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Study of placental morphometric anatomy in mothers with gestational diabetes mellitus and influence of gestational diabetes mellitus on the fetal weight

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ABSTRACT

The placenta is an organ which is an indicator of maternal and fetal disorders. Gestational Diabetes mellitus complicates 2-5% of all pregnancy. Therefore our work was an analysis of changes in placental morphometric anatomy in mothers of gestational diabetes mellitus and the influence of gestational diabetes mellitus on the fetal weight. Sixty-two placentas of full-term pregnancy collected from labour room/operation theatre of Gynaecology and obstetrics, department of government medical college and super facility hospital Azamgarh, Uttar Pradesh. Out of sixty-two placentas, 31 are from mothers with no known history of preexisting gestational diabetes mellitus cases as controls and 31 collected from mothers with gestational diabetes mellitus. We found mean placental weight, mean placental area, mean placental volume, mean no of cotyledons significantly more in placentas of gestational diabetic mothers. Mean fetal weight of gestational diabetic mothers were more in comparison with controls. Mean transverse diameter of placentas of the diabetic mothers were more than mean transverse diameter of placentas of the non-diabetic mothers, statistically significant. Mean longitudinal diameter also more in placentas of diabetic mothers, not statistically significant. Mean thickness at the centre more in placentas of diabetic mothers, statistically significant. Mean thickness mid-way between centre and margin and mean thickness at margin more in diabetic placentas, not statistically significant. Gestational diabetic mothers had more round-shaped placentas. Marginal insertion of umbilical cord presents more in placentas of gestational diabetic mothers.

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INTRODUCTION

Placentas connect the fetus with the uterine wall of the mothers. It is a fetomaternal organ. In this fetal tissue comes to direct contact with maternal tissues without any rejection. It consists of chorionic villi. Chorionic villi are the functional unit of the placenta. Nutrient and oxygen exchange occurs between fetal and maternal circulation for growth and development of the fetus. Human placenta has two components fetal and maternal components. In human hemochoreal type of placenta found. In the hemo-

choreal type of placenta, fetal derived cells comes direct contact with maternal blood. Diabetes is a common complication of pregnancy. The placenta is an organ which is an indicator of maternal and fetal disorders. These pregnancy disorders are correlated with high maternal morbidity and mortality induced by gross pathological changes in the placenta, (Raghavendra *et al.*, 2014). Gestational Diabetes mellitus complicates 2-5% of all pregnancy.

Anatomic features of the placentas; Weight, central thickness and diameter were greater in the placentas of gestational diabetic mothers in comparison with the placentas of non-diabetic mothers. According to the study of Winick and Noble (1967); Laga *et al.* (1973), and Shams *et al.* (2012); fibrinoid necrosis and Hyalinization are more in the placentas of diabetic mothers. Gestational diabetes produces different types of abnormalities e.g. Thickening of the basal membrane of trophoblast, separation of the basal membrane of capillaries, proliferation and distension of endothelial cells, disarrangement of perivascular space and decrease in vascular surface of terminal villi, Chorangiosis (> 10 blood capillaries per villi). There are alterations in placental function in uncontrolled diabetes, leading to macrosomia, intrauterine growth retardation and congenital malformation (Ashfaq *et al.*, 2005). Therefore our work was analysis of changes in placental morphometric anatomy in mother of gestational diabetes mellitus and influence of gestational diabetes mellitus on the fetal weight.

MATERIALS AND METHODS

Sixty-two placentas of full-term pregnancy collected from labour room/operation theatre, Gynaecology and obstetrics department, government medical college and super facility hospital, Azamgarh, Uttar Pradesh. Out of sixty-two placentas, 31 are from mothers with no known history of preexisting gestational diabetes mellitus as controls and 31 collected from mothers with gestational diabetes mellitus. Subjects included in our research were age between 20-44 years and from all socioeconomic groups. There were no differences according to race culture or environment differences. All placentas obtained either from the vaginal route or caesarean section. The collected placenta preserved in 10% formalin after the amnion and chorion trimmed. All placentas weighed on weighing machine graduated in grams after wash with running tap water and dried with blotting paper.

Weight of placenta

Weight of each placenta recorded in grams with the help of weighing machine.

The diameter of the placenta

The maximum diameters of each placenta were measure with a metallic scale graduated in centimetres. The right angles of the first one the second maximum diameter recorded. These two diameters are known as transverse diameter and longitudinal diameter. Means of these two diameters gives the diameter of placentas.

Thickness of placenta

The thickness of placenta measure by piercing a large needle through five points, each placenta was divided into three equal zones – central middle and peripheral by drawing two imaginary circles on its maternal surface, the centre of placenta act as an axis. We took three thicknesses- 1. Thickness at centre; 2. Thickness midway between centre and margin. 3. Thickness at the margin.

No. cotyledons

Placentas took on both hands facing the fetal surface upward then little pressure applied from the central part of the fetal surface of the placenta to periphery with the thumbs of both hands. The peripheral part held by the other fingers this method caused the separation of the cotyledon to make them prominent in the maternal surface then it put on a tray with the maternal surface facing upward counting start from the left side of one end and going towards the right. In this way, counting continued in a spiral manner.

Surface area of placenta

For calculation placental area we used a formula which was given by Pryse-Davies *et al.* (1973). Placental surface area = $\pi/4 \times d_1$ (maximum diameter) x d_2 (minimum diameter)

Volume of placenta

With the help of the water displacement method, the volume of the placenta was calculated. Taken four-liter graduated cylindrical plastic bucket two liters of water was taken in the bucket, the placenta was placed in it thus the volume increases. This was the placenta's volume.

Examination of fetal surface

Placenta kept flat on the table, foetal surface above and noted the following things—

a) Insertion of umbilical cord – eccentric, central, marginal.

b) Shape of placenta - noted

c) Examination of maternal surface

d) Maternal cotyledons- noted

RESULTS

Central umbilical cord insertion was present in 13 percent of gestational diabetic mother's placentas and 41.93 percent of central umbilical cord insertion was present in non-diabetic mother's placentas(Table 4 and Figure 1(A), Figure 1(B) & Figure 3). In 29% of gestational diabetic mother's placentas and 25.80% of eccentric umbilical cord insertion present in the placentas of non-diabetic mothers, eccentric umbilical cord insertion was present (Table 4). In 58% of gestational diabetic mother placentas and 32.25% of marginal umbilical cord insertion observed in the placentas of non-diabetic mothers, marginal umbilical cord insertion occurs (Table 4 and Figure 2(A) & Figure 2(B)). Therefore, marginal umbilical cord insertion primarily occurs in the placentas of gestational diabetic mothers. In 58.06 percent of gestational diabetic mothers and 54.83 percent of non-diabetic mothers, rounded shaped placentas exist (Table 3 and Figure 4). In 41.93 percent of gestational diabetic mothers and 45.16 percent of non-diabetic mothers, ovoid shaped placentas exist (Table 3).

There are more round-shaped placentas in gestational diabetic mothers and more placentas in non-diabetic mothers that are ovoid-shaped. The placental weight of diabetic mothers was greater than that of non-diabetic mothers, and the mean diabetic placental weight was 593.9 gram, and the mean non-diabetic placental weight was 512.3 g (Table 1 and Figure 5). P-Value = 0.0001. Since the p-value < 0.05 is highly significant. In diabetic mothers, the mean number of placental cotyledons was greater than the number of placental cotyledons in non-diabetic mothers.

The mean of diabetic placental cotyledon was 19.06, and the mean of non-diabetic mother's placental cotyledon was 17.94. P-value=0.0045 and statistically significant because the p-value was < 0.05 (Table 2 and Figure 6). The mean transverse placental diameter of a diabetic mother was greater than the mean transverse placental diameter of a non-diabetic mother. A diabetic mother's mean transverse placental diameter was 18.94 cm and the non-diabetic mother's mean transverse placental diameter was 17.71 cm P-value=0.0171. Because P < 0.05, statistically significant (Table 2 and Figure 7).

The mean longitudinal placental diameter of diabetic mothers was greater than the mean longitudinal placental diameter of non-diabetic mothers. The mean longitudinal placental diameter of a diabetic mother was 17.61 cm and the mean non-diabetic mother's longitudinal placental diameter was 17.06 cm P-Value= 0.1213. Since the P-value was > 0.05, it is not statistically significant (Table 2 and Figure 8). The mean placental area of diabetic mothers was greater than the mean placental area of non-diabetic mothers. In diabetic mothers, the mean placental area was 265.7cm^2. In non-diabetic mothers, the mean placental area was 239.0cm^2. P= 0.0156. Since p < 0.05, it is statistically significant (Table 1 and Figure 9). The mean placental volume of gestational diabetic mothers was greater than the non-diabetic (control) mothers' mean placental volume. The mean placental volume was 636.7cm^3 for gestational diabetic mothers. In non-diabetic (control) mothers, the mean placental volume was 519.6cm3. P= 0.0001.

The P-value of a gestational diabetic mother's placental volume was statistically significant because p < 0.05 (Table 1 and Figure 10). The mean placental thickness of gestational diabetic mothers at the centre was more than the mean placental thickness of non-diabetic mothers at the centre. Mean placental thickness at the centre of gestational diabetic mothers was 4.081cm. Mean placental thickness at the centre of non-diabetic (control) mothers was 3.694cm. P-value=0.0393**.** P-value of thickness at the centre of placentas of a gestational diabetic mothers was statistically significant because of P<0.05 (Table 2 and Figure 11). Mean placental thickness midway between centre and margin of gestational diabetic mothers was more than mean placental thickness midway between centre and margin of non-diabetic (control) mothers.

Mean placental thickness midway between centre and margin of gestational diabetic mothers was 4.065cm. Mean placental thickness midway between centre and margin of non-diabetic (control) mothers was 3.806cm. P-value= 0.1867. P-value was not statistically significant because p-value **>** 0.05 (Table 2 and Figure 12). Mean placental thickness at the margin of gestational diabetic mothers was more than the mean placental thickness at the margin of non-diabetic (control) mothers. Mean placental thickness at the margin of gestational diabetic mothers was 3.710cm.

Mean placental thickness at the margin of non-diabetic (control) mothers was 3.516cm. P-value= 0.1933. P-value of thickness at the margin of placentas of a gestational diabetic mothers was not statistically significant because P-value **>**0.05 (Table 2 and Figure 13). Mean fetal weight of mothers of gestational diabetes mellitus was more than the mean fetal weight of mothers of non-diabetic. Mean fetal weight of gestational diabetic mothers was 3.848Kg. Mean fetal weight of non-diabetic mothers was 2.848Kg. P-Value= 0.0001. It was statistically

A B

Figure 1: (A) showing the fetal surface of placenta of non-diabetic (control) mother; (B) showing the maternal surface of placenta of non-diabetic mother.

A B

Figure 2: (A) showing the fetal surface of preserved placenta of the diabetic mother; (B) Showing maternal surface of preserved placenta of diabetic mother.

significant because p-value **<** 0.05 (Table 1 and Figure 14).

DISCUSSION

In this study central, insertion of umbilical cord present in the 13% placentas of gestational diabetic mothers and 41.93% central insertion of umbilical cord present in the placentas of non-diabetic mothers. Eccentric insertion of umbilical cord present in the 29% placentas of gestational diabetic mothers and 25.80%eccentric, insertion of umbilical cord present in the placentas of non-diabetic mothers. Marginal insertion of umbilical cord presents in the 58% placentas of gestational diabetic mothers and 32.25% of marginal insertion of umbilical cord present in the placentas of non-diabetic mothers. Marginal insertion of umbilical cord predominantly present in the placentas of gestational dia-

Table 1: Comparisons of placental parameters of morphometry of non-diabetic and diabetic placentas.

Placental parameters of morphometry	Nondiabetic (control) Mean ± SD	Diabetic Mean ± SD	P-value of t-test
Mean placental weight(g)	512.3±61.19	593.9±48.69	=0.0001 P***
Mean placental area(cm^2)	239.0±36.89	265.7±47.01	=0.0156 P*
Mean placental volume(cm^3)	519.6±63.99	636.7±108.3	=0.0001 P***
Mean fetal weight(Kg)	2.848±0.4122	3.848±0.2365	=0.0001 P***

P < 0.05.

Table 2: Comparisons of Placental parameters of gross anatomy of non-diabetic and diabetic placentas.

Placental parameters of gross anatomy	Nondiabetic (control) Mean ± SD	Diabetic Mean ± SD	P-value of t-test
Mean number of cotyledons	17.94±1.365	19.06±1.632	=0.0045 P**
Mean transverse diameter(cm)	17.71±1.865	18.94±2.065	=0.0171 P*
Mean longitudinal diameter(cm)	17.06±1.289	17.61±1.453	=0.1213 Not significant
Mean thickness at centre(cm)	3.694±0.6011	4.081±0.8276	=0.0393 P*
Mean thickness midway between centre and margin(cm)	3.806±0.7033	4.065±0.8139	=0.1867 Not significant
Mean thickness at margin(cm)	3.516±0.5699	3.710±0.5884	=0.1933 Not significant

Table 3: Comparisons of shape of non-diabetic and diabetic placentas.

Shape of placentas	Non-diabetic(control)	Diabetic
Rounded	54.83%	58.06%
Ovoid	45.16%	41.93%

Table 4: Comparisons of insertion of umbilical cord of non-diabetic and diabetic placentas.

Insertion of umbilical cord	Non-diabetic(control)	Diabetic
Central	41.93%	13%
Eccentric	25.80%	29%
Marginal	32.25%	58%

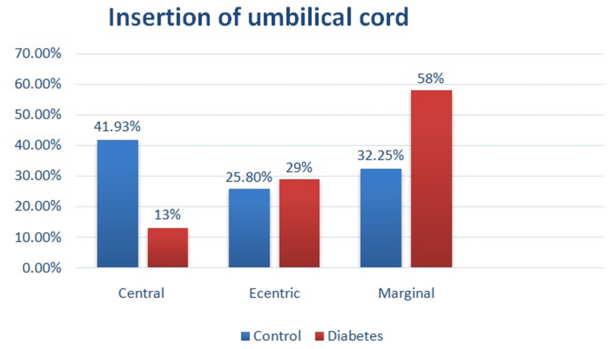

Figure 3: Showing insertion of umbilical cord of diabetic and non-diabetic (controls) placentas.

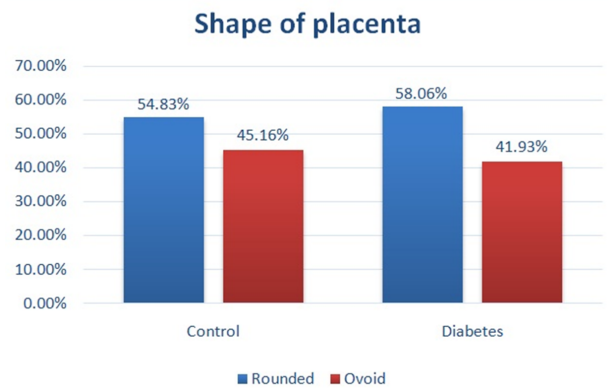

Figure 4: Showing shape of diabetic and non-diabetic placentas.

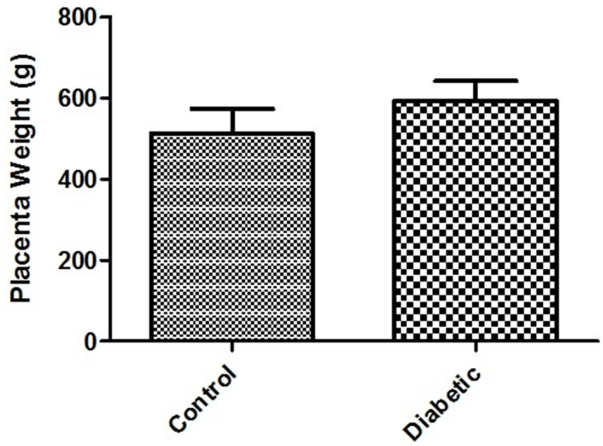

Figure 5: Showing comparison of weight of diabetic and non-diabetic placentas.

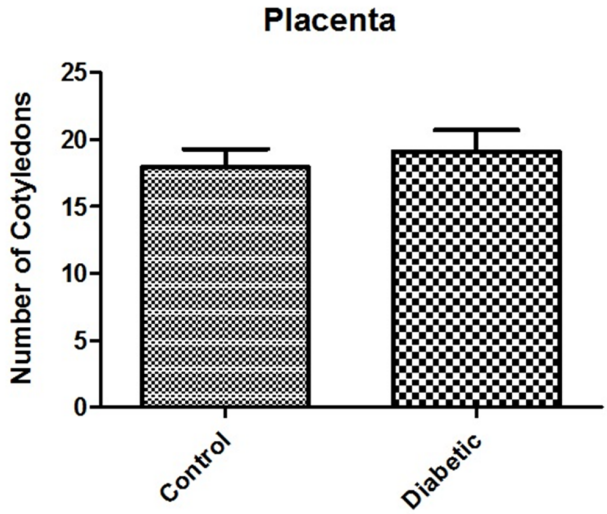

Figure 6: Showing comparison of numbers of cotyledons of diabetic and non-diabetic placentas.

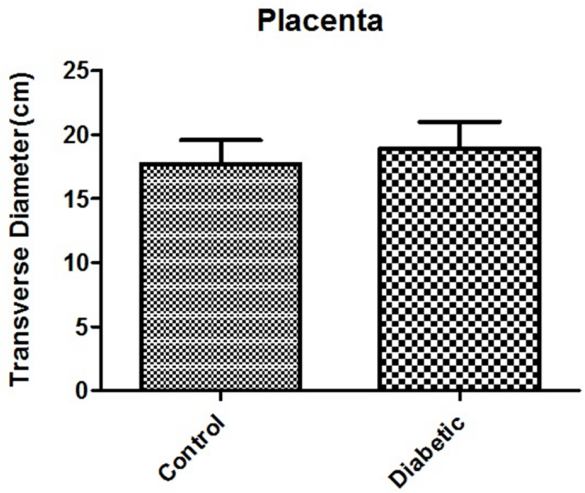

Figure 7: Showing comparison of Transverse diameter of diabetic and non-diabetic placentas.

betic mothers. In our study, round-shaped placentas present in the 58.06% gestational diabetic mothers and 54.83% non-diabetic mothers. Ovoid shaped placentas present in the 41.93% gestational diabetic mothers and 45.16% in non-diabetic mothers. More round-shaped placentas present in gestational diabetic mothers and more ovoid-shaped placentas present in non-diabetic mothers. The weight of placentas of diabetic mothers are more than the placenta of non-diabetic mothers and mean placental weight of diabetic placenta was 593.9 gram and mean placental weight of non-diabetic placenta was 512.3 gram. P-Value was 0.0001 of t-test. It was statistically significant because p-value < 0.05**.** According to Mayhew *et al.* (1993) placental, weight increases due to hyperplasia throughout gestation that was reflected by higher DNA contents. According to Boyd *et al.* (1986) due to hyperinsulinaemia, increased placental growth occurs. It was the co-existing metabolic or endocrine effect. Desoye and Shafrir (1996) stated the same as Boyd *et al.* (1986).

According to Jones and Fox (1976) and Teasdale (1983); Teasdale and Jacques (1986) hyperplasia occur in diabetic placentas and which terminates at

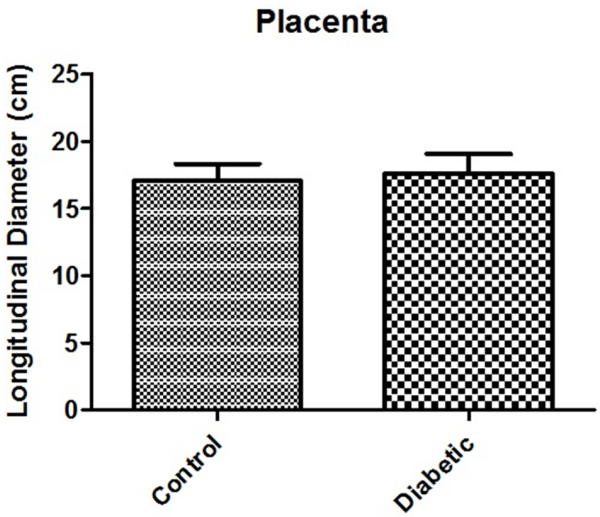

Figure 8: Showing comparison of longitudinal diameter of diabetic and non-diabetic placentas.

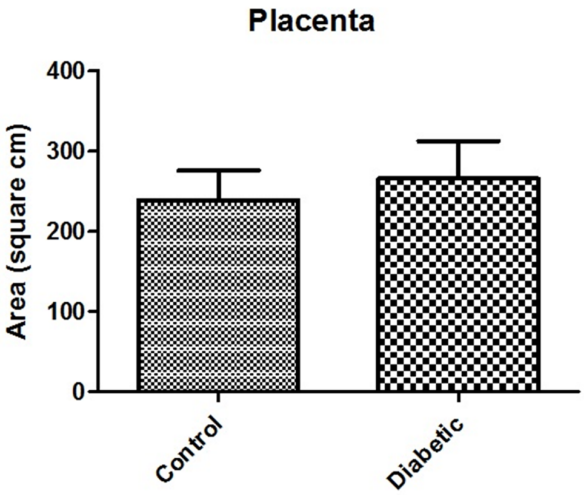

Figure 9: Showing comparison surface area of diabetic and non-diabetic placentas.

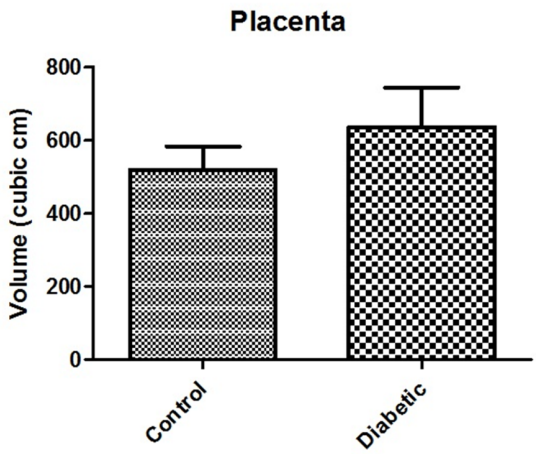

Figure 10: Showing comparison of volume of diabetic and non-diabetic placentas

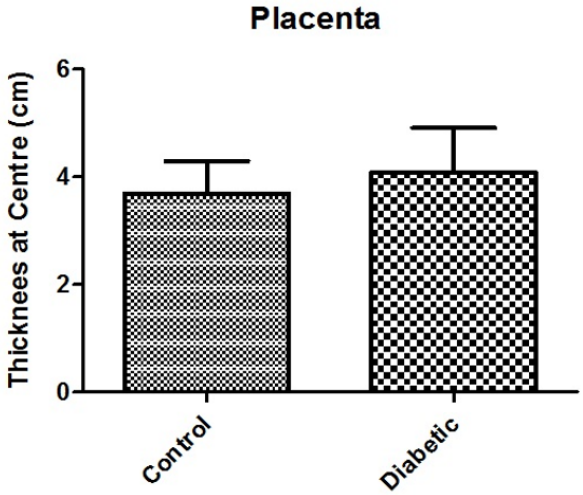

Figure 11: Showing comparison of thickness at centre of diabetic and non-diabetic placentas.

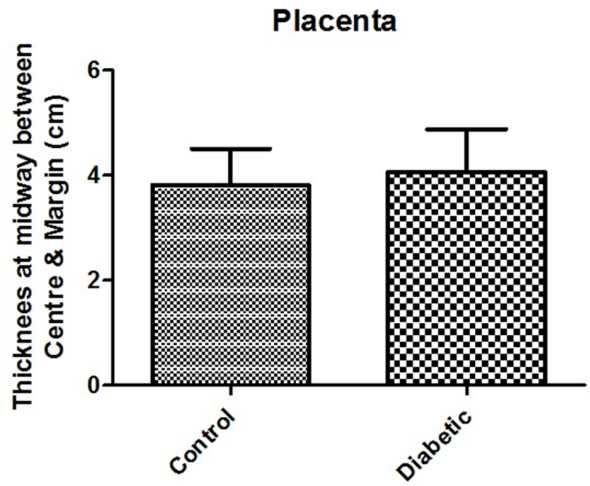

Figure 12: Showing comparison of thickness midway between centre and margin of diabetic and non-diabetic placenta.

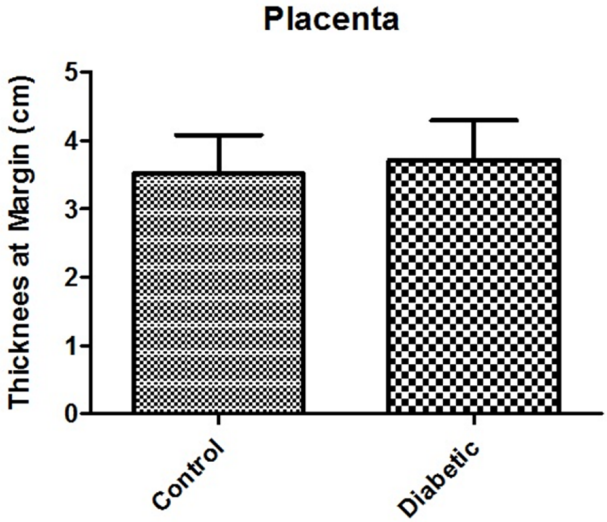

Figure 13: Showing comparison of thickness at margin of diabetic and non-diabetic placentas.

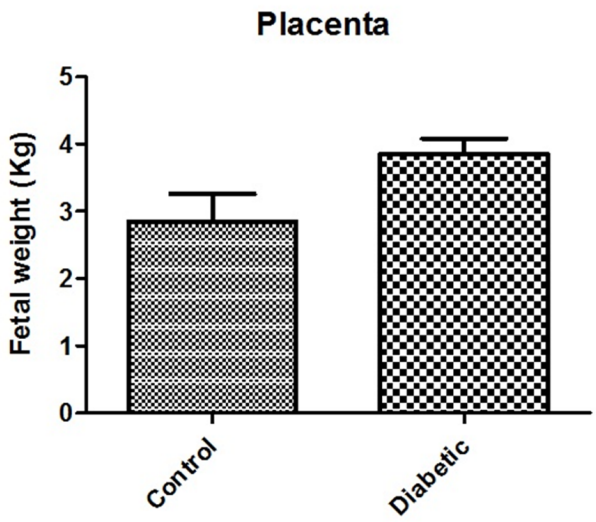

Figure 14: Showing comparison of fetal weight of gestational diabetic and non-diabetic mothers.

around third trimester of gestation. The mean numbers of cotyledons of placentas of diabetic mothers was more than placentas of non-diabetic mothers. The mean number of cotyledons of the diabetic placenta was 19.06 and the mean number of cotyledons of placentas of the non-diabetic mothers was 17.94. P-Value was 0.0045 and it was statistically significant because the p <0.05. According to Ashfaq *et al.* (2005) and Teasdale (1987) weight, size, the number of cotyledons, volume and surface area of placentas was more in gestational diabetic mothers. Pretorius *et al.* (1996) also observed similar findings.

The mean transverse diameter of placentas of diabetic mothers was more than the mean transverse diameter of placentas of the non-diabetic mothers. Mean transverse diameter of placentas of diabetic mothers was 18.94cm and mean transverse diameter of placenta of the non-diabetic mother was 17.71cm P-Value was 0.0171. It was statistically significant because the p-value was < 0.05. Mean longitudinal diameter of placentas of diabetic mothers was more than the mean longitudinal diameter of placentas of the non-diabetic mothers. Mean longitudinal diameter of placentas of a diabetic mother was 17.61cm and mean longitudinal diameter of placenta of a non-diabetic mother was 17.06cm P-Value was 0.1213. It was not statistically significant because p > 0.05. Mean placental area of diabetic mothers was more than the mean placental area of non-diabetic mothers. Mean placental area of diabetic mothers was 265.7cm^2. Mean placental area of non-diabetic mothers was 239.0cm^2. P-value was 0.0156. It was statistically significant because p < 0.05.

Mean placental area of gestational diabetic mothers was more than the mean placental area of non-diabetic (control) mothers. (Driscoll, 1965) Placental areas of the gestational diabetic mother were more as compared to non-diabetic mother. Rath *et al.* (1994); Okudaira *et al.* (1966); Zacutti *et al.* (1992) also have similar findings. The mean placental volume of gestational diabetic mothers was 636.7cm^3.

Mean placental volume of non-diabetic (control) mothers was 519.6cm^3. P-value was 0.0001. P-value of the volume of placentas of a gestational diabetic mother was statistically significant because p < 0.05. Driscoll (1965); Teasdale (1981); Mayhew *et al.* (1993) also stated placental volumes was more in gestational diabetic mothers as compared to non-diabetic mothers (control). Mean placental thickness at the centre of gestational diabetic mothers was more than the mean placental thickness at the centre of non-diabetic (control) mothers. Mean placental thickness at the centre of gestational diabetic mothers was 4.081cm. Mean placental thickness at the centre of non-diabetic (control) mothers was 3.694cm. P-value was 0.0393. P-value of thickness at the centre of placentas of gestational diabetic mothers was statistically significant because p < 0.05. Mean placental thickness midway between centre and margin of gestational diabetic mothers was more than mean placental thickness midway between centre and margin of non-diabetic (control) mothers. Mean placental thickness midway between centre and margin of gestational diabetic mothers was 4.065cm.

Mean placental thickness midway between centre and margin of non-diabetic (control) mothers was 3.806cm. p < 0.1867. P-value was not statistically significant. Mean placental thickness at the margin of gestational diabetic mothers was more than the mean placental thickness at the margin of non-diabetic (control) mothers. Mean placental thickness at the margin of gestational diabetic mothers was 3.710cm. Mean placental thickness at the margin of non-diabetic (control) mothers was 3.516cm. P-value was 0.1933. P-value of thickness at the margin of placentas of a gestational diabetic mother was not statistically significant because p > 0.05.

Mean fetal weight of mothers of gestational diabetes mellitus was more than the mean fetal weight of non-diabetic mothers. Mean fetal weight of gestational diabetic mothers was 3.848Kg. The mean fetal weight of non-diabetic mothers was 2.848Kg. P-Value was 0.0001. It was statistically significant because p <0.05. Rath *et al.* (1994); Jones and Fox (1976); Raghavendra *et al.* (2014) stated more

fetal weight and macrosomia and large babies occur due to poorly controlled gestational diabetes mellitus. We found more fetal weight in gestational diabetes mellitus. This morphometric and macroscopic changes of placenta influence both fetuses and mothers so detection of gestational diabetes mellitus in the early stage of pregnancy may help for prevention of complications.

CONCLUSION

In our study, we found mean placental weight was more in gestational diabetic mother in comparison with non-diabetic mother. It is statistically significant. Mean placental area more in gestational diabetic mother in comparison with non-diabetic mother. It was statistically significant. Mean placental volume more in gestational diabetic mother in comparison with control. It was statistically significant. Mean no of cotyledons also significantly more in placentas of the diabetic mother as compared to placentas of non-diabetic mothers. Mean fetal weight of gestational diabetic mother was more in comparison with control. It was statistically significant. Gestational diabetic mothers had more round-shaped placenta in comparison with non-diabetic mothers. Marginal insertion of umbilical cord presents more in placentas of gestational diabetic mothers. Mean transverse diameter of placentas of the diabetic mothers was more than the mean transverse diameter of placentas of the non-diabetic mothers. It was statistically significant. Mean longitudinal diameter also more in placentas of the diabetic mother as compared to placentas of the non-diabetic mothers. It was not statistically significant. Mean thickness at the centre more in placentas of diabetic mothers. It was statistically significant. Mean thickness mid-way between centre and margin more in the diabetic placenta. It was not statistically significant. Mean thickness at margin more in diabetic placentas. It was not statistically significant. These changes occur in gestational diabetes mellitus influences fetal health. Our study helps to Gynaecologist for management of gestational diabetes mellitus.

Ethical Approval

I declare that this study was approved by the institutional ethics committee.

Conflict of interest

The authors declare that they have no conflict of interest for this study.

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The authors declare that they have no funding support for this study.

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