

Accuracy of Uterine Artery Doppler in Second Trimester in Determining Pre-Eclampsia

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Abstract

Background: To determine the accuracy of uterine artery doppler in second trimester (18-24 weeks) in determining preeclampsia.

Methods: In this descriptive study a total of 89 women with singleton pregnancy attending routine second trimester anomaly scan were included. Uterine artery doppler sonography was conducted in the women coming for routine anomaly scan. Flow velocity waveforms of right and left uterine artery were imaged with the patient in the semi recumbent position and uterine artery was identified in the longitudinal scan, lateral to uterus. Resistive index, pulsatility index and presence and absence of early diastolic notch and its depth in terms of notch index were calculated.

Results: Uterine artery doppler finding in second trimester in determining preeclampsia showed abnormal findings in 41.57% women in which 24.32% had type I (Resistive index >0.58), 45.95% (17/37) type II (Mild notching of uterine artery at beginning of diastole) and 29.73% had type III [(Severe notching + abnormal Resistive index (>0.58)]. After the follow-up of each patient we found that pre-eclampsia was developed in 28.09% (25/89) cases. The accuracy, sensitivity, specificity, positive and negative predictive values of uterine artery doppler were 75.28%, 80%, 73.44%, 54.05% and 90.38% respectively

Conclusion: By detecting abnormal uterine artery Doppler indices (high RI) between 18-24 weeks of pregnancy can identify those women who are at risk for development of preeclampsia.

Key words: Pre-eclampsia, Uterine artery Doppler, Second trimester, Resistive index, Pulsatility index

Introduction

Pre-eclampsia is associated with maternal mortality and morbidity, perinatal death, preterm birth and intrauterine growth retardation in developing as well as developed countries.^{1, 2} It is reported in 5-7% of all

pregnancies. It comprises of two stages. The first stage is asymptomatic and may lead to second symptomatic stage. In the first stage, abnormal placental development in the first trimester leads to placental insufficiency. The placental components are then released into circulation. The symptomatic stage is characterized by maternal hypertension, renal impairment and proteinuria. The risk of HELLP syndrome, eclampsia and end organ damage is increased. Abnormal placentation is due to the decreased endovascular invasion by cytotrophoblasts with or without inadequate remodeling of uterine spiral vessels. If accurate prediction of preeclampsia is made in asymptomatic stage 1 then it will be possible to provide proper antenatal surveillance and therapy to improve the outcome.³⁻⁵

Uteroplacental circulation is assessed by doppler ultrasonography of uterine arteries. During pregnancy uterine artery doppler flow velocity waveform show low pulsatility with a high end diastolic pattern. This is due to trophoblastic invasion of spiral uterine arteries in early placentation period resulting in marked fall in vascular resistance. Failure of these results in high resistance flow is depicted by indices as resistive index and pulsatility index. Presence of an early diastolic notch is result of an increase in the resistance to blood flowing into placenta. Presence of notch, unilateral or bilateral and depth of notch determined by notch index increases sensitivity and specificity of predicting pre-eclampsia.⁶ With abnormal uterine artery doppler findings as increased resistive index (>0.58) and early diastolic notching, sensitivity and specificity to predict pre-eclampsia is 76.9% and 52.9% respectively. However if bilateral uterine artery notching is found, then sensitivity and specificity increases to 88% and 83 % respectively.⁷⁻¹⁰

Pre-eclampsia is a major risk as mentioned earlier due to the vast spectrum of complications it causes both in the mother and the fetus. In our country due to variable factors antenatal visits are not frequent. In this situation if in second trimester, a surveillance uterine artery doppler study can be done, it will filter the high

risk population regarding developing pre-eclampsia later in pregnancy, so proper counseling of patient in terms of frequent visits can be done.¹¹ In short by Doppler we can identify the high risk pregnant ladies. The Doppler is inexpensive, radiation free, non-invasive, and easily available modality. Focused follow up of high risk cases will reduce the burden on resources and a better outcome can be ensured

Patients and Methods

The study was conducted from January to June 2017 in department of diagnostic Radiology, Benazir Bhutto Hospital, Rawalpindi. The sample size of 89 was calculated using by taking anticipated population proportion as 64% and precision 10%.⁸ Consecutive non-probability sampling was used. All women coming for routine second trimester anomaly scan were included. Women with twin pregnancy, anomalous fetus or medical comorbidities like cardiovascular diseases, hypertension, diabetes, chronic kidney or liver diseases were excluded from study. Uterine artery Doppler sonography was conducted upon the women coming for routine anomaly scan. Flow velocity waveforms of right and left uterine artery were imaged with the patient in the semi recumbent position and uterine artery were identified in the longitudinal scan, lateral to uterus. In this position bifurcation of common iliac artery were identified and recording was made at the point where uterine artery and external iliac artery have crossed each other as detected by the color flow doppler. Pulsed wave doppler was used to obtain three consecutive waveforms. Resistive index, pulsatility index and presence and absence of early diastolic notch and its depth in terms of notch index were calculated. Women were followed regarding development of pre-eclampsia. Uterine Artery Doppler findings for pre-eclampsia was categorized as: Type I: Resistive index >0.58; Type II: Mild notching of uterine artery at beginning of diastole; Type III: Severe notching + abnormal Resistive index (>0.58).

Resistive Index was taken as an indicator of resistance of an organ to perfusion. It is parameter for characterizing arterial waveform at Doppler ultrasonography. It is calculated as Peak systolic velocity-End diastolic velocity/Peak systolic velocity. Pulsatility index was taken as a measure of the variability of blood velocity in vessel. It is equal to the difference between the peak systolic velocity and end diastolic velocity divided by mean velocity during cardiac cycle.

Notch index was the result of increase in the resistance to the blood flowing into placenta. Depth of the notch is determined by the notch index which is defined as C-D/C (C=Post systolic zenith; D=Post systolic nadir, or, NI=Minimal velocity in early diastolic notch/Maximal velocity in diastole

Pre-eclampsia was defined by high blood pressure and excess of patient's urine after 20 week of pregnancy. It can lead to eclampsia if left untreated. According to the international society for study of hypertension pre-eclampsia is diagnosed if previously normotensive women have diastolic blood pressure above 90 mmHg measured twice 4 hours apart and also with proteinuria of >300mg in 24 hours urine specimen or 02+ protein dipstick test twice 04 hours apart.

True Positive cases were cases which showed uterine artery doppler findings suggestive of pre-eclampsia and subsequently develops pre-eclampsia. The qualitative variables like true positives, types of abnormal uterine artery Doppler flow were expressed as frequency and proportions. Accuracy, sensitivity, specificity, negative and positive predictive values were calculated.

Results

A total of 89 women with singleton pregnancy attending routine second trimester anomaly scan were included in our study. The mean age and gestational age of the women was 26.33±4.40 years and 20.89 ± 2.02 weeks respectively.

Table I. Uterine artery doppler findings and development of Preeclampsia

Preeclampsia status		Development of Preeclampsia		Total
		Yes	No	
Uterine artery Doppler findings	Yes	20	17	37
	No	05	47	52
Total		25	64	89

The age distribution showed that 44 (49.44%) women were in the age range of 18-25 years. Sixty seven (75.28%) women were multipara. Uterine artery doppler finding in second trimester in determining

preeclampsia showed abnormal findings in 37(41.57%) women in which 9(24.32%) had type I (Resistive index >0.58), 45.95% (17/37) type II (Mild notching of uterine artery at beginning of diastole) and 29.73% had type III [(Severe notching + abnormal Resistive index (>0.58)] (Figure 1&2).

After the follow-up of each patient we found that pre-eclampsia was developed in 28.09% (25/89) cases. The accuracy, sensitivity, specificity, positive predictive value and negative predictive value of uterine artery Doppler were 75.28%, 80%, 73.44%, 54.05% and 90.38% respectively (Table 1).

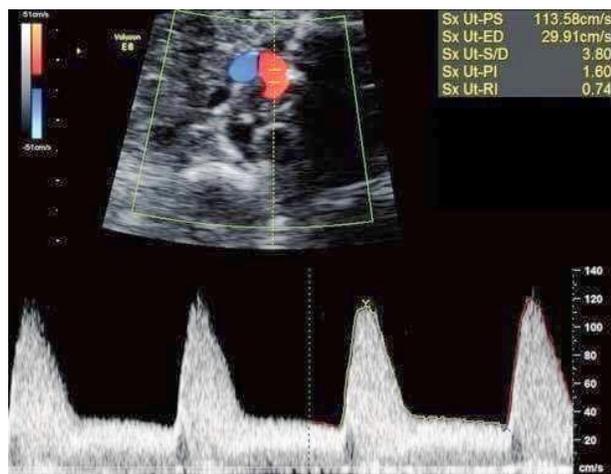


Figure 1; Type 1-increased resistive index

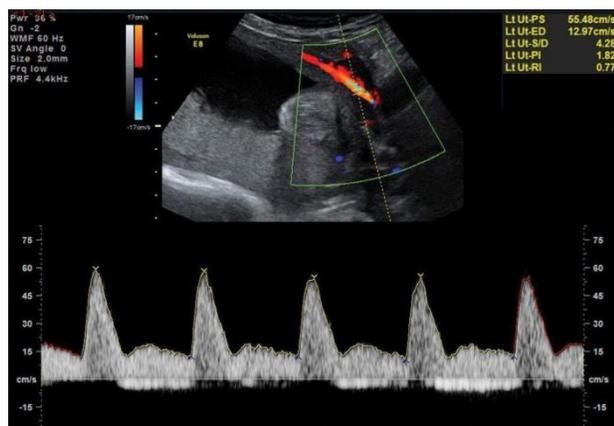


Figure 2: Notching in uterine artery waveform

Discussion

Pre-eclampsia affects about 2% of total pregnancies. It is one of the major causes of fetomaternal morbidity and mortality.¹² Due to improvement of antenatal care, the targeted approach of identifying women at high risk for subsequent development of preeclampsia is

very beneficial. The likelihood of developing preeclampsia is affected by a number of factors like Afro-Caribbean race, obesity, nulliparity, and personal or family history of preeclampsia. Maternal history alone may detect pre-eclampsia in only about 30% of cases with false-positive rate of 10%.^{13,14}

During second trimester, screening for women at high risk of developing pre-eclampsia is of utmost importance. The early diagnosis and prompt treatment leads to excellent fetomaternal outcomes. The fetal demise, growth restriction can be avoided by early antihypertensive therapy and early delivery.¹⁵

Doppler ultrasonography of uterine artery is a noninvasive modality that can be used to determine vascular perfusion of utero-placental area. So it can be considered as indirectly assessment of trophoblast development during pregnancy.¹⁶ The Doppler modality has better prediction of preeclampsia in preterm rather than term cases. Similarly the prediction is more accurate in the second trimester. The most Doppler studies show that the preeclampsia can be predicted as initially the placental perfusion is impaired.¹⁷

A study on 30000 pregnant women showed that the pulsatility index (PI) was above the 95th centile in 78% of those women who developed preeclampsia later on. This resulted in delivery before 34 weeks. The 32% developed late pre-eclampsia.¹³

In present study abnormal finding was observed in 37(41.57%) women in which 9(24.32%) had type I (Resistive index >0.58), 45.95% (17/37) type II (Mild notching of uterine artery at beginning of diastole) and 29.73% had type III [(Severe notching + abnormal Resistive index (>0.58)]. After the follow-up of each patient we found that pre-eclampsia was developed in 28.09% (25/89). Accuracy of the Doppler to detect predicts eclampsia was 75.28%. A study by Arduini et al showed the sensitivity, specificity, PPV, NPV and accuracy of utero-placental waveform analysis was 63.6%, 84.2%, 70%, 80%, 76.6% respectively.¹⁸ In our study the, 17 cases (19%) cases were false positive. The Doppler predicted the pre-eclampsia but patient showed no evidence of it. In a study by Phupong et al study showed that when high mean pulsatility index with or without presence of any early diastolic notch was taken as diagnostic criteria the sensitivity, specificity, PPV and NPV were 76.9%, 52.9%, 10.2% and 97.1% respectively for detection of preeclampsia with or without having SGA infant.⁹

Another study showed that 85.2% pregnancies with RI>0.7 and 14.8% with RI<0.7 had developed preeclampsia.¹⁹ Coleman and his colleagues studied

pregnant women the gestational age of 24-24 weeks. The sensitivity specificity, positive predictive value of test with cut-off value of RI=0.58 were 91%, 425 and 37%, respectively.²⁰As the gestational age advances, the specificity and PPV increase while sensitivity decreases. This is one of the problems when Doppler is used as screening tool for preeclampsia.²¹

Conclusion

By detecting abnormal uterine artery doppler indices (high RI) between 18-24 weeks of pregnancy can identify women at risk for preeclampsia development.

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