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A comparative study of placental morphometry in diabetic and normal mothers in a tertiary care hospital of West Bengal

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Abstract

Among the hundred cases ranging from 19-38 years, fifty placentae were from normal uncomplicated pregnancies and the rest from diabetic mothers. In case of normal pregnancies, the average (±standard deviation) placental weight, volume, thickness, diameter, area and circumference were 513.3 (±53.13) g; 437.4 (±59.8) cm^3,1.79 (±0.24) cm, 17.5 (±1.52) cm, 242.19 (±40.21) cm^2, 54.95 (±4.78) cm respectively. In case of diabetic mothers, the corresponding values were 579.2 (± 44.3) g, 503.9 (± 46.11) cm^3, 2.45 (±0.49) cm, 17.56 (±1.57) cm, 243.96 (±41.41) cm^2, 55.14 (±4.93) cm. The average birth weight of baby and foeto-placental ratio were 2.55 (±0.25) kg and 4.97(±0.5) respectively in normal cases and 3.42 ± 0.26 kg and 5.91 ± 0.33 respectively in cases of diabetic pregnancy. Among the different parameters the birth weight of baby was the best predictor of the placental morphometric parameters while body weight and age of mother were poor predictors.

Key words

Pregnancy, diabetes, placenta.

Introduction

Diabetes mellitus (Type 1, Type 2 and gestational) is now a major health concern in our society. Pregnancy complicated by diabetes mellitus has been associated with alteration in placental anatomy and physiology (Fletcher,1981). Although transplacental glucose flux flow is limited and independent of glucose transporter availability, transport of essential and non-essential amino acids, and expression of genes involved in lipid transport and metabolism are significantly affected by diabetes mellitus (Diamant et al., 1982).

According to the Centres for Disease Control and Prevention, from 1980 to 2005, the crude incidence of diagnosed diabetes mellitus increases from 3.3 per 1000 to 7.4 per 1000. Studies suggest that the prevalence of diabetes mellitus among women of childbearing age is increasing due to more sedentary lifestyles, changes in diet, and the virtual epidemic of childhood and adolescent obesity that is presently involving our country (Park, 2005).

The placenta is a membranous vascular organ of female mammals except monotremes and marsupials. It develops during pregnancy from the chorion of the embryo

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and decidua basalis of the maternal uterus and connects the foetus with the maternal uterine wall (Sadler, 2010). The human placenta is aptly described as "discoid" (due to the shape), "haemochorial" (due to direct contact of the maternal blood with chorion), "deciduate" (as same amount of maternal tissue is shed during parturition) and "villous" (labyrinthine) structure (Sadler, 2010). The placenta usually remains attached to the upper part of the posterior wall of uterus. It has a rough, shaggy looking maternal surface, which is mapped out into 15-20 cotyledons separated by intervillous septae and a smooth, shiny foetal surface covered by chorion and amnion. The site of insertion of umbilical cord either centrally, marginally or eccentrically (Cunningham et al., 2010).

Placenta is the mirror of maternal and foetal status and the most accurate record of the infant prenatal experience. After delivery, if the placenta is examined minutely it provides much insight into the prenatal health of the baby and the mother (Cunningham, 2010).

The aim of the present work is to improve the knowledge about gross and morphometric changes of diabetic placenta in West Bengal population.

Materials and methods

After acquiring local ethical committee approval and informed patient consent, the materials of the present study i.e. placentae were collected at random from pregnancy cases attending the Department of Obstetrics and Gynaecology, NRS Medical College and Hospital, Kolkata, during the period one year. All the cases included in the study were booked cases according to WHO, in each case antenatal check-up was done routinely.

The placentae collected from cases included in this study were broadly divided into two groups.

Group A: Normal uncomplicated pregnancy, 50 cases;

Group B: Pregnancy complicated with diabetes mellitus (Type I, Type II and Gestational diabetes mellitus), 50 cases.

Each group comprised of patients with known last menstrual period), expected date of delivery, blood sugar levels, body weight and gestational period ranging from 36 to 40 weeks.

The following parameters were measured or computed: Weight, volume, thickness, diameter, area and circumference of placenta and cord insertion site.

An electronic weighing device was used to measure the weight. The volume of the placenta was determined by water displacement method. The diameter of the placenta was measured with a measuring tape. For measuring the thickness, a thin long graduated needle was inserted at the centre, at the margin and midway between the centre and margin and the average of the three reading was taken as the thickness of the placenta.

The area (A) was computed from quation $A = \pi \times (\text{maximum diameter})/2 \times (\text{minimum diameter})/2$. The circumference (P) was computed from $P = \pi \times (\text{maximum diameter} + \text{minimum diameter})/2$. To estimate the cord insertion site, the minimum distance between the site of cord insertion and the margin of the placenta was measured and denoted as 'x'; assuming the placenta to be a perfect circle, the mean

radius 'r' was obtained and then the insertion site was worked out as x/r x 100 and expressed in per cent.

Body weight and age of mother at the time of delivery, birth weight of baby and with gestational age were also recorded.

The data were tabulated in a Microsoft Excel spread sheet and analysed by Epi-info 3.5.1 software (Centres for Disease Control and Prevention (CDC), Atlanta, GA).

Results

One hundred cases were included in the study, 50% of which were diabetic. Among the normal pregnancies, six babies were born at preterm and 44 were born at term and among the diabetic mothers only one had undergone preterm delivery, the rest of the mothers delivered at term.

The mothers included in this study were from different age groups starting from 19 years to 38 years with average value and standard deviation of 27.92 and 5.08 years respectively; the commonest observed age was 24 years. The mean gestational age was 37.17 weeks (range: 32-39 weeks) with standard deviation 1.08 weeks. The commonest gestational age was 37 weeks.

There was a great variation in the body weight of the mothers, ranging from 50 to 79 kg with average weight and standard deviation of 65.68 kg and 7.98 kg respectively. The most frequently observed weight was 72 kg. The average body weight of baby was 2.983 kg with standard deviation of 0.508 kg. The commonest observed body weight of baby was 2.500 kg, ranging from 1.600 to 4,000 kg.

Table 1 shows the analyzed parameters of normal and diabetic mothers and their babies; significant differences in the average body weight of mothers and in the birth weight of babies were observed between normal and diabetic mothers (P value < 0.05).

Among the different parameters, significant differences were found for placental weight, volume and thickness, birth weight of baby and foeto-placental ratio; the results are shown in Table 2.

Table 3 shows the different types of insertion of umbilical cord. Medial eccentric variety was the commonest type of insertion of umbilical cord on the foetal surface of placenta.

The correlation among different parameters are shown in Table 4. Baby weight at birth was the best. Baby weight at birth was the best predictor of placental morphometric parameters and in contrast body weight and age of mother were poor predictors for those parameters.

Table 5 shows the linear regression equations for all placental morphometry parameters. The coefficient of determination, r^2, allows to determine how certain one can be in making predictions from a certain model/graph and denotes the strength of the linear association.

Gestational age at delivery did not show any significant correlation with placental morphometry parameters in case of diabetic mothers though it showed a moderate correlation with placental diameter, placental circumference, placental area and foeto-placental ratio in normal uncomplicated pregnancy (Table 4).

Table 1. Parameters of normal and diabetic mothers.

Parameters		Mean	Range	Mode	Standard deviation	*p*
Age of mother (years)	Normal	28.68	19-38	26	5.4415	not significant
	Diabetic	27.16	19-36	23	4.6174	
Body weight (kg)	Normal	63.8	50-76	55	8.3910	< 0.05
	Diabetic	67.56	54-79	70	7.1462	
Gestational age at delivery (weeks)	Normal	37.34	32-39	38	1.5066	not significant
	Diabetic	37.0	36-38	37	0.2020	
Birth weight of baby (kg)	Normal	2.5480	1.6-3.1	2.5	0.2557	<0.01
	Diabetic	3.4180	3-4	3.5	0.2651	

Table 2. Morphometric parameters of placenta from normal and diabetic pregnancy.

Parameters	Normal pregnancy (n=50)			Diabetic pregnancy (n=50)			*p*
	Mean	Range	SD	Mean	Range	SD	
Placental weight (g)	515.3	350-600	53.13	579.2	500-675	44.3	<0.001
Placental volume (cm^3)	437.4	300-530	59.8	503.9	410-570	46.11	<0.001
Placental thickness (cm)	1.79	1-2.5	0.24	2.45	1.8-3.2	0.49	<0.001
Placental diameter (cm)	17.5	12-20	1.52	17.56	12-20	1.57	not significant
Placental area (cm^2)	242.19	113.04-314	40.21	243.96	113.04-314	41.41	not significant
Placental circumference (cm)	54.95	37.7-62.8	4.78	55.14	37.7- 62.8	4.93	not significant
Birth weight of baby (kg)	2.55	1.6-3.1	0.25	3.42	3-4	0.26	<0.001
Foeto-placental ratio	4.97	3.2-5.71	0.5	5.91	5-6.36	0.32	<0.001

Table 3. Insertion of umbilical cord on the foetal surface of placenta.

No. of cases	Central	Eccentric		
		Medial	Lateral	Marginal
Normal (n = 50)	14 (28%)	22 (44%)	12 (24%)	2 (4%)
Diabetic (n = 50)	20 (40%)	23 (46%)	6 (12%)	1 (2%)
TOTAL (n = 100)	34 (34%)	45 (45%)	18 (18%)	3 (3%)

Discussion

Relevant studies of different anomalies of placenta in relation to its morphometry are discussed sequentially.

Brody and Frenkel (1953) reported that, in 70% of premature labour, the cord was inserted marginally into the placenta. Aherne and Dunhill (1966) described relation

Table 4. Correlation coefficients (r) of baby weight at birth, body weight of mother during delivery, gestational age at delivery and age of mother with morphometric parameters of placenta. Strong to moderate correlation is indicated in bold.

Parameters	Baby weight at birth (kg)		Body weight of mother at delivery (kg)		Gestational age at delivery (weeks)		Age of mother (years)	
	Normal (n = 50)	Diabetic (n = 50)	Normal (n = 50)	Diabetic (n = 50)	Normal (n = 50)	Diabetic (n = 50)	Normal (n = 50)	Diabetic (n = 50)
Placental weight	**0.50**	**0.74**	0.00	0.00	0.10	0.00	0.00	0.14
Placental volume	**0.42**	**0.72**	0.00	0.10	0.22	0.00	0.00	0.28
Placental thickness	**0.46**	**0.44**	0.14	0.14	0.28	0.00	0.00	0.10
Placental diameter	**0.56**	**0.54**	0.17	0.00	**0.35**	0.00	0.00	0.10
Placental circumference	**0.57**	**0.54**	0.17	0.00	**0.35**	0.00	0.00	0.10
Placental area	**0.54**	**0.54**	0.17	0.00	**0.32**	0.00	0.00	0.10
Foeto-placental ratio	**0.50**	**0.39**	0.00	0.00	**0.42**	0.10	0.10	0.17

Table 5. Linear regression equations between placental morphometric indices and baby weight at birth.

Parameters	Baby weight at birth (kg)	
	Normal (n = 50)	Diabetic (n = 50)
Placental weight (kg)	r^2 =0.25 =252.311+103.214×Baby weight	r^2 =0.54 =158.654+123.039×Baby weight
Placental volume (cm^3)	r^2 =0.18 =186.369+98.521×Baby weight	r^2 =0.52 =75.643+125.295×Baby weight
Placental thickness (cm)	r^2 =0.21 =0.685+0.435×Baby weight	r^2 =0.20 = -0.362+0.825×Baby weight
Placental diameter (cm)	r^2 =0.31 =8.993+3.339×Baby weight	r^2 = 0.29 =6.746+3.164×Baby weight
Placental circumference (cm)	r^2 =0.32 =28.158+10.517×Baby weight	r^2 =0.29 =21.167+9.939×Baby weight
Placental area(cm^2)	r^2 =0.29 =25.364+85.097×Baby weight	r^2 =0.29 =-44.615+84.427×Baby weight
Foeto-placental ratio	r^2 =0.24 =2.500+0.970×Baby weight	r^2 =0.15 =4.278+0.477×Baby weight

between birth weight of babies, placental area and volumes in normal infants. They also obtained a reduction in the placental volume of abnormally small infants (350 ± 65m). Benirschke and Driscoll (1967) described that velamentous insertion of cord is associated with foetal malformation.

Younoszai and Haworth (1969) established that infants with smaller than normal placentae for their gestational ages also were found to suffer from intrauterine growth retardation. Thomson et al. (1969) found that the placenta of diabetic women tends to be heavier than that of the non-diabetic women. These placental were also paler in colour due to villous oedema and the placental weight and size are directly proportional to birth weight of the babies. Foetal macrosomia, congenital malformations and intrauterine growth retardation are commonly seen in poorly controlled diabetes (Fletcher, 1981). Benirschke and Kaufman (2000) proposed that the placenta is the most accurate record of the infant's prenatal experience. They suggested that if the placenta is minutely examined after delivery it may provide much insight into the prenatal life of the neonate and maternal complications during pregnancy if any. Complications like hypertension, diabetes mellitus of the mother developing during present pregnancy also causes several relevant changes in placenta.

The placenta in pregnancy complicated with diabetes is generally larger than normal and has numerous structural abnormalities that are likely to have a role, resulting in disturbances of foetal growth and development (Singer, 1984). Normal placenta at term has a thickness of about 2.5 cm to 3 cm. If it is less than 2.5 cm it may be associated with pre-eclampsia, intra- uterine growth restriction etc. and thickness greater than 4 cm is usually found in case of maternal diabetes and intrauterine foetal infections (Kaplan, 1996).

According to Park (2005) the diabetic pregnancy is characterized by numerous disturbances in the foetal growth and development. Majumdar et al. (2005) showed in their study that maternal factors causing small weight placenta are also related with small birth weighted baby. Jansson et al. (2006) suggest that altered placental function may be a mechanism contributing to foetal over growth in diabetic pregnancies.

There have been many reports in the literature of placental weights and foeto-placental ratios at different gestational ages. It is well known that in normal preterm and term infants there is a direct relation between the birth weight of babies and the weight of the placentae The chorionic villous surface area is dependent upon the placental weight and infant weight in turn is related to the chorionic surface area. After the 36^{th} week placental weight increases due to hyperplasia of fibrous tissue. Placentae weighing over 600 g are usually found in gestational diabetes (Cunningham at al., 2010).

Conclusion

In diabetic mothers all the placental morphometric parameters (weight, volume, thickness, diameter, area, and circumference) tend to become higher in comparison to the normal placentae. Birth weight of the new born of diabetic mother is strongly associated with placental weight and volume and significantly higher than the baby of normal mother. The present study depicts the actual scenario of West Bengal population where incidence of diabetes is growing day by day. Therefore, further research to study these changes in vivo would be worthwhile in future.

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