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A Study of Doppler ultrasound indices of spiral placental and umbilical arteries in pregnant women with singlet on Pregnancy suffering type -1 diabetes mellitus, gestational diabetes and normal pregnant women

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ABSTRACT

Background: Doppler ultrasound is a noninvasive method to investigate the nature of blood flow in an unborn baby (fetus) to check the health of the fetus. In pregnant women with insulin-dependent diabetes blood flow varies in the embryonic and fetal placental arteries due to pathological changes caused by the disease.

Methods and material: Doppler ultrasound indices includes: resistive Index, pulsatility Index, systolic/diastolic ratio.Sixteen (16) pregnant women diagnosed with insulin-dependent diabetes, but with controlled blood sugar levels and without complications of vasculopathy, forty two (42) pregnant women with gestational diabetes undergoing dietary control as two experimental groups and sixty seven (67) healthy pregnant women as the control group were included in this study. The data was analyzed using ANOVA (Analysis of Variance).

Results: The average value of Doppler ultrasound indices of placental spiral arteries and mean value of Doppler ultrasound indices of fetal umbilical artery at the point of segregation from placenta and the free loop among the three groups were statistically not significant. Doppler ultrasound indices of pregnant women suffering from insulin-dependent diabetes but with no vasculopathy, showed no significant difference with the indices obtained in healthy, non-diabetic pregnant women.

Conclusion: We conclude that pathological changes in placental vessels depend on the severity of illness and way of glycemic control. In condition wherein gestational diabetes is well controlled especially in the absence of vasculopathy, pathological changes of fetal and placental vascular compartments fail to cause blood flow changes.

KEYWORDS: Insulin-dependent diabetes; gestational diabetes; Doppler ultrasound; spiral arteries; umbilical arteries.

INTRODUCTION

Investigation of Doppler ultrasound indices of umbilical and placental spiral arteries were attempted in this study among pregnant women with a singleton pregnancy suffering from insulin-dependent diabetes, gestational diabetes and normal pregnancies.

Uterine artery after originating from the hypogastric artery, is divided into smaller branches in the uterus and finally creates the spiral arteries that's also called uterine- placental artery which is responsible to blood supply placental inter villous space [1]Trophoblastic invasion to spiral arteries causes conversion of these arteries to dilated inelastic arteries that is capable of transferring a greater volume of blood from the placenta to the developing fetus. These physiological changes begin in the first trimester of pregnancy and continue till second trimester [2]. Placenta with help of hormones, cytokines and growth factors, has regulating role in embryonic development and continuation of pregnancy. However, diabetes can cause changes in the structure and function of the placenta [3]. Studies show that in diabetes can cause increasing in the thickness of the placenta[4], placental basement membrane and decreased blood flow of uteroplacenta [5].

Doppler ultrasound is a noninvasive method to assess the condition and circulation of uterine arteries and placental arteries like spiral and fetal umbilical arteries. Investigations for evaluating Doppler ultrasound indices such as: Pulsatility Index (PI), Resistive Index (RI), systolic/ diastolic (S/D) were applied in pregnant women with diabetes. Recee and colleagues demonstrated that Pulsatility Index (PI) of umbilical artery in diabetic pregnancy with vasculopathy was higher in comparison with that in diabetic pregnant females without vasculopathy [6]. To and Mok undertook umbilical arterial and venous Doppler measurements near term and were unable to distinguish between diabetic and nondiabetic pregnancies[7].

Placental growthis directly related tofetal development. Fetal-growth iscontrolby the balance between the need to feed fetus and maternal protection, this balance is directly linked to thestructure and function of the placenta. Inuncontrolled diabetes, fetal weight increases[8] and structure of placenta changes to hyperproliferative and hyper vascular state, resulting in the reduction of maternal –placental blood supply and placental size and increased theneed of fetaland compensatory of placenta[9].

Further studies in diabetic pregnancies with complications have been performed, but the question remains whether in pregnancies with glucose intolerance or insulin-dependent diabetes which is well controlled, are there any changes in the function and structure of placenta and blood flow?

The present study has examined the changes in Doppler ultrasound indices in placental spiral artery and fetal umbilical artery in two locations, free loops and in the point of placental segregation in three groups of pregnant women with: (i)insulin dependent diabetes without vasculopathy, (ii) gestational diabetes and in (iii) healthy pregnant women.

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METHOD AND MATERIAL

In this cross sectional study, 254 pregnant females at 36- 40 gestational age were investigated and were referred to the prenatal care unit in the Imam Hospital of Medical Science of Tehran University during 2012- 2014.

The subjects' Inclusion criteria included: gestational age 40-36 weeks, single pregnancy and the Exclusion criteria: multiple pregnancies, fetal anomalies, intra uterine growth retardation (IUGR), history of medical underlying diseases (except diabetes) like epilepsy, lupus, smoking, illicit drug abuse or addiction to other drug. The gestational age was calculated based on the LMP reliable. If LMP was uncertain ultrasound was used in pregnancy (before 12 weeks) to determine gestational age.

Intrauterine growth restriction refers to a fetus with an estimated fetal weight < 10th percentile on ultrasound that, because of a pathologic process, has not attained its biologically determined growth potential[10].

Sixteen pregnant women with insulin dependent diabetes were selected on the basis of having suffered this disease since less than 5 years ago and blood glucose level was in normal range and HbA1c 20-40 mmol/mol.

It has been recommended that a 2-h 75-g OGTT be performed on all women at 24 to 28 weeks' gestation not previously found to have overt diabetes during early testing in their current pregnancy[11]. Forty two pregnant women with gestational diabetes were screened and selected via GTT with 75 g glucose in 26- 28 gestational week of their pregnancy, after detection of the disease only by controlling diet, glucose level was kept in the normal range. Subjects in this group had dietitian recommendeddiet in whichat least175grams of carbohydrates wasincluded in the dailyfood[12]. Gestational diabeticpregnant womenunderwent cardiac, retinal and renal examinations and those showing vasculopathy were excluded.

Finally, 16 pregnant ladies with insulin dependent diabetes, 42 with gestational diabetes and 67 normal pregnant women were chosen. It was explained to pregnant women participating in the study and their informed consent was obtained.

After selection of samples and recording information regarding gravidity, parity and measuring Body Mass index (BMI), ultrasound was performed for detection of biometry, excluding of multiple pregnancies, obvious fetal anomalies and IUGR.

BMIbased on height andweight f pregnant womenatthe firstvisitandbefore10 weeksof gestationwas measured.Doppler examination was done by an expert and trained person and with Transabdominal convex Transducer (Acuson Antares, USA) and mean of 3-5 MHZ. Blood flow of spiral artery in the space between decidua and basal placenta was measured.

Pulsed wavedoppler ultrasound with 2 mm gates and insonation angle less than 30 in 3 points and in a distance less than 3 cm from origine has been used. Time of measurment was less than 20 min andthermal index < 1.0 and mechanical index < 0.7. blood flow of umbilicall cord was measured in 2 areas in free loop and at the placental insertion. Measurment was applied when there was no uterine contraction and fetus was in apnotic and resting condition.

Before birth Placenta length and width were measured by ultrasound. If the placenta was linear in the front, placenta is regarded as the highest and if that crescent was fundal measurements were carried out in two parts, and the findings were recorded [13].

Spiral artery Doppler ultrasonography in the posterior placenta technically difficult and high error probability, therefore, patients with anterior placenta were considered.



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Immediately after birth, umbilical cord clamping of the umbilical cord connecting the placenta and then cut the clamp by a person who was unaware of the status of maternal diabetes and by Libra Beurer making Germany carefully 10 grams weighed and all data were recorded.

Uterine artery Doppler ultrasound was not evaluated in this study and the objective was to study the spiral and umbilical artery.

Resistive Index (RI), Pulsatility Index (PI), systolic/ diastolic (S/D) have been recorded in each case. Further, results were analysed with SPSS software and mean of above variables have been compared with ANOVA(Analysis of Variance) statistical tests and were classified based on Danken method and in a significance level 0.05.

RESULTS

Mean of BMI, placenta lenght, placenta width and placenta weight have not significant difference between3 groups, but gravidity and parity were different in these 3 groups (table1).

	Experimental groups			
Variable				
	Healthy group	Insulin dependent diabetes	Gestational diabetes mellitus	p.value
		(n=16)	(n=42)	
	(n=67)			
BMI	25.7 <u>±</u> 4.9	29.89 <u>+</u> 2.89	27.88 ±0.54	0.1 ^{ns}
Gravidity	1.7 <u>±</u> 1	3.67±1.15	1.97±1.04	0.02*
Parity	0.65 ±1	2.34±0.57	0.81±0.96	0.01**
Placenta length (cm)	15.8062±3.4865	16.167 <u>+</u> 3.033	18.67 ±2.1733	0.3411 ^{ns}
Placenta width (cm)	4.031±1.0738	4.3567±1.0490	3.6760 <u>+</u> 0.7234	0.3622 ^{ns}
Placenta weight(gr)	489.403 ±135.6006	489.7619±121.685	456.67±150.4438	0.9119 ^{ns}

Table 1: Demographic characteristics and the weight and dimensions of the placenta

*m±SD (Mean± Standard deviation)

Doppler ultrasound indices of placental spiral artery, umbilical artery at the point of placental insertion and umbilical artery in free loop were statistically not significant among these 3 groups (table 2).

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Table 2: Doppler indices in different parts of the placenta and fetus

	Experimental groups					
Indices of doppler Ultrasound`	Helthy group (n= 67)	Insulin dependent diabetes (n= 16)	Gestational diabetes mellitus (n= 42)	p.value		
Placental spiral artery						
Pulsatility Index	0.44 <u>±</u> .38	0.59±0.19	0.63 <u>±</u> 0.67	0.18 ^{ns}		
Resistive index	0.31±0.12	0.44±0.13	0.35±0.17	0.11 ^{ns}		
Systolic/ deastolic	1.51±0.43	0.85±0.39	1.76 ±0.85	0.11 ^{ns}		
Umbilical artery at the point of placental insertion						
Pulsatility Index	0.82± 0.25	0.93± 0.32	0.83± 0.32	0.79 ^{ns}		
Resistive index	0.53 <u>±</u> 0.12	0.55± 0.13	0.58±0.43	0.7 ^{ns}		
Systolic/ deastolic	2.3 <u>±</u> 0.64	2.36 ± 0.65	2.2± 0.67	0.72 ^{ns}		
Umbilical artery in free loo	р					
Pulsatility Index	0.9 <u>±</u> 0.52	0.75±0.19	0.87±0.29	0.85 ^{ns}		
Resistive index	0.53±0.13	0.51±0.12	0.6 ±0.29	0.3 ^{ns}		
Systolic/ deastolic	2.39±0.99	2.9±0.53	2.5±0.93	0.76 ^{ns}		

*m±SD (Mean± Standard deviation)

DISCUSSION

Abnormal environment of diabetic pregnant mother causes adipose tissue stimulation and placental cells which at the end leads to increase of releasing of inflammatory cytokines, this is an event which is rare in a normal pregnancy. Insulin results in stimulation of glucose earobic metabolism in fetus and increases demand of O_2 [4] and in diabetic pregnant females, there is increasing in placental basement membrane thickness and decreas in uterine and placental blood flow [5]. In diabetic pregnancies especially type I, level of fetal fibroblast growth factor II increases which leads to angogenesis in placenta and

placental hypercapillarization [14]. On the other hand, abnormal perfusion of placenta is clarified with alteration in blood flow of spiral artery and in doppler ultrasound indices .

In this study, placental weight and placentalsize in pregnant women with type 1 diabetes with healthy control groups did not differ with gestational diabetes.

And can thus be explained in insulin-dependent diabetes in pregnancy fwell controlled and Short periodof previous illness, Structural and functional changes such a shypertrophy and hyper vascular of placent a does not occur secondary to increased need. So it does not change the size and weight of the placenta.

Results of this study shows that, doppler ultrasound indices of spiral and umbolical arteries in 2 points; in the free loop and insertion point in Insulin dependent diabetic pregnants have been controled well and has no vasculopathy and didn't have any difference with pregnant with gestational diabetets and healthy pregnant wemon (as a control group).

Insuline dependet diabetes which present before and in first stages of pregnanacy, can affect on fetus developement and caueses structural and functional changes in placenta. It seems, that duration of defect, severity of disease and the way of controlling glucose level have an important roles in these alterations.

Pregnant females with insuline dependent diabetes in this study has this disease for less than 5 years and blood glucose level was controled well with HbA1c 20-40 mmol/mol and in the examination there wasn't any vasculopathy. Proper control of glucose caused that pathological alteration due to diabetes not to happen in placenta and placental vessels in this group of pregnants or it wasn't in a situation to cause changes in blood flow.

In pregnant female with gestational diabetes who needed diet control, there was no placental changes due to short duration of disease and low severity of it. Thereby, doppler ultrasound indices in insulin dependent diabetic and geatational diabetic pregnant ladies have no difference with control group normal pregnant.

In this study, changes in placental Doppler ultrasound were considered and histopathology changes in was not evaluated, it is one of the limitations of in this study but can be evaluated in another study by examining placental histopathology change in this group of pregnant women.

Conclusion:

Results of this study showed that in pregnant females with insulin dependent diabetes that blood glucose level was controled well without any vasculopathy, pathological alterations in fetal and placental vessels wasn't enough to cause chages in blood flow and Consequently alterations in doppler ultrasound indices. In pregnant female with gestational diabetes with well controled glucose in a normal level, doppler ultrasound indices has no difference with normal pregnants and we can conclude, that in diabetic pregnant female if glucose is controled in the absence of vasculopathy, there won't happen any patholpgical changes in placental and fetal vessels and consequently no developing of blood flow changes can be seen and results in no change in doppler indices.

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REFERENCES

- 1-Lyall F. Priming and remodelling of human placental bed spiral arteries during pregnancy-a review. Placenta. 2005; 26:S31-S6.
- 2-Koen L. Deurloo, MD, Antoinette C. Bolte, MD, PhD, Jos W. R. Twisk, PhD, John M. G. van Vugt, MD, PhD. Longitudinal Doppler Measurements of Spiral Artery Blood Flow in Relation to Uterine Artery Blood Flow. J Ultrasound Med 2009; 28:1623–1628.
- 3- Desoye G, Hauguel de Mouzon S, Shafrir E. The placenta in diabetic pregnancy. In Textbookof Diabetes and Pregnancy. Hod M, Jovanovic L, DiRenzo G-C, deLeiva A, Langer O, Eds.London, Dunitz M. 2003; p. 126–147.
- 4-Yang WC, Su TH, Yang YC, Chang SC, Chen CY, Chen CP. Altered perlecan expressionin placental development and gestational diabetes mellitus. Placenta . 2005;26:780–788.
- 5-Saldeen P, Olofsson P, Laurini RN. Structural, functional and circulatory placentalchanges associated with impaired glucose metabolism. Eur J Obstet Gynecol ReprodBiol.2002;105:136–142.
- 6-Reece EA, Hagay Z, Assimakopoulos E, Moroder W, Gabrielli S, DeGennaro N, etal. diabetes mellitus in pregnancy and the assessment of umbilical artery waveforms using pulsed Doppler ultrasonography. Journal of ultrasound in medicine. 1994;13(2):73-80.
- 7-To wn, Mok CK. Fetal umbilical arterial and venous Doppler measurements in gestational diabetic and nondiabetic pregnancies near term. Journal of Maternal-Fetal and Neonatal Medicine. 2009;22(12):1176-82.
- 8- Langer O, Yogev Y, Xenakis EMJ, Brustman L. Overweight and obese in gestational diabetes: The impact on pregnancy outcome. American journal of obstetricand gynecology. 2005; 192(6):1768-76.
- 9- Mandl M, Haas J, Bischof P, Nöhammer G, Desoye G. Serum-dependent effects of IGF-I and insulin on proliferation and invasion of human first trimester trophoblastcell models. *Histochemistry and cell biology*. 2002; 117(5):391-9.
- 10-SOGC CLINICAL PRACTICE GUIDELINE. Intrauterine Growth Restriction: Screening, Diagnosis, and Management. August 2013; No. 295
- International Association of Diabetes and Pregnancy Study Groups Consensus Panel.Diabetes Care. 2010 Mar;33(3):676-82. PMID: 20190296
- 12-Bantie JP, Wylie-Rosett J, Albright AL, et al: Nutrition recommendations and interventions fordiabetes.Diabetes Care. 2008; 31(1 suppl); s61.
- 13-Proctor LK, Toal M, Keating S, Chitayat D, Okum N, Windrim RC, Smith GCS, A Kingdom JCP. Placenta size and the prediction sever early onset intrauterine growth restriction in womenwithlow pregnancy-associated plasma-protein-A. Ultrasound in Obstetrics and Gynocology.2009; 34(3). pages 274-282.
- 14-Hill DJ, Tevaarwerk GJ, Caddell C, Arany E, Kilkenny D, Gregory M: Fibroblast growth factor 2 is elevated in term maternal and cord serum and amniotic fluid inpregnancies complicated by diabetes: relationship to fetal and placental size. J Clin Endocrinol Metab. 1995; 80:2626–2632.