies. In pre-eclamptic pregnancies, NCI and ACI were found in 70% and 30% placentae respectively. Differences in the insertion of umbilical cord on placenta between two groups were found to be statistically significant. We also observed that the incidence of ACI was 2.57 times more in pre-eclamptic pregnancies as compared to normal pregnancies [Table 1].

In the present study, we observed that in normal pregnancies, 91.67% placentae were normal shaped, whereas only 8.33% placentae were altered shaped. In pre-eclamptic pregnancies, normal and altered shaped placentae were found in 78.33% and 21.67% respectively. We observed that incidence of altered shaped placenta was 2.6 times more in pre-eclamptic pregnancies as compared to normal pregnancies. Statistically, the differences in the shape of placenta between two groups were found to be significant [Table 2].

Table 1: Distribution of umbilical cord insertion in normal and pre-eclamptic pregnancies

Types of cord insertion	Normal pregnancies (n=60)	Pre-eclamptic pregnancies (n=60)
Normal cord insertion* (NCI)	53 (88.33%)	42 (70.0%)
Abnormal cord insertion** (ACI)	7 (11.67%)	18 (30.0%)
Total	60 (100%)	60 (100%)

Chi-square (χ^2) = 6.113, df = 1, p = 0.013, Statistically significant. *Normal cord insertions (NCI) included centric and eccentric cord insertions. **Abnormal cord insertions (ACI) included marginal and velamentous cord insertions.

Table 2: Distribution of placental shapes in normal and pre-eclamptic pregnancies

Shape of placenta	Normal pregnancies (n=60)	Pre-eclamptic pregnancies (n=60)
Normal shape $	55 (91.67%)	47 (78.33%)
Altered shape $$	5 (8.33%)	13 (21.67%)
Total	60 (100%)	60 (100%)

Chi-square (χ^2) = 4.18, df = 1, p = 0.04, Statistically significant. $Normal placental shapes included discoidal and oval shaped placentae. $$Altered placental shapes included triangular, square and irregular shaped placentae.

In our study, we observed that in normal pregnancies, 94.34% placentae with NCI were normal shaped and 5.66% placentae with NCI were altered shaped [Table 3]. Whereas, in pre-eclamptic pregnancies, 83.33% placentae

with NCI were normal shaped and 16.67% placentae with NCI were altered shaped [Table 4]. Normal shaped placentae with ACI were found in 71.43% placentae of normal pregnancies, whereas in pre-eclamptic pregnancies, normal shaped placentae with ACI were found in 44.44% placentae [Table 3 & 4]. In normal pregnancies, altered shaped placentae with ACI were found in 28.57% placentae, whereas in pre-eclamptic pregnancies, altered shaped placentae with ACI were found in 55.56% placentae [Table 3 & 4]. We also observed that in both normal and pre-eclamptic pregnancies, altered shaped placentae were associated more with ACI than NCI. The relation between umbilical cord insertion and placental shape was found statistically significant in both types of pregnancies but found more significant in pre-eclamptic pregnancies as compared to normal pregnancies [Table 3 & 4].

In this study, we observed that in normal pregnancies, 57.14% placentae with ACI had a placental weight less than 400 grams, whereas only 9.43% placentae with NCI had a placental weight less than 400 grams [Table 5]. In pre-eclamptic pregnancies, 77.78% placentae with ACI had a placental weight less than 400 grams; whereas 40.48% placentae with NCI had a placental weight less than 400 grams [Table 6]. Thus, in both pregnancies, ACI was more associated with low placental weight as compared to NCI and this association was seen more in pre-eclamptic pregnancies as compared to normal pregnancies. Statistically, the relation between umbilical cord insertion and placental weight was found significant in both normal and pre-eclamptic pregnancies [Table 5 & 6].

Table 3: Relation between umbilical cord insertion and placental shape in normal pregnancies (n=60)

Types of cord insertion	Shape of placenta		Total
	Normal shape	Altered shape	
Normal cord insertion (NCI)	50 (94.34%)	3 (5.66%)	53 (100%)
Abnormal cord insertion (ACI)	5 (71.43%)	2 (28.57%)	7 (100%)

Chi-square (χ^2) = 4.249, df = 1, p = 0.039, Statistically significant.

Table 4: Relation between umbilical cord insertion and placental shape in pre-eclamptic pregnancies (n=60)

Types of cord insertion	Shape of placenta		Total
	Normal shape	Altered shape	
Normal cord insertion (NCI)	35 (83.33%)	7 (16.67%)	42 (100%)
Abnormal cord insertion (ACI)	8 (44.44%)	10 (55.56%)	18 (100%)

Chi-square (χ^2) = 9.384, df = 1, p = 0.0021, Statistically highly significant.

Table 5: Relation between umbilical cord insertion and placental weight in normal pregnancies (n=60)

Types of cord insertion	Weight of the placenta (in grams)			Total
	<400	401-500	>500	
Normal cord insertion (NCI)	5 (9.43%)	38 (71.7%)	10 (18.87%)	53 (100%)
Abnormal cord insertion (ACI)	4 (57.14%)	2 (28.57%)	1 (14.29%)	7 (100%)

Chi-square (χ^2) = 11.178, df = 2, p = 0.0037, Statistically highly significant.

Table 6: Relation between umbilical cord insertion and placental weight in pre-eclamptic pregnancies (n=60)

Types of cord insertion	Weight of the placenta (in grams)			Total
	<400	401-500	>500	
Normal cord insertion (NCI)	17 (40.48%)	21 (50.0%)	4 (9.52%)	42 (100%)
Abnormal cord insertion (ACI)	14 (77.78%)	3 (16.66%)	1 (5.56%)	18 (100%)

Chi-square (χ^2) = 7.131, df = 2, p = 0.028, Statistically significant.

Discussion

Variations in the umbilical cord insertions are due to "trophotropism" in which placenta grows well towards the richly vascularised area to obtain better perfusion.[7] In normal pregnancies, central and/or eccentric cord insertions were the commonest type of placental attachment of the umbilical cords.[11-13] Similar to above, in our study, normal cord insertions were found 88.33% placentae of normal pregnancies [Table 1]. The risk of abnormal cord insertion was increased in pregnancies complicated with metabolic diseases i.e. gestational diabetes, chronic hypertension.[14] Pre-eclampsia is one of the common pregnancy associated pathological syndrome which complicates about 6–20% of all pregnancies in developing countries.[15] Marginal cord insertions were associated with hypertensive pregnancies[16] and the insertion of umbilical cord becomes marginal to velamentous in nature, as the severity of pregnancy induced hypertension increases.[13] Ebbing C. et al. reported that pregnancies associated with the marginal cord insertion increases the risk of velamentous cord insertion in subsequent pregnancies.[14] In the present study, the incidence of abnormal cord insertion was 2.57 times more in pre-eclamptic pregnancies as compared to normal pregnancies [Table 1]. This finding

is consistent with those reported by earlier researchers.[13,14,16]

In the present study, normal shaped placentae were found in 91.67% placentae of uncomplicated pregnancies [Table 2]. This finding is consistent with the study done by Kulandaivelu AR. et al[17] and Raghunath G. et al.[18] Pregnancies complicated with certain diseases i.e. gestational diabetes, anemia, pre-eclampsia were associated with altered shaped placentae.[19] In the present study, the incidence of altered shaped placentae was 2.6 times more in pre-eclamptic pregnancies as compared to normal pregnancies [Table 2]. This finding is consistent with the study done by Sudha R. et al.[19] Hypertensive pregnancies alter the uteroplacental environment which may affect the placental shape because the microscopic growth of the placenta is dependent on the repeated branching of uteroplacental vascular trees. Thus the variable placental shapes were obtained by modifying the arborization of the vascular trees.[3] This is reinforced by Cotter SL. et al, who derived the altered shaped placentae by disruption of the normal field of spiral arteries.[20]

Normally placenta will grow equally out from the cord insertion, which results in oval or discoidal shaped placentae with central cord insertion. Abnormal cord insertion is associated with impaired development and function of the placenta, which results altered shaped placentae.[3] In the present study, abnormal cord insertions were significantly associated with altered shaped placentae in both pregnancies and this association was seen more in pre-eclamptic pregnancies as compared to normal pregnancies [Table 3 & 4]. Similar to our study, Yampolsky M. et al, found a little measurable correlation between non-central cord insertion and placental shapes.[21]

In our study, altered shaped placentae were significantly associated with lower placental weight in both normal and pre-eclamptic pregnancies [Table 5 & 6]. Alteration in the development of placenta with abnormal cord insertion may influence the relationship between placental weight and fetal weight.[22] A placenta with non-central cord insertion was associated with sparser placental chorionic vascular density and such placentas showed a markedly reduced placental efficiency. Due to reduced placental efficiency, reduced birth weight was found for a given placental weight.[21]

Conclusion

Abnormal cord insertions and altered shaped placentae were significantly associated with pre-eclamptic pregnancies and these abnormal cord insertions had potential to affect the placental outcomes. Abnormal cord insertions were significantly associated with altered shaped placentae and lower placental weight in both normal and pre-eclamptic pregnancies. Conclusively, abnormal cord insertion affects the architecture of the placenta, which hampers the nutrient transfer to the fetus and ultimately leads to adverse perinatal outcomes. Thus early assessment of the abnormal cord insertion by sonography might be helpful in early identification of fetal at risk and proper management of such pregnancies reduces the perinatal mortality.

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