

# Comparison of the uterine artery Doppler indices during pregnancy between gestational diabetes and diabetes mellitus and healthy pregnant women

Nazanin Farshchian  
Farhad Naleini  
Amir Masoud Jaafarnejhad  
Parisa Bahrami Kamangar

Department of Radiology, Faculty of Medicine, Kermanshah University of Medical Sciences, Kermanshah, Iran

## Corresponding Author:

Nazanin Farshchian,  
Department of Radiology, Faculty of Medicine,  
Kermanshah University of Medical Sciences, Kermanshah, Iran  
Tel: 09123757729  
Email: Nfarshchian@kums.ac.ir

## Abstract

**Introduction:** Diabetes can adversely affect the fetoplacental circulation. This can cause complications such as congenital malformations of the fetus, fetal demise, fetal growth abnormalities, pre-eclampsia, and preterm labor. The objective of this study was to compare the uterine artery Doppler indices (resistance index (RI), plasticity index (PI), and peak systolic velocity (PSV)) among pregnant women with diabetes mellitus and gestational diabetes, with healthy pregnant women.

**Methodology:** In this study, 60 pregnant women within gestational age of 20 to 40 weeks were consecutively selected. They were in three groups: diabetes mellitus, gestational diabetes, and healthy mothers. They were examined by Doppler ultrasound of the uterine artery and the RI, PI, and PSV were recorded. The data were analyzed using analysis of variance (ANOVA and Kruskal-Wallis tests).

**Results:** There was no significant difference in terms of the uterine artery RI among the three studied groups ( $P > 0.05$ ). There was a significant difference regarding PI among the three groups ( $P < 0.05$ ). No significant difference existed with regard to PSV among the three studied groups ( $P > 0.05$ ).

**Conclusion:** There was a difference regarding PI between mothers with diabetes mellitus and gestational diabetes, and healthy mothers.

**Key words:** Diabetes mellitus; gestational diabetes; uterine artery; Doppler ultrasound

Please cite this article as: Farshchian N. et al. Comparison of the uterine artery Doppler indices during pregnancy between gestational diabetes and diabetes mellitus and healthy pregnant women. *World Family Medicine*. 2017; 15(9):32-35. DOI: 10.5742/MEWFM.2017.93098

## Introduction

Diabetes mellitus (DM) is not a single disease; rather it is a group of metabolic derangements characterized by hyperglycemia. It is the result of defect in insulin secretion, insulin function, or a combination of these. Chronic hyperglycemia causes damage to various organs including eyes, kidneys, nervous system, and cardiovascular system. According to the latest guidelines of the American Diabetes Association (ADA), the diagnosis of DM is made by any of the following: one time glucose level of more than 200 mg/dL associated with classic symptoms (polydipsia, polyuria, and polyphagia); fasting plasma glucose of > 126 mg/dL (fasting is defined as not taking calories for at least 8 hours previously); hemoglobin A1C (HbA1C) of > 6.5%, or 2-hour 75-g oral glucose tolerance test (OGTT) of > 200 mg (1). Gestational diabetes is defined when hyperglycemia is detected for the first time during pregnancy (2). It occurs in about 3 to 10% of pregnancies and its cause is not well understood (3). In gestational diabetes, if fasting plasma glucose is more than 126 mg/dL or random plasma glucose is > 200 mg/dL, the diagnosis is made and no challenge test is required. In cases where that plasma glucose is lower than the mentioned thresholds, glucose challenge test is done (4, 5).

Early in pregnancy, diabetes can cause congenital malformations and raises the risk of abortion. It also has adverse effects on the fetal organs such as brain and heart (6-8). Plus, maternal diabetes can cause excessive growth of the fetus and macrosomia (9). Macrosomia can result in difficult labor and raises the likelihood of cesarean section requirement. In case of natural delivery, the risks of neonates' shoulder injury, hypoxia, and brain injury are increased (10-12).

Considering the risks of diabetes during pregnancy, this study was intended to examine the effect of diabetes on uterine artery circulation and compare this among three groups of mothers: DM, gestational diabetes, and normal healthy mothers. Here, we used Doppler ultrasound which is a non-aggressive method to study the uterine artery. This method has been shown to be able to predict pregnancy loss, increased rate of complications, and uterine perfusion

disturbances (13). This study aimed to compare the uterine artery Doppler ultrasound indices among the three groups of mothers: DM, gestational diabetes, and normal healthy mothers.

## Materials and Methods

In this analytic case-control study, 60 pregnant women were selected and included consecutively. They were within gestational age of 20 to 40 weeks. These presented to our medical center in 2016. According to laboratory tests performed, they were categorized as having DM, gestational diabetes, or being normal healthy mothers without hyperglycemia. The inclusion criteria were gestational age from 20 to 40 weeks, no intrauterine growth retardation, singleton pregnancy, no systemic background diseases such as hypertension, and not taking medications such as insulin. The gestational age was calculated according to the LMP. If the LMP was unreliable, the first ultrasound examination (in the first trimester) of the fetus was used to calculate the gestational age. Mothers in the DM group had the condition for less than 5 years, without vascular diseases, and their blood glucose was under control.

The uterine artery color Doppler ultrasound was done using Xmatrix iu22 (Philips) with CONVEX 3.5 to 5-MHz probe for the three groups. The location of the uterine artery after separating from the hypogastric artery and passing over external iliac vessels was marked and RI, PI, and PSV were measured. The three groups were matched regarding maternal as well as gestational age. In cases where the placenta was located right-hand or left-hand of the uterus, the nearest uterine artery was used for measurement of the indices. In cases where the uterus was located at the midline, the average of two measurements made at the right and left uterine arteries was recorded.

Data were expressed using descriptive indices including mean and SD (standard deviation). The data were analyzed using analysis of variance (ANOVA) and Kruskal-Wallis tests. All analyses were done using SPSS software (ver. 22.0, IBM, US). A P value of less than 0.05 was considered as statistically significant.

## Results

There were 60 pregnant women. Each group contained 20 subjects. Table 1 presents demographic characteristics of the sample.

**Table 1: Demographic characteristics of 60 pregnant women**

	Diabetes mellitus	Gestational diabetes	Control healthy
Age, year	37.85 (±4.99)	35.55 (±3.63)	35.55 (±6.01)
Gestational age, week	31.7 (±3.64)	31.9 (±4.41)	32.45 (±3.34)

Data are presented as mean (±SD).

A significant difference was observed regarding the uterine artery PI among the three studied groups ( $P < 0.05$ ). No difference was observed between DM and gestational diabetes regarding the uterine artery PI. However, uterine artery PI in the healthy control group was significantly lower compared to the DM and gestational diabetes groups (Table 2).

**Table 2: Comparison of uterine artery PI (pulsatility index), RI (resistance index), and PSV (peak systolic velocity) among diabetes mellitus, gestational diabetes, and control groups**

	Diabetes mellitus	Gestational diabetes	Control healthy	P value
RI	0.611 ( $\pm$ 0.078)	0.591 ( $\pm$ 0.087)	0.558 ( $\pm$ 0.177)	0.4
PI	0.999 ( $\pm$ 0.27)	0.975 ( $\pm$ 0.3)	0.772 ( $\pm$ 0.237)	0.03
PSV	85.45 ( $\pm$ 24.17)	74.68 ( $\pm$ 28.69)	96.49 ( $\pm$ 39.95)	0.085

Data are presented as mean ( $\pm$ SD).

As seen in Table 2, the uterine artery RI did not reach a significant difference among the three groups. Likewise, PSV was comparable among the three groups (Table 2).

## Discussion

During the first trimester, trophoblasts penetrate into the uterine arteries and cause dilation of the spiral vessels and increased uterine blood flow. In fact, the uterine blood flow increased from 50 cc per minute in non-pregnant women to 700 cc per min in pregnant mothers towards the end of the pregnancy. In addition, in a normal pregnancy, the uterine artery RI reduces in placental-fetal circulation (14). In a previous study, no difference was noted regarding Doppler ultrasound indices of the fetal spiral vessels and umbilical artery among DM, gestational diabetes, and healthy mothers (15). In agreement with what we observed here, a former study noted that 3D Doppler ultrasound did not show any difference between DM and gestational diabetes. However, all indices in diabetic mothers showed decreased values when compared to healthy mothers and fetal and uterine blood flow had significant associations with 3D Doppler indices (16). In contrast to our results, a previous study reported that although no difference was noted regarding mean values of PI of the uterine artery between pre-eclampsia and gestational diabetes, with worsening of gestational diabetes, the uterine artery PI values were higher in mothers whose pre-eclampsia became worse compared to those whose pre-eclampsia did not worsen. This discrepancy can be due to difference in study designs (17). In another study, PI of fetuses with macrosomia was significantly compared to normal fetuses (18). It has been shown that increased uterine artery impedance had significant association with vascular disorders before pregnancy. In women who delivered their neonates at earlier gestational ages, the uterine artery PI had increased significantly which is compatible with our study (19). The uterine artery waveforms and the systolic to diastolic blood pressure ratio did not show difference between the two groups (20). Although the mentioned studies have used the uterine artery Doppler indices in early diagnosis of uterine artery disturbances due to diabetes and have found it useful, the discrepancy in the results can be due to the number of patients studied and the examined vessel. For example, in a previous study, placental spiral arteries and umbilical artery were examined. However, here we examined the uterine artery. Based on the obtained findings, in absence of vascular disorders and control of hyperglycemia, uterine artery Doppler indices of mothers with DM and gestational diabetes are close to healthy mothers. Only uterine artery PI had a difference among

the groups. But, RI and PSV were comparable among the three groups.

One of the limitations we had was the low sample size. Therefore, we recommend performing further studies with larger sample sizes. So far, no study has examined the uterine artery Doppler ultrasound of mothers with DM and gestational diabetes.

## Conclusion

Mothers with DM and gestational diabetes have uterine artery RI and PSV values close to healthy mothers and no significant difference was observed. The only significant difference was PI of the uterine artery among the three groups.

## Acknowledgement

This article is based on a thesis submitted to the graduate studies office in partial fulfillment of requirements for the degree of Radiology by Amir Masoud Jaafarnejhad in Kermanshah University of Medical Sciences, Faculty of Medicine. Financial support by the Research Council of Kermanshah University of Medical Sciences (Grant Number: 94211)

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