

Ultrasonographic Evaluation of Placenta Thickness and Fetal Cord Cross Section in Gestational Diabetes Mothers Compared to Control Group

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Abstract

Background

The metabolic enhancement resulted from hyperglycemia in gestational diabetes leads to macrosomia, which can affect the placenta. In gestational diabetes mellitus (GDM) pregnant women, the thickness of placenta and cord diameter can change at ages prior to treatment initiation. Therefore, this study was conducted to examine the thickness of placenta and umbilical cord in mothers with gestational diabetes, compared to the control group, in order to indirectly investigate the effects of hyperglycemia on fetus.

Materials and Methods: In this cross-sectional study, pregnant women in the gestational ages ranged 28-32 weeks, who underwent a 3-hour glucose test to detect gestational diabetes mellitus, were evaluated using ultrasound in terms of placenta thickness and umbilical cord area, compared to the control group.

Results: Out of 93 pregnant women in gestational ages of 28-32 weeks, 45 had gestational diabetes and 48 of them were selected as the control group. The mean age of the individuals was 26.33 years old with standard deviation of 4.88. There was a significant increase in the thickness of the placenta and the transverse diameter of the cord in the case group and there was a direct and significant relation ($P<0.05$). Also, there was a significant relationship between cord area and the thickness of placenta ($P<0.05$).

Conclusion

The thickness of placenta and consequently the cord area in mothers with gestational diabetes increases independently from changes caused by macrosomia and fetus weight.

Key Words: Cord diameter, Gestational diabetes, Placenta thickness.

*Please cite this article as: Momen Garibvand M, Hanafi MG, Fadaee MR. Ultrasonographic Evaluation of Placenta Thickness and Fetal Cord Cross Section in Gestational Diabetes Mothers Compared to Control Group. Int J Pediatr 2020; 8(9): 12001-12009. DOI: **10.22038/ijp.2020.45444.3727**

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Received date: Jan.23, 2020; Accepted date: Jun.22, 2020

1- INTRODUCTION

Gestational diabetes is defined as a condition in which blood glucose can be observed during pregnancy for the first time, and its exact cause of is not determined, so its timely diagnosis is important. The progress of maternal hyperglycemia is one of the risk factors for the fetus during pregnancy, and its prevalence of GDM has been estimated to be 2-5% (1), which has increased in recent years. Maternal hyperglycemia can lead to abortion or malformation in early pregnancy. The amount of gestational hyperglycemia abnormally in 12-28 weeks or more than 28 weeks, can also cause anomalies in the fetus, of which macrosomia and respiratory distress disorders are the most common ones (2).

Precise biometric evaluation of gestational age is one of the important criteria of pregnancy, and currently there are several parameters to be used for inclusion of CRL in the first trimester of pregnancy and Biparietal diameter (BPD), Head circumference (HC), Abdominal circumference (AC), and Femur length (FL) for older fetuses. However, there might be defects in these estimates. On the other hand, linear growth relative to the fetal age in placenta provides an opportunity to use this parameter to evaluate the proportion of the fetal growth.

Being in contact with mother and fetus circulation through different surfaces, the placenta plays pleiotropic roles during fetal growth. Therefore, it may be affected by changes in either of these two surfaces. The active insulin existing in the maternal circulation is transferred to the fetus by passing through the placental blood barrier, and consequently it has various effects on the function and structure of fetus and placenta itself (3, 4), and also the nature and amount of these changes depend on the level of hyperglycemia during the critical period of fetal growth and the effects of environmental

metabolites on fetal growth. Despite the advanced pregnancy care in the past decades for achieving adequate blood glucose control in diabetic pregnant women, hyperinsulinemic fetus is very prevalent during pregnancy. Changes in maternal-fetal blood transportation are the most important factor in insulin secretion, which can change the glucose and amino acid levels of Glucose transporter 1 (or GLUT1); and consequently, it leads to changes in glucose levels of fetal blood (5). Compared to other tissues of the body, the placenta shows a large amount of insulin receptors; and due to its position in fetal growth, it may be affected by changes (3, 4). Therefore, in GDM patients, the effects of maternal hyperglycemia on morphological changes of fetus can be significant compared to the control group.

The hyperinsulinemic effect on fetus is a macrosomia, which owns higher possibility of disease leading to metabolic syndrome in the lower decades of life when the person is exposed to a variety of diseases and obesity. Nevertheless, amniocentesis is less evaluated for routine investigation of the effects of hyperglycemia on the fetus. It is also an invasive approach increasing the possibility of infection, early rupture of the membrane, or damage to the fetus itself; so, sonographic evaluation of placenta is an easy, non-destructive, and inexpensive method to regulate and manage initial treatment for pregnancy diseases such as diabetes. The perfusion disorder of fetus usually results in asymmetric growth or SGA formation. Also, in the Doppler evaluation, in which the placenta failure is the purpose, cord thickness can also be affected. On the other hand, the increased hypermetabolic caused by hyperglycemia leads to macrosomia and placentomegaly, in which placental thickness and cord diameter in GDM pregnant women cannot be affected at ages prior to the treatment. This study was conducted to investigate

the thickness of placenta and cord in mothers with gestational diabetes, compared to the control group, in order to indirectly indicate the effects of hyperglycemia on the fetus.

2- MATERIALS AND METHODS

2-1. Study design

This cross-sectional study is a descriptive-analytic one implemented in the time interval of May-December 2019 on pregnant women with the gestational age of 24_28 weeks, who underwent 75-gram oral glucose tolerance test (OGTT) along with the measurement of the plasma glucose during fasting, as well as 1 and 2 hours later, in pregnant women with 24-28 weeks of pregnancy who had not been diagnosed previously with overt diabetes. GDM is diagnosed when more than one of the following plasma glucose level-related parameters, which are determined by the American Diabetes Association, are observed (2011) (19), and pregnant women who had normal laboratory results (OGGT) at all four parameters, were selected as the control group.

1. Fasting glucose above 5.1 mmol / l (92 mg / dl)
2. 10.0mmol/L(180 mg/dl) after 1 hour
3. 8.5 mmol / l (153 mg / dL) after 2 hours.

Women with a history of diabetes before pregnancy and those diagnosed with diabetes mellitus were excluded from the study. After GDM diagnosis, GDM women and control group were sent to Golestan Hospital Ultrasound Center for biometric ultrasound and measurement of

placenta thickness and cord area at gestational age of 28-32 weeks. In addition, mothers with a history of type 1 or 2 DM or fetuses with congenital, intrauterine growth restriction (IUGR), oligohydramnios, polyhydramnios, disorders, or pathologic findings in the first trimester screening were excluded from the study.

2-2. Sonographic Examination

Sonographic evaluation of the fetus was performed using GE vuluson E6 ultrasound machine with Transducer3.5-5MHZ, through which the biometric measurement was done using HC, AC, BPD, and FL parameters, and then, placenta thickness was measured in state without uterine contraction and at maximum thickness, in the cord insertion (**Figure. 1**). Afterwards, the floating site of the cord was selected as a transverse section of the cord, and the measurement was performed (**Figure. 2**).

2-3. Calculation of Sample Size and Sampling

93 female patients sent to Golestan Hospital and screened for gestational diabetes and diagnosed with GDM based on the report, were recruited as the case group (45 individuals), along with 48 other pregnant women with normal screening test as the control group.

2-4. Statistical Survey

Data were expressed as mean and standard deviation (SD). Data were analyzed using SPSS (statistical analysis system, version 22.0). The statistical difference between the two groups was studied by Student-test. Statistical significance level was considered to be $P < 0.05$.



Fig. 1: Correct measurement of the cord area in transverse section and in the floating site of the cord.

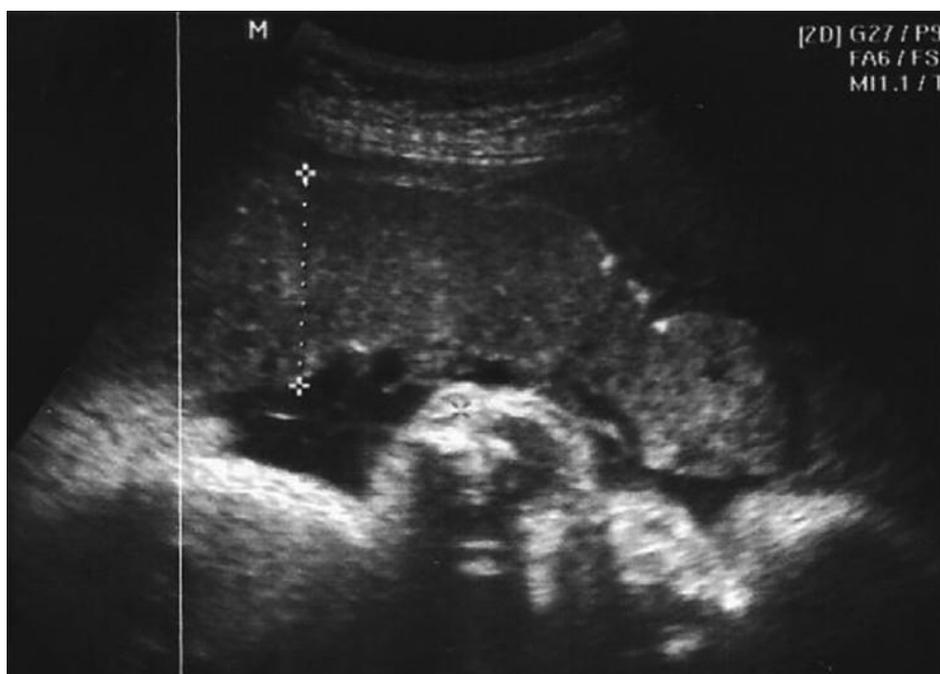


Fig.2: Measurement of the AP thickness of the placenta at the connection site of the cord to placenta was done in the non-contraction state of the myometrium. AP: maximum anteroposterior.

3- RESULTS

In the current study, out of 93 pregnant women with the ages ranged from 19 to 40 years old with mean age of 26.33 years old and standard deviation of 4.88, 76.3% were younger than 30 years and 23.7% were older than 30 years (**Figure.3**). Also, 45 (48.3%) of them were in case group and 48 (51.6%) were in control group. The mean gestational age was 29.9 weeks with

standard deviation of 1.42, and the mean fetal weight (EFW) was 1497.7 g with standard deviation of 245.88. Mothers had no history of previous diseases such as diabetes, hypertension, thyroid, and infertility. In the study groups, there were no cases of fetal hydrops or infectious disease, including syphilis, cytomegalovirus infection, toxoplasmosis, schistosomiasis, and myiasis. In the sonographic

measurement of placental thickness during gestational age of 28-32 weeks, there was a positive and significant correlation between placental thickness and cord diameter in mothers with gestational diabetes compared to the control group (**Table. 1**). There was no significant relationship between fetal weight (EFW), and GDM in the studied subjects ($P>0.05$). **Table.1** illustrates the Pearson correlation of the placental thickness and GDM. There was a significant relationship between placental thickness and GDM in subjects under study ($P<0.05$). There was no significant relationship between maternal age and GDM in the study subjects ($P>0.05$). There was a direct and significant relationship between cord area

and GDM in the studied subjects ($P<0.05$). Independent of EFW changes, placenta thickness, and cord diameter, as confounder factors, were significantly higher in GDM subjects, compared to the control group ($P <0.05$). There was a significant relationship between placental thickness and cord diameter in study subjects ($P<0.05$). There was a direct and significant relationship between fetal weight and placental thickness in the studied subjects ($P<0.001$). There was a direct and significant relationship among maternal age and placental thickness and cord diameter in the studied subjects ($P<0.05$), indicating that hemoperfusion and consequently, placental growth were performed better in younger mothers.

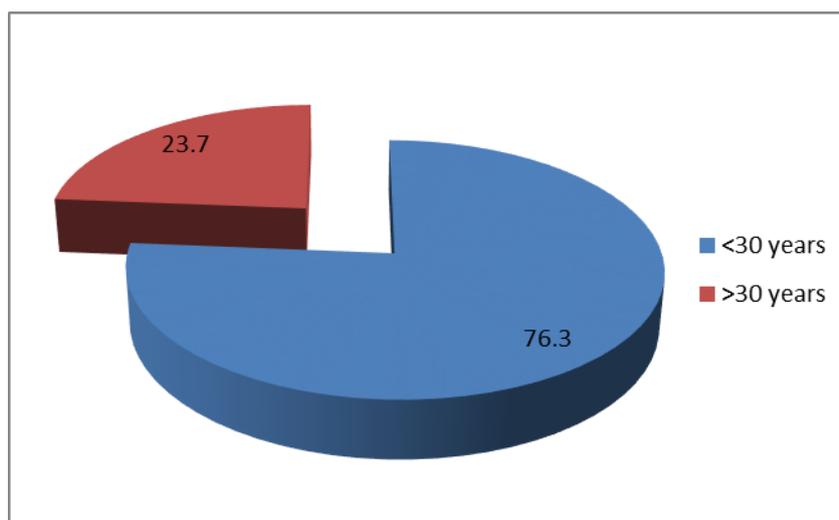


Fig.3: Age distribution of the subjects under study.

Table-1: Indicates the Pearson correlation of the study variables.

Variables		Pearson correlation	P-value
EFW	GDM	0.148	0.436
Placenta thickness	GDM	0.33	0.04
Cord area	GDM	0.437	0.01
Mother age	GDM	0.130	0.494
Cord area	GDM	0.437	0.01
Placenta thickness	Cord area	0.735	0.001
Placenta thickness	EFW	0.64	0.001
Placenta thickness	Mothers age	0.422	0.02
Cord area	Mothers age	0.479	0.007

GDM: gestational diabetes mellitus, EFW: estimated fetal weight.

4- DISCUSSION

Hyperglycemia and hypoxia are two important factors in the pathophysiological process of GDM complications and also in GDM, through several pathways including leukostasis, vasoconstriction, and prognosis, blood glucose causes hypoxia and oxidative stress in the placenta (20–24). Therefore, in GDM, glucose is considered as a predictive, angiogenic, and pre inflammatory factor affecting placental vessels and impaired vascular function during critical periods, and also causes placental hyper proliferation (25). The histopathological changes of placenta in gestational diabetes can be evaluated by placental hypertrophy, followed by increased cord diameter in sonographic imaging. On the other hand, different parameters are used to evaluate the rate of fetal growth in order to determine the intrauterine conditions of the fetus (28-26).

Normal function and structure of placenta are essential factors for the formation of healthy fetus, and consequently, for normal birth weight (29). Early diagnosis of any fetal and placental pathology can help the gynecologist and obstetrician to more precisely consider prenatal care. In addition, placental growth is an important determinant of birth weight, which is the predictor of abdominal circumference, and head circumference, femur length, and biparietal diameter in gestational age of 17-20 weeks. Numerous studies have investigated various aspects of placental growth including its volume, weight, and surface area. In a study conducted by Clamp et al, there was a significant correlation between growth of placenta in the second trimester and birth weight (31). Also, in a study conducted by Kinare et al. (32), it was shown that there is a significant relationship between placental thickness in mid-pregnancy and birth weight. Moreover, Kartikayan et al. have reported the correlation between placental thickness and gestational age and fetal

growth (33). Sonographic measurement of placenta thickness is a useful and simple clinical method for detection of initial warnings, which can be performed at any gynecological center (34). With respect to the risk of gestational diabetes in the occurrence of macrosomia, its risks to the placenta can be illustrated by increasing the placental thickness. However, in the evaluation of mothers with gestational diabetes, the placental thickness and cord diameter are unfortunately overlooked in macrosomic evaluation of the fetus. Meanwhile, the results of our study showed that there was a significant and direct relationship between cord area and GDM in the studied subjects ($P < 0.05$).

Also, in a study performed by Halil et al., it was shown that the volume of placenta had increased in GDM and cord thickness had increased in the diastolic and systolic phases (7), and these are consistent with the results of our study. Compared to the control group, the placental thickness and cord diameter were significantly higher in GDM subjects, independent from EFW changes as confounder factor ($P < 0.05$), indicating that even with normal findings, the parameters related to fetal weight, placenta thickness, and cord diameter are higher in fetuses with diabetic mothers.

In addition, in our study, there was a significant relationship between placental thickness and cord diameter ($P < 0.05$). The current study demonstrated that there was a significant and direct relationship between fetal weight, placental thickness, and cord diameter ($P < 0.05$). In a study performed by Andrea et al. (2015), it was shown that, the figures of placental weight and volume in diabetic mothers were higher compared to those of normal pregnancies (6), which is in accordance with the results of this study. Moreover, Taricco et al. illustrated that the fetal weight was lower than placental weight in pregnant women with GDM (12), which is inconsistent with the results of our study.

In the present study, it was revealed that placental thickness and cord diameter have been higher in mothers with gestational diabetes compared to the control group. Ashfuq et al., also indicated that placental weights in GDM mothers were 22% and 33% in diameter, and 85% in Central Thickness compared to placenta in non-diabetic mothers (14), which is in accordance with the results of our study.

5-CONCLUSION

Generally, independent from fetal weight increase in mothers with gestational diabetes, placenta undergoes changes in the field of glucose-induced hypermetabolism, which is available for the fetal blood in order to provide the required oxygen and nutrient for the fetus. This supply and demand cycle between the fetus and the maternal blood leads to an increase in placental growth and in cord diameter. Therefore, increased placental thickness and cord diameter may be used as auxiliary diagnostic methods before formation of macrosomic changes in fetus.

6- ACKNOELEDGMENTS

The present article was extracted from the MD thesis written by Mohammad Reza Fadaee. The study was financially supported by hearing and speech research center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran

7- CONFLICT OF INTEREST

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