



## Effect of Maternal Diabetes on Placental Weight, Fetal Weight and Feto-Placental (FP) Ratio

### KEYWORDS

Gestational Diabetes mellitus, Morphometric , Placental weight, Feto-placental ratio

### Vandana Tiwari

M.D. (Anatomy) King George's Medical University UP, Lucknow, India-210001

### Amita Pandey

Professor Department of Obs and Gynae King George's Medical University UP, Lucknow, India

### Punita Manik

Professor Department of Anatomy, King George's Medical University UP, Lucknow, India

### A.K.Pankaj

Assistant Professor Department of Anatomy, King George's Medical University UP, Lucknow, India

### Anita Rani

Professor Department of Anatomy, King George's Medical University UP, Lucknow, India

### ABSTRACT

**Introduction:** Normal growth and survival of the fetus depends on proper development and function of placenta. The diabetic pregnancy is characterized by numerous disturbances in fetal growth and development. The current study was undertaken to determine placental weight, fetal weight and fetoplacental ratio in diabetic mothers.

**Methods:** A prospective observational study was carried out on 70 placentae (20 placentae of Control Group and 50 placentae of Diabetic Group) from August 2013 to July 2014 in the Department of Anatomy, King George's Medical University (K.G.M.U.) UP, Lucknow collected from government hospital, K.G.M.U. UP, Lucknow. Thereafter placental weight, fetal weight and fetoplacental ratio was measured.

**Results:** In diabetic pregnancy, placental weight and fetal weight was found to be more than control group while increase in feto-placental ratio was statistically insignificant.

**Discussion:** Increased Placental weight of diabetic mothers may be associated with impaired functioning, leading to increase fetal weight due to compensatory mechanism.

### Introduction

Placenta is the mirror of maternal and fetal status. It is feto-maternal organ, separating the fetal and maternal circulations. The placenta is responsible for the transfer of nutrients and waste products between the fetal and maternal circulations and plays a crucial role in fetal growth and well-being.<sup>(6,5)</sup>

The placenta of diabetic women has attracted much interest because the diabetic pregnancy is characterized by numerous disturbances in fetal growth and development.<sup>(11)</sup> Diabetes Mellitus (DM) in pregnant women may be categorized into clinical diabetes or pregestational diabetes (prior to her pregnancy, women is already diagnosed with type 1 or type 2 diabetes) and gestational diabetes (GDM), which is stated as any degree of glucose intolerance, first recognised during pregnancy.<sup>(12,3)</sup> GDM represents nearly 90% of all pregnancies complicated by DM.<sup>(2)</sup>

DM in pregnancy is associated with a variety of placental abnormalities. The extent of these changes depend on a number of factors, particularly, the quality of glycemic control achieved during the critical periods in placental development.<sup>(8)</sup> These pathological changes in the placentae of diabetic mothers are in turn important risk factors contributing to fetal anoxia and fetal compromise in pregnancy. Furthermore abnormal maternal glycemic levels may alter the placental morphometric characteristics related to maternal-fetal exchanges.<sup>(13)</sup>

Alterations in placental function due to uncontrolled diabetes results in fetal complications like macrosomia, congenital malformations and intrauterine growth retardation.

<sup>(10,16)</sup> This study is aimed to detect possible changes in placental weight, fetal weight and feto-placental ratio in diabetic mothers (both pregestational and gestational) and compare these changes with placentae of control mothers (without diabetes mellitus or any other medical disease).

### Materials and Methods

The study was carried out on 70 placentae, collected from Obstetrics and Gynecology department of Queen Mary's Hospital, King George's Medical University UP, Lucknow. Twenty placentae (Group A) were from normal term pregnant women (without diabetes, having normal blood sugar levels) and fifty placentae (Group B) from term pregnancies complicated by pregestational or gestational diabetes.

The diabetic mothers, either on Medical Nutritional Therapy (MNT) or on insulin, were included in the study and pregnant females having normal glucose level and any of the other maternal illnesses (hypertension, anaemia, preeclampsia, eclampsia, hypothyroid) were excluded from the case group. The informed consent was taken from the patients.

Placentae of term deliveries was collected irrespective of their mode of delivery i.e. normal vaginal delivery, instrumental delivery or Lower Segment Caesarian Section (LSCS). There after placentae were examined for any structural abnormality, tagged with a specific number and preserved in 10% formalin. All the placentae were studied for their placental weight in the Department of Anatomy, K.G.M.U. UP.

The placental weight (along with membranes) was record-

ed with the help of weighing machine of 2 kg. capacity. Just after delivery, fetal weight was taken with the help of weighing machine of labor room. Feto-placental ratio was obtained by dividing fetal weight by placental weight.

## Results

The present study revealed that the mean placental weight was found to be higher in the diabetic mothers than placenta was in normal pregnancies. In study group 46% patients had placental weight >500 g while in control group only 15% with placental weight >500 g. The control group had 50% placental weight in the range ≤400 g. This difference in placental weight amongst cases and controls was statistically significant ( $p=0.040$ ) (Table 1).

As compared to control group, case study group had babies with increased birth weight. Majority of babies in both the groups had birth weight ≥2.5 kg. The proportion of cases having birth weight ≥3.5 kg was significantly higher in cases (38%) as compared to controls (0%). Mean birth weight of babies born to mothers of study group was  $3.20\pm 0.57$  Kg as compared to  $2.63\pm 0.37$  Kg in controls. This difference was statistically significant ( $p<0.001$ ) (Table 3). The babies of diabetic mothers having birth weight of >4kg correspond to fetal macrosomia.

Although feto-placental Ratio (FP-ratio) of the cases were higher as compared to controls but the difference between two groups was statistically insignificant ( $p>0.05$ ) (Table 2).

## Discussion

The placental weight may be an important factor in determining fetal growth. Untreated maternal diabetes and poorly controlled diabetic mothers usually showed complications like stillbirths, congenital fetal malformations, and fetal macrosomia.<sup>(15,23)</sup> In the present study, placental weight of controls ranged from 325 to 575 g (mean=430g). Our findings were similar to those of Hertig *et al.* (1960) and Woodling *et al.* (1976) whose normal placental weight ranged between 450 to 550 g.<sup>(14,22)</sup> The mean placental weight of diabetic group (mean=506g±107.75) was found to be higher than controls. According to Teasdale (1981) placental weights of diabetic mothers showed tendency to be heavier than the gestationally matched controls due to significant accumulation of non parenchymal tissue and only a moderate increase in parenchymal tissue.<sup>(21)</sup> According to Boyd *et al.* (1986) and Queenan *et al.* (1999) increased placental growth was a consequence of a co-existing metabolic or endocrine effect of hyperinsulinaemia in response to hyperglycemia in fetuses of diabetic mothers.<sup>(4,20)</sup> Fetal hyperglycemia may derange the osmotic environment of the cell, resulting in injury or cell death of endothelial cells in fetal capillaries. The damaged endothelial cells may be replaced without subsequent removal of old basal lamina. New endothelial cells synthesize their own basal lamina leading to excessive thickness of basal lamina of fetal capillaries in the chorionic villi. The basal lamina of chorionic capillaries is the part of placental barrier, so its thickness will increase the whole thickness of placental barrier which may lead to reduced transport of oxygen and other nutrients across the barrier. In response to this low oxygen transport the terminal villi shows hyperplasia which may be partially responsible for increase in weight of placenta in diabetic group.<sup>(17)</sup>

The present study showed that diabetic mothers gave birth to larger babies. Amongst diabetic mothers, baby birth weight was found to range from 2.1 kg to 4.2 kg (mean

=3.2 kg). Diabetic pregnancy is usually associated with increased neonatal birth weight and fetal macrosomia. The fetal macrosomia is defined as the weight of term infant found to be >4kg or >90th percentile for gestational age. According to Driscoll (1965) and Queenan *et al.* (1999) in diabetic pregnancy, glucose passes through the placenta readily and reaches to the fetus, causing fetal hyperglycemia.<sup>(9,20)</sup> This hyperglycemia will lead to hyperplasia of islet of Langerhans and increased insulin secretion in fetus leading to fetal overweight in maternal diabetes. The results of our study resonates with that of Chowdhury *et al.* (2011) who also reported increased neonatal birth weight (mean=3.3 kg) in diabetic pregnancies.<sup>(6)</sup>

The ability of the fetus to grow and thrive in-utero is presumed to be a function of the placenta. The normal ratio between newborn weight and placenta has been reported as 6:1.<sup>(7)</sup> However measurement varies widely and differs in different countries with different placental preparations i.e. placental weight taken with or without membranes. The fetal and placental weight were found to be increased in diabetic mothers.<sup>(18,19)</sup> An increased feto-placental ratio represents an adaptive process by the feto-placental unit in an unfavorable maternal environment. When there is a limitation on fetal growth velocity due to nutritional deficiencies, the placenta may undergo hypertrophy. An increased feto-placental ratio would be a sign of fetal growth disturbance. In the present study, the increase in feto-placental ratio in study group was found but the difference was not statistically significant as compared to the control group. In study group, the value of foeto-placental ratio ranged from 4.5 to 10. Abramovich, (1969) found that a linear relationship is maintained between fetal and placental weight throughout pregnancy.<sup>(11)</sup> In the present study placenta of diabetic mothers showed a definitive and distinct placental weight change in comparison to their controls.

## Conclusion

The adverse effect of diabetes on the outcome of pregnancy are well established. In present study diabetic mothers showed significant increase in placental and fetal weight but feto-placental ratio was found to be insignificantly increased because of linear relationship between fetal weight and placental weight present throughout the pregnancy.

## ACKNOWLEDGEMENTS

We are thankful to the department of Obstetrics and Gynecology, Queen Mary's Hospital, King George's Medical University UP, Lucknow for their dedicated co-operation, and to all faculty and staff of the Department of Anatomy, K.G.M.U. UP, Lucknow without whose help our work could not have been completed successfully.

**Table 1: Comparison of placental weight in diabetic and non diabetic mothers**

Placental weight	Total	Cases (n=50)		Control (n=20)	
		No.	%	No.	%
300-400 g	23	13	26.0	10	50.0
401-500 g	21	14	28.0	7	35.0
501-750 g	26	23	46.0	3	15.0

$\chi^2=6.424$  (df=2);  $p=0.040$  (S)

**Table 2: Comparison of Baby Birth weight of babies in case and control groups**

Birth Weight (kg)	Total	Cases (n=50)		Control (n=20)	
		No.	%	No.	%
2.00-2.49	13	5	10.0	8	40.0
2.50-3.49	38	26	52.0	12	60.0
3.50-4.50	19	19	38.0	0	0

t=4.181; p<0.001

**Table 3: Comparison of mean placental weight, mean fetal weight and fetoplacental ratio in diabetic and non diabetic study groups**

Placental characteristic	Cases (n=50)		Controls (n=20)		Significance	
	Mean± SD	Range	Mean± SD	Range	t	p
Weight	506.3±107.75	300-740	430.25±73.83	325-575	2.891	0.005 (S)
Fetal weight	3.20±0.57	2.1-4.2	2.63±0.37	2.0-3.4	4.181	0.001(S)
FP-ratio	6.45±1.12	4.5-10.0	6.15±1.04	4.1-8.0	1.036	0.304

\*p value <0.005 considered as significant

**REFERENCE**

- Abramovich, D.R.,(1969) The weight of placenta and membranes in early pregnancy. *J Obstet Gynaecol*, 76(6): 523-6.
- American Diabetes Association (2006) Diagnosis and Classification of Diabetes Mellitus. *Diabetes Care*, 29(Supplement 1).
- American Diabetes Association (2009) Diagnosis and classification of diabetes mellitus. *Diabetes Care*, 32(Suppl 1): 62-67.
- Boyd, P.A., Scott, A., & Keeling, J.W.(1986) Quantitative structural studies on placenta from pregnancies complicated by diabetes mellitus. *Br J Obstet Gynaecol*, 93: 31-50.
- Calderon, I.M. (2007) Morphometric study of placental villi and vessels in women with mild hyperglycemia or gestational or overt diabetes. *Diabetes Res Clin Pract*, 78: 65-71.
- Chowdhury, A.H.M.M.M., Shamim, K.M., Ferdousi, R., Begum, J.A., & Banu, L.A.(2011) A Comparative Study of Effects of Different Grades of Maternal Established Diabetes Mellitus on Placental and Neonatal Weight. *Bangladesh J. Anat*, 9(1): 53-58.
- Cunningham, F.G., Leveno, K.J., Bloom, S.L., Hauth, J.C., Gilstrap, L.C., & Wenstrom, K.D. (2005) *Williams obstetrics in Implantation, embryogenesis and placental development*. 22nd ed. New York :Mc Graw –Hill, 39-90.
- Desoye, G., & Shafir, E. (1996) The human placenta in diabetic pregnancy. *Diabetes Rev*, 70-89.
- Driscoll, S.(1965) The pathology of pregnancy complicated by diabetes mellitus. *Med Clin North Am*, 49:1053-67
- Evers, I.M., (2003) Placental pathology in women with type 1 diabetes and in a control group with normal and large-for-gestational-age infants. *Placenta*, 24: 819-825.
- Fletcher, A.B., (1981) The infant of diabetic mother. In : *Neonatology Pathophysiology and Management of the Newborn*, Philadelphia, Lippincott, 287-307
- Forsbach-Sanchez, G., Tamez-Perez, H.E. & Vazquez-Lara, J. (2005) Diabetes and pregnancy. *Arch Med Res*, 36: 291-299.
- Hanson, U., & Persson, B.(1993) Outcomes of pregnancies complicated by type 1 insulin-dependent diabetes in Sweden: acute pregnancy complications, neonatal mortality and morbidity. *Am J Peri-natol*, 10: 330-333
- Hertig, A.T. (1960) Pathological aspects In: *Villee CA Placenta and Fetal Membranes*. Williams & Wilkins, New York 109-124.
- Hidden, U., Glitznier, E., Hartmann, M., & Desoye, G. (2009) Insulin and IGF system in human placenta of normal and diabetic pregnancies. *J Anat*, 215(1): 60-68.
- Langer, O.(2005) Gestational diabetes: The consequences of not treating. *Am J Obstet Gynecol*, 192: 989-997.
- Kumar, V., Cotran, S., & Robin, S.L. (2000) *Basic Pathology*. 7th ed, Pennsylvania, WB Saunders, 1082-4
- Lao, T.T., Lee, C.P., & Wong, W.M. (1997) Placental weight to birth weight ratio increased in mild gestational glucose tolerance placenta. *Placenta*, 18: 227-30.
- Makhseed, M.A., Ahmed, M.A., & Musini, V.M.(2004) Impaired gestational glucose tolerance its effect on placental pathology. *saudi Med J*, 25 (9): 1241-1244.
- Queenan, J.T. (1999) *Management of high risk pregnancy*. Blackwell Science, England, 4: 261-70.
- Teasdale, F.(1981) Histomorphometry of the placenta of the diabetic woman: class A diabetes mellitus. *Placenta*, 2: 241-52.
- Woodling, B.A., Kroener, J.M., Puffer, H.W., Furukawa, S.B., Anderson, G., Ochoa, R.G., & Warner, N.E. (1976) Gross examination of the placenta. *Clin Obstet Gynecol*, 19: 21-44.
- Yang, H.X. (1993) Placental pathology in gestational diabetes. *Placenta*. 28(12): 758-759.