



Original Article

Placental Morphological Pattern in Diabetic Pregnant Women in Comparison to Non-diabetic Pregnant Women

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Abstract

Background: The placenta of diabetic women has attracted much interest to the researchers from different disciplines, largely because it is thought that placental damage or dysfunction may be partially responsible for the unduly high incidence of perinatal complications in maternal diabetes. As postnatal placental examination is of immense significance to understand the fetal and perinatal conditions in antenatal and perinatal periods due to placental dysfunction or compromise resulting from diabetes in pregnancy.

Objectives: The aim of this study was to investigate the morphological changes in placenta of pregestational and gestational diabetes mellitus.

Methods: This cross-sectional comparative study was carried out in the Department of Anatomy, Rajshahi Medical College, Rajshahi in collaboration with the Department of Obstetrics & Gynae, Rajshahi Medical College Hospital and Diabetic Hospital Rajshahi, Bangladesh over a period of three years from January 2019 to December 2021. The study was conducted on 70 pregnant women, among them 35 women were diabetic and 35 women were non-diabetic. Then shape, weight, thickness and diameter of placenta were compared between diabetic and non-diabetic pregnant women. Data were analyzed by SPSS software, version 24 and p value < 0.05 was considered statistically significant for all tests.

Results: The study revealed that majority of the diabetic mothers (54.3%) and non-diabetic mothers (60%) were within the age range of 20-30 years. The BMI of diabetic mothers was 27.7 ± 1.8 kg/m² and non-diabetic mothers was 26.7 ± 1.7 kg/m². The shape of the placenta was not affected by pregestational diabetes or GDM with oval-shaped placenta being predominant in either group (p = 0.478). Forty percent of the placenta from diabetic mothers were heavier (weighed > 500 gm) as compared to 5.7% of placenta from the non-diabetic pregnant women (p = 0.001). Over two-thirds (68.6%) of the placenta of the former group were larger (≥ 400 cc) as opposed to 14.3% of the non-diabetic mothers (p < 0.001). Thickness and diameter of the placenta were fairly comparable between the study groups (p = 0.445 and p = 0.164, respectively).

Conclusion: The study concluded that placentas of diabetic mothers are significantly larger and heavier than those of the non-diabetic mothers. Thickness and diameter of the placenta were also greater in pregnant mothers with diabetes or GDM than those in non-diabetic mothers.

Key words: Diabetic pregnant women, Pregestational diabetes mellitus, Gestational diabetes mellitus and Morphological changes of placenta.

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Introduction

The placenta is a thick disc with a dense network of blood vessels. one side it is attached to the

umbilical cord and on the other side it is firmly anchored to the uterine wall. The placenta is the most important distinctive membrane. Human

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placenta is classified as chorioallantoic, since it is vascularized by vessels homologous with the allantoic of the lower mammals, haemochorial because maternal blood in the intervillous space bathes the surface of the chorion, villous because of its villi, deciduate because maternal decidua is shed at birth along with the fetal placenta.¹ In the development of any vertebrate embryo, only part of the zygote forms the actual embryo, the other parts lying outside the embryonic territory, called extraembryonic parts, form the fetal membrane. Thus, fetal membrane develops from extraembryonic part of the zygote, although some of them are not membranous in a strict sense.² All these auxiliary organs arise partly for the protection of the embryo. Morphologically, it is partly of fetal origin (the trophoblast) and partly of maternal origin (arising from the transformation of the uterine mucosa).³

At full-term, the placenta is a flattened discoid mass with an approximately circular or oval outline with an average volume of some 500 cc (range 200-950 cc), average weight about 500 g (range 200-800 g), a diameter of 15 to 20 cm and a thickness of average 2.3 cm. It is thickest at the center but rapidly diminishes in thickness towards its periphery where it continues as the chorion leave. Viewed from the uterine aspect after delivery, the placenta is mapped into some 15 to 30 lobes by a series of intervening grooves. The lobes are termed cotyledons. Grooves between the lobes are formed by the bases of decidual septa. The fetal surface, covered by amnion, is smooth, shiny and transparent and is mottled in appearance due to the subjacent chorion. The umbilical cord is usually attached near the center of the fetal surface. A number of large arteries and veins, the chorionic vessels, converge towards the umbilical cord.

The human placenta is the vital organ responsible for the facilitation of nutrient uptake, gaseous exchange and wastage elimination between mother and fetus. The placenta is also a vital source of hormone production such as progesterone and human chorionic gonadotropin that maintain the pregnancy. Consequently, placental dysfunction can lead to a number of adverse fetal outcomes.

Moreover, because the placenta reflects the metabolic milieu of both mother and fetus, it serves as a valuable tool for studying the metabolic perturbations that may take place during pregnancy, such as diabetes mellitus.⁴

Evidence from the literature shows that well-controlled glucose levels during pregnancy are usually associated with normal placental morphology. Among the morphological changes in placenta due to gestational diabetes that have been observed since 1965, large-sized placenta was commonly reported by Winick and Noble⁵, Diamant et al.⁶, Teasdale⁷, Mayhew et al.⁸ Though, Mayhew et al.⁹ and Mayhew and Sisley¹⁰ observed no difference in the parenchyma, villous tissue or intervillous space between diabetic and control placenta but claimed that these placentae possessed a larger capillary bed, increased number of vasculosyncytial membrane, reduced plasma diffusion distance and higher oxygen conductance. Still others found no difference in the result of morphometric analysis of the placenta between the diabetic and the normal subjects.¹¹

Generally placental abnormalities most consistently associated with maternal diabetes are an increased incidence of villous immaturity, increased measures of angiogenesis and increased placental weight. Any differences in placental structure that might occur between the gestational and overt diabetic mothers should also be kept in mind in order to identify any pathophysiological distinction between the two diabetic categories. At the same time, it was assumed that the study would facilitate understanding of various anatomical and physiological aspects of fetoplacental relationship in general.

Materials and Methods

This cross-sectional study was conducted in the Department of Anatomy, Rajshahi Medical College in collaboration with the Department of Obstetrics & Gynae, Rajshahi Medical College Hospital and Diabetic Hospital Rajshahi, Bangladesh over a period of three years from January 2019 to December 2021. All the diabetic and non-diabetic pregnant women (ranging between 18-35 years) admitted in the hospitals

during the study period were the study population. However, any medical or systemic or obstetric diseases during pregnancy affecting placental morphology were excluded from the study. A total of 70 pregnant mothers (35 diabetic pregnant women and 35 non-diabetic pregnant women) at term who fulfilled the eligibility criteria were consecutively taken as study sample. The morphological characteristics (shape, weight, thickness and diameter) of placenta were then compared between diabetic and non-diabetic pregnant women.

Collection and preparation of specimens:

The placenta with attached membranes was collected soon after delivery between the first week of August 2020 to second week of September 2021. Immediately after collection, the placenta was placed on a tray and both the maternal and fetal surfaces were examined. The film of blood on the maternal surface was removed by hand gently without disturbing any firm clot which was embedded in the substance of the

placenta. Placentae were washed in running tap water and excess water was removed with blotting paper. Shape of the placenta was determined by the observation of the specimen on a flat tray. After inspection, the specimen was mopped with cotton wool and blotting paper. The weight of the placenta was recorded in grams with a weight machine. The thickness of the placenta was measured by a large needle in five points. For this purpose, the placenta was divided into three zones from center to periphery. Then the thickness was measured from five points. One in the central, 2 in the middle and 2 others in peripheral zones with average of the 5 measurements being taken as the thickness of the placenta. In order to measure the diameter of the placenta, it was placed flat on a tray. At first, the longest transverse diameter was measured in centimeters with a graduated steel tape. Then the longest transverse diameter at right angle to the first was measured. The average of these two was taken as the diameter of the placenta.

Results

Majority of the diabetic mothers (54.3%) and non-diabetic mothers (60.0%) were within the age range of 20-30 years with mean BMI of diabetic mothers was $27.7 \pm 1.8 \text{ kg/m}^2$ and non-diabetic mothers was $26.7 \pm 1.7 \text{ kg/m}^2$ (Table-01).

Table-01. Comparison of age and BMI between diabetic and non-diabetic group.

| Demographic characteristics | Group | |
|-------------------------------|----------------|--------------------------|
| | DM (n = 35) | Non-diabetic (n = 35) |
| Age (years) | | |
| < 20 | 1(2.9) | 0(0.0) |
| 20 – 30 | 19(54.3) | 21(60.0) |
| ≥ 30 | 15(42.9) | 14(40.0) |
| BMI (kg/m²) | 27.7 ± 1.8 | 26.7 ± 1.7 |

The shape of the placenta was not statistically different between the diabetic and the non-diabetic mother with oval-shaped placenta being predominant in either group ($p = 0.478$). Forty percent of the placenta from diabetic mothers weighed $> 500 \text{ gm}$ as compared to 5.7% of placenta from the non-diabetic

pregnant women ($p = 0.001$) and it was statistically highly significant. Thickness and diameter were almost comparable between the study groups ($p = 0.445$ and $p = 0.164$) and non-significant (Table-02).

Table-02. Comparison of placenta between diabetic and non-diabetic group.

| Morphology of placenta | Group | | p-value | Significant (S)/ Non Significant (NS) |
|-----------------------------------|----------------|--------------------|---------|--|
| | DM (n = 35) | Non-DM (n = 35) | | |
| Shape of placenta | | | | |
| Circular | 4(11.4) | 4(11.4) | 0.478 | NS |
| Heart shaped | 1(2.9) | 3(8.6) | | |
| Oval | 13(37.1) | 12(34.3) | | |
| Round | 12(34.3) | 7(20.0) | | |
| Irregular | 5(14.3) | 9(25.7) | | |
| Weight of placenta (gm) | | | | |
| ≤ 500 | 21(60.0) | 33(94.3) | 0.001 | S |
| > 500 | 14(40.0) | 2(5.7) | | |
| Thickness of placenta (cm) | | | | |
| ≤ 3 | 10(28.6) | 13(37.1) | 0.445 | NS |
| > 3 | 25(71.4) | 22(62.9) | | |
| Diameter of placenta (cm) | | | | |
| ≤ 22 | 31(88.6) | 34(97.1) | 0.164 | NS |
| > 22 | 4(11.4) | 1(2.9) | | |

*Chi-squared Test (χ^2) was done to analyze the data; figures in the parentheses denote corresponding percentage.

Discussion

The placenta's functions are crucial to both the mother and the developing child. The first benefit is that it serves as a barrier between maternal and fetal circulation, ensuring the interchange of metabolic and gaseous products between mother

and fetus. Gestational diabetes mellitus (GDM) leads to an abnormal placental environment which may cause some structural alterations of placenta and affect placental development and function. The objective of this study was to identify the morphological pattern of placenta in non-diabetic and diabetic pregnant women.

In this study, shape of the placenta was not influenced by pregestational diabetes or GDM with oval-shaped placenta being predominant in either group. But a study was done by Tandon et al.¹² where the majority placenta shape was circular in both non-diabetic pregnancy and diabetic pregnancy which was not similar with our study finding.

In the present study, there was no significant difference between placentae of diabetic mothers and non-diabetic pregnant women in terms of mothers' age. Our findings were in good agreement with the study Meng et al.¹³ and Tandon et al.¹⁴ But these values were not consistent with the study done by Whittington et al.¹⁵ where there was significant difference between placentae of diabetic mothers and non-diabetic pregnant women in terms of mothers' age.¹⁵

In the current study, it was demonstrated that 40% of the placenta from diabetic mothers weighed > 500 gm as compared to 5.7% of placenta from the non-diabetic pregnant women and it was highly significant ($p=0.001$). These findings were in accordance with the studies done by Bhanu et al.¹⁶ and Meng et al.¹³. Bhanu et al.¹⁶ concluded that 37.5% of the placentas of GDM mothers had weight > 500 g, whereas in control only 4.2% placentas were >500 g and it was statistically highly significant ($p < 0.001$).¹⁶ But our findings were not similar with the study done by Tandon et al., (2018) where the difference in placental weight between non-diabetic group and diabetic group was not statistically significant ($t=0.92$, $p=0.36$).¹² The weight of placenta is an important and functionally significant parameter to villous area and fetal metabolism.

Compensatory macrosomia and hyperplasia are the causes of the increased placental weight in diabetic patients. The chorionic plate and all varieties of villi in the placenta that are fetal, or affected by macrosomia, are, because the fetal portion of the placenta is impacted by macrosomia. In comparison to a placenta of a mother without diabetes, the placenta's weight, diameter, and central thickness are all higher. Generalized fetal macrosomia, a condition

associated with GDM, affects the placenta in diabetic mothers.

In this study, near about three-quarter (71.4%) of the placental thickness of the diabetic group were > 3 cm as similar to more than three-fifth (62.9%) of the non-diabetic pregnant women ($p = 0.445$). Though it was statistically non-significant but thickness was greater in pregnant mothers with diabetes or GDM than those in non-diabetic mothers. These findings were conflicting with Bhanu et al.¹⁶ where central thickness of the placentas were significantly higher in GDM group ($p < 0.001$) than those their control counterparts.¹⁶

In the current study diameter of placenta was almost comparable between the study groups ($p=0.164$) and it was not significantly different between the groups which was similar with a study done by Tandon et al.¹² where the mean placenta diameter in non-diabetic group was 18.02 ± 2.40 cm, while in diabetic it was 18.09 ± 2.50 cm and this difference in placental diameter between non-diabetic group and diabetic group was not statistically significant ($t=-0.10$, $p=0.92$).¹² But the findings were conflicting with Bhanu et al.¹⁶ where placental diameter was significantly higher in GDM group ($p < 0.001$) than the control group.

The placenta's formation, structure, and function are altered in GDM. According to the review, these modifications result in fetal overgrowth by making nutrients more readily available, as well as other negative effects on the growing fetus, because they are associated to oxygen shortage in the fetus and changes in the trans placental transport of nutrients. The placental weight/fetal weight ratio was shown to be greater in GDM and is primarily connected with histological changes among the morphological variations.¹⁷

One of the limitations of the study was that as the Anatomy Department has no histopathologic study facilities of its own, we have to depend on the Histopathology Department of the Medical College. So, processing of the specimen was hampered to some extent in some cases.

Conclusion

From the findings of the study, it appears that the morphological parameters of placenta were altered in diabetic mothers than non-diabetic pregnant women. So, diabetic mothers might be careful about their glucose monitoring and diabetes control.

Conflict of interest: None declared

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