

Original Article

# Mid-trimester uterine artery Doppler ultrasound as a predictor of adverse obstetric outcome in high-risk pregnancy

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## Abstract

**Objective:** The aim of this study was to assess uterine artery Doppler ultrasonography efficiency in prediction of adverse pregnancy outcome in high-risk pregnancies.

**Materials and Methods:** We selected 70 pregnant women who were high risk for development of preeclampsia, abruption, low birth weight (LBW), and preterm delivery during their pregnancy, and Doppler ultrasonography was performed for them in 18–24 gestational weeks for evaluation of uterine artery notching. Absence of diastolic flow in uterine artery waves was defined as notching. The women were divided into two groups: with notching (Group A) and without notching (Group B), then they were compared for complications such as preeclampsia, abruption, LBW, and preterm delivery.

**Results:** In 70 high-risk pregnant women, 27 women (39.2%) were in Group A and the others were in Group B. The birth weight in Groups A and B was  $2,897.5 \pm 757.15$  and  $3,248.39 \pm 374.27$ , respectively. In our study, 15 patients were delivered before 37 gestational weeks (preterm labor). Preeclampsia, abruption, and LBW were significantly higher in the group with positive notching, but preterm delivery did not show any statistical difference between the two groups.

**Conclusion:** According to the results, uterine artery Doppler ultrasonography had high negative predictive value for prediction of preeclampsia, abruption, and LBW. Therefore, absence of uterine artery notching in mid-trimester evaluation of high-risk pregnant women may predict better pregnancy outcome. We recommend Doppler ultrasonography for all high-risk pregnant women in second trimester for prediction of pregnancy outcome.

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**Keywords:** Doppler ultrasonography; High-risk pregnancy; Notching; Pregnancy outcome

## Introduction

Cases of pregnancies that have higher risks of complications for mother and the fetus than normal population of pregnancies are called high-risk pregnancy. A history of hypertension and preeclampsia are among the most important reasons of high-risk pregnancy, so that the chance of preeclampsia in individuals with a positive history is 11 times more than normal

population of pregnancies [1]. Surely other problems, such as history of gestational diabetes, recurrent abortions, present diabetes, collagen vascular diseases, and polycystic ovarian syndrome can be associated with an increased risk of mother and fetus complications, therefore such a pregnant woman is associated with a high-risk pregnancy [1,2]. We know, study of the flow in the umbilical artery is one of the considered means in high-risk pregnant women to check the possibility of an acute or chronic asphyxia of the fetus and related complications, so not only one of the most important methods is used to diagnose the disorder of fetus and placental circulation is Doppler ultrasonography, but also some studies reported that uterine artery Doppler ultrasonography in second trimester can

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predict the fetal asphyxia and disorder of fetus and placental circulation in third trimester [3–6]. Because the pathophysiology of preeclampsia is incomplete, trophoblastic invasion to the spiral artery leads to a decrease in uteroplacental circulation. It would be possible that the test become one of the screening methods for preeclampsia [2,3,7–10]. However, there were no significant differences between the pregnant women with normal and abnormal Doppler in prediction of preeclampsia, intrauterine growth restriction (IUGR), and hypertension of pregnancy in some studies [11]. Irión et al [12] reported the Doppler screening test to be unreliable for low-risk pregnancy.

Although some other researchers suggest uterine artery Doppler ultrasonography can predict preeclampsia and Small for Gestational Age in high-risk pregnancies [7–10,13], further studies are necessary to assess the efficacy of this screening test in high-risk pregnancies. Therefore, this study was carried out to further evaluate the predicting value of this screening test for pregnancy complications in high-risk pregnant women.

## Materials and methods

This is an analytical prospective study in which high-risk pregnant patients with the inclusion criteria were simply enrolled. Inclusion criteria included all the pregnant women with a gestational age less than 24 weeks who referred to a midwifery clinic and had at least one of the following risk factors: preeclampsia, gestational diabetes, overt diabetes, recurrent abortions, intrauterine fetal death, infertility, polycystic ovarian syndrome, and chronic hypertension in their past medical history. For these women, between the 18<sup>th</sup> and 24<sup>th</sup> week of pregnancy abdominal Doppler ultrasonography with 3/5 MHz transducer for evaluation of uterine artery notching was performed. Our sonography machine was Vingmed sound CFM 750 and high pass wall filter did set at 100 Hz (and 50% power). In this study, when diastolic flow in uterine artery waves was absent, it was defined as notch in uterine artery. In these cases that placenta was completely in one side of the uterine, only the ipsilateral uterine artery was examined, because of false notch forming in contralateral uterine artery waves. Demographic and clinical information with Doppler ultrasonographic results were collected via a questionnaire. Then, the subjects were divided into two groups based on the presence or lack of notch in their uterine artery Doppler sonography: Groups A (with notch) and B (without notch); and were followed till the end of pregnancy and delivery; prenatal care and therapeutic attempts were carried out and in case of any complications in pregnancy, such as preeclampsia, placental abruption, low birth weight (LBW), and preterm labor were mentioned in the questionnaire. In this study, preeclampsia was defined as a blood pressure  $\geq 140/90$  mmHg (systolic blood pressure of 140 or higher and diastolic blood pressure of 90 or higher) in a woman without any history of hypertension with presence of 300 mg protein in 24-hour urine or  $\geq 1+$  albumin in a random urine sample [2].

Also, in this study, complication of LBW was defined as a neonatal weight lower than 2,500 g, and preterm labor was

defined as delivery before 37 weeks of gestational age. Multiple pregnancies and women whose follow-up was impossible until delivery were excluded from the study.

The collected data were analyzed using SPSS software, version 13 (SPSS Inc., Chicago, IL, USA). Independent sample *t* test was used for continuous data and  $\chi^2$  test and Fisher's exact test were used for categorical data. The *p* values less than 0.05 were considered to be statistically significant. The Ethics Committee of Babol University approved the study and all cases gave informed consent.

## Results

This information was collected from high-risk pregnant women whose uterine artery blood flow was evaluated by abdominal Doppler ultrasonography between the 18<sup>th</sup> and 24<sup>th</sup> week of pregnancy (Table 1).

Table 2 shows the demographic data of these women both as a total and in two groups based on existence of notch in uterine artery Doppler.

Group A: women with notching in uterine artery in Doppler study

Group B: women without notching in uterine artery in Doppler study

In this study, there were no statistical significant differences between Groups A and B characteristics of age, body mass index, and gravidity so they were equal in such terms (Table 2).

In the study conducted on 70 high-risk pregnant women between 18 and 24 weeks of pregnancy, 27 (39.2%) patients had notching (Group A) and the other patients (43) didn't have any notching (Group B) in uterine artery Doppler study.

As is revealed in Table 3, in the comparison of pregnancy outcomes, frequency of complications such as preeclampsia, abruption, and LBW in Group A (with notching in uterine artery) is significantly higher than Group B (without notching in uterine artery). But preterm delivery had no significant difference between the two groups.

Also, the mean neonatal weight in Group A was significantly lower than that of Group B ( $2,897.5 \pm 7.5$  vs.  $3,248.3 \pm 37$ ; predictive value = 0.032).

Table 1  
Distribution of risk factors in high-risk pregnant women

Risk factor	<i>n</i> (%)
Chronic hypertension	10 (13.7)
Preeclampsia	4 (5.9)
Overt diabetes	4 (5.9)
Gestational diabetes	7 (9.8)
Recurrent abortion	1 (1.4)
IUFD	5 (7.8)
PCOS	9 (12.8)
Infertility	27 (38.5)
PCOS + Infertility	3 (4.2)

IUFD = intrauterine fetal death; PCOS = polycystic ovarian syndrome.

Table 2

Baseline characteristic of high-risk pregnant women in two groups with or without notching in uterine artery Doppler investigation

Characteristic	Group A	Group B	Total	<i>p</i> <sup>b</sup>
	Mean ± SD	Mean ± SD	Mean ± SD	
Age (yr)	29.5 ± 6.5	28.1 ± 5.7	28.8 ± 6.1	0.349
BMI (kg/m <sup>2</sup> ) <sup>a</sup>	26 ± 3.1	26.1 ± 3.5	26.7 ± 3.4	0.871
Gravidity ( <i>n</i> )	1.85 ± 0.87	1.97 ± 1.19	1.99 ± 1.0	0.701
Neonatal weight (gm)	2,897.5 ± 757.2	3,248.4 ± 374.3	3,110.7 ± 576.0	0.320

<sup>a</sup> BMI: weight/(height)<sup>2</sup>; <sup>b</sup> *t* test was used for comparison between two groups.

Group A: women with notching in uterine artery in Doppler study. Group B: women without notching in uterine artery in Doppler study.

BMI = body mass index; SD = standard deviation.

## Discussion

In our study conducted on 70 high-risk pregnant women, appearance of uterine artery notching at 18–24 weeks in Doppler ultrasonography was significantly associated with an increase in the rate of LBW, abruption, and preeclampsia. Also, in this study, 39.2% of high-risk women had notching in Doppler ultrasonography of one uterine artery at 18–24 weeks at least. This is similar to a study by Coleman et al [13] in New Zealand in which 40% of high-risk patients at 22–24 weeks had at least one uterine artery with notching. In a study by El-Hamedi et al, [7] this rate was 38% of high-risk pregnancies and also in this group, rate of LBW and preeclampsia was significantly increased. But in a study conducted by Zimmermann et al [14], this rate was 17.6% at 21–23 weeks in high-risk pregnant women. The reason of decreasing in this rate in Zimmerman's study was that they had reported only bilateral notches in uterine artery Doppler, whereas what we reported was the presence of notch in the Doppler of at least one uterine artery. Also, the gestational age was higher in cases of Zimmerman's study [14]. With the gestational age rising above 18 weeks, maternal vascular tone changes gradually leading to a decrease in vascular resistance [15] that may explain the lower percentage of notching in Zim's study.

In our study, only 9% of high-risk women without notching finally had preeclampsia, whereas in high-risk women with notching this ratio was 50%, so that these results have a significant role in consulting for possibility of preeclampsia and patient work-up. On the other hand, this test has a positive predictive value of 48% and a negative predictive value of 88.3% for preeclampsia. In a study conducted by Coleman et al [13] also bilateral notching in uterine artery had sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) of 62%, 89%, 47%, and 94%, respectively, in the diagnosis of preeclampsia, which is

comparable with our study. Certainly, in this study, notching was noticed in bilateral uterine arteries and patients had early onset of preeclampsia, which led to delivery before 34 weeks, whereas in our study all patients with preeclampsia and all cases with uterine (bilateral or unilateral) artery notching are mentioned.

In our study, only 11 cases (25.5%) of high-risk pregnant women without notching had complication that could be mentioned in consulting for possibility of pregnancy's complication. Likewise, Vainio et al [6], in a study on bilateral notching at 12–14 weeks, noticed that absence of bilateral uterine arterial notching could lead to a pregnancy without preeclampsia or IUGR. Kurdi et al [16] in Saudi Arabia reported that odds ratio for preeclampsia is 12.8 if bilateral uterine artery notching exists at 20 weeks of gestation, whereas this ratio decreases to 0.11 if evaluation of uterine artery is normal and author has suggested at the same time that all pregnant women are done routine ultrasonography at 20 weeks of pregnancy for evaluation of anomaly or determining of gestational age, can undergo uterine artery Doppler ultrasonography to determine the level of their prenatal care too. In our study, complications of LBW and abruption were significantly higher in high-risk patients with positive notching at 18–24 weeks of pregnancy. Although in our study, PPV for LBW (33.3%) and abruption (14.8%) is relatively low, but as a rule, lower PPV would be because of lower prevalence of complication and this may be the cause of PPV decreasing. In our study, though the rate of preterm delivery in patients with notching was higher, but there were no statistically significant differences between two groups. Such a fact indicates that uterine artery Doppler ultrasonography at second trimester can only predict the complications of blood supply defects between placenta and fetus.

In a study conducted by Barkehall-Thomas et al [17] in Australia in 2003, it was found out that existence of notching

Table 3

The prevalence of adverse pregnancy outcome, sensitivity, specificity, and predictive value of uterine artery notching

Poor outcome measures	Notching present ( <i>n</i> = 27)	Notching negative ( <i>n</i> = 43)	<i>p</i>	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Preeclampsia	13 (48.14%)	5 (9%)	0.001	72.2	73.1	48.1	88.3
Abruption	4 (15%)	0 (0%)	0.019	100	65.1	14.8	100
LBW	9 (35%)	1 (2.3%)	0.004	90	70.0	33.3	97.7
Preterm delivery	10 (35%)	5 (12.9%)	0.061	66.6	69.1	37.0	88.4

 $\chi^2$  and Fisher's exact test were used for comparison between two groups.

LBW = low birth weight (&lt;2,500 g); NPV = negative predictive value; PPV = positive predictive value.

had a sensitivity of 30% and specificity of 93.8% in appearance of gestational hypertension, IUGR, and premature delivery. The author concluded that uterine artery Doppler ultrasonography at 22–24 weeks increases the possibility for prediction of preeclampsia and severe IUGR in patients with unexplained elevation of  $\beta$ -human chorionic gonadotropin, but it is not recommended as a routine screening test for all pregnant women.

However, Aquilina et al [18] in London concluded that assessment of both inhibin A and uterine artery Doppler ultrasonography in unselected pregnant women at 18–22 weeks could increase the sensitivity of prediction of preeclampsia, but there is a controversy in performing Doppler ultrasonography as a routine screening test in all pregnant women to predict the possibility of development of preeclampsia and related complications [14,16,19–21], if we could increase the possibility of prediction of preeclampsia and other gestational complications related to fetoplacental perfusion with uterine artery Doppler ultrasonography in high-risk pregnancies and pregnant women with unexplained elevated inhibin A or  $\beta$ -human chorionic gonadotropin, in case of presence of notching, we could diagnose, treat, and decrease these complications with intensive antenatal care and prophylactic treatments such as low-dose aspirin, calcium, and so forth in the second trimester and this can be useful as a way to access our goal for decreasing the neonatal and maternal mortality and morbidity rate with antenatal care as much as possible.

In conclusion, uterine arteries Doppler ultrasonography has relatively high NPV for prediction of preeclampsia, abruptio, and LBW and so in the high-risk women who have normal Doppler study in second trimester we can assure the patient to have a normal pregnancy outcome with low complication rate. So, the value of the mid-trimester uterine artery Doppler notching is its high NPV for these complications in case without uterine artery Doppler notching.

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