

Original Article

Transvaginal Doppler of uteroplacental circulation in early prediction of pre-eclampsia by observing bilateral uterine artery notch and resistance index at 12-16 weeks of gestation

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Abstract

Objectives: To study the role of bilateral uterine artery (UA) diastolic notch and resistance index at 12-16 weeks of gestation for early prediction of pre-eclampsia using transvaginal color Doppler imaging. **Methods:** Hundred antenatal women with singleton pregnancy at 12-16 weeks of gestation were considered for the study. Transvaginal Doppler study of uterine circulation was performed, diastolic notch and various velocimetry indices were noted and compared for significant, difference between normal and abnormal outcome group. The sensitivity, specificity, positive predictive value and negative predictive value were calculated for diastolic notch and notch with resistance index (RI) **Results:** Pre-eclampsia developed in 31.42% of the women with bilateral (UA) diastolic notch at 12-16 weeks. Detection rate increased upto 56% when $RI \geq 0.65$ was also included in abnormal uterine artery waveform. Specificity increased from 66.4% to 84.7% and sensitivity from 68.75 to 87.5%. **Conclusions:** Uterine artery Doppler study between 12-16 weeks is a good screening method for identification of women at high risk of developing complication related to utero-placental insufficiency.

Key words: transvaginal doppler, uteroplacental circulation, uterine artery diastolic notch, preeclampsia

Introduction

In recent years, ultrasonography is commonly used in measurement of fetal biometry and diagnosis of congenital anomalies and IUGR. Color flow is used to prognosticate high risk pregnancy and therefore its management. But the problem which still exists is

the identification of those pregnancies which are at risk of increased maternal and fetal morbidity as in PIH and IUGR. Various biochemical tests used in screening of high risk population of pre-eclampsia have lower positive predictive values, high cost and less patient compliance. So we are still in search of easily available noninvasive test for the prediction of PIH in early pregnancy.

Paper received on 03/02/2007 ; accepted on 02/07/2009

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Doppler is a noninvasive method for evaluation of fetoplacental circulation without any disturbance to human pregnancy. In pre-eclampsia and IUGR there is inadequate trophoblastic invasion of spiral arteries which leads to impedance of blood flow in uterine arteries,

reflected as high resistance in uterine artery Doppler waveform.

A high resistance and persistent notching in uterine artery Doppler waveform has shown promise as a screening test at 20 and 24 weeks. It has been possible with transvaginal ultrasound probe to predict these changes much earlier. Large scale randomized trials (CLASP¹ and EPREDA trial²) have failed to demonstrate a significant benefit with the use of low dose aspirin after 20 weeks for the prevention of pre-eclampsia and IUGR. However there was a trend in both CLASP study ¹ and EPREDA trial² which suggested that low dose aspirin may be more effective if commenced before 20 weeks of gestation. We have conducted this study to find out the predictive value of transvaginal Doppler in early pregnancy for the prediction of pre-eclampsia and subsequent delivery of a small for gestational age infant.

Methods

Hundred antenatal women at 12 to 16 weeks of singleton pregnancy were selected for the present study from April 2004 to December 2005, in the Department of Obstetrics and Gynaecology of SMS Medical College, Zenana Hospital, Jaipur. Women booking for antenatal care were interrogated, examined and investigated. After an informed consent, the woman was placed in the dorsal position with knee flexed, a transvaginal ultrasound scan was done to see fetal well-being, biometry and Doppler assessment of uterine circulation for uterine artery indices using Ecocee Toshiba USG machine with 6.5 Mhz transvaginal curvilinear transducer. After initial assessment, the cervix was identified. Uterine artery was first located on one side by placement of probe in that fornix and color flow mapping was done. The uteroplacental circulation is measured by various uterine artery Doppler indices i.e. Resistance Index (RI), Pulsatility index (PI) and S/D ratio (ratio of peak systolic to least diastolic flow). Increased resistance to flow in the uterine artery is associated with the appearance of diastolic notch and increase in all these indices. Same procedure was repeated on the opposite side. The whole procedure took about 8-10 min. These women were again rescanned at 24-26 weeks of gestation and further followed up clinically for development of pre-eclampsia and IUGR.

Normal mean, standard deviation and normal range (mean \pm 2 SD) of uterine artery indices were calculated at two intervals of screening with control group and values were used for determining the specificity and negative predictive value of the test. The mean and standard deviation value of subject and control group were compared to determine whether the difference in values was statistically significant. P values of < 0.05 were considered to be statistically significant. The sensitivity and positive predictive value at 12-16 weeks and 24-26 weeks were calculated from this group of patients with pre-eclampsia. Patient correlation was done with the early pregnancy uterine artery Doppler findings.

Results

Of the 100 women, 12 were lost to follow up so not included in study; 16 women developed pre-eclampsia (subject group) and 72 women did not (control group).

The mean of various uterine artery indices showing resistance is higher in the subject group than in control and this difference was statistically significant ($p < .05$) (Table 1), except for mean systolic velocity.

Bilateral (UA) diastolic notch was seen in 39.77% of the women at 12-16 weeks (Fig. 1, 2) and in 28.5% of women the notch persisted at 24-26 weeks of gestation (Fig. 3, 4). Pre-eclampsia developed in 31.42% of the women with B/L notch at 12-16 weeks and in 90% of the women with persistent B/L notch at 24-26 weeks of gestation (Table 2).

The maximum number (37.5%) of women (Table 3) who developed pre-eclampsia with B/L notches at 12-16 weeks had a mean RI of 0.60 and with unilateral notches (U/L) had a mean RI of 0.65 (18.75%).

Table 4 shows that 31.42% of the women with B/L notch at 12-16 weeks developed pre-eclampsia. Detection rate increased upto 56% when $RI \geq 0.65$ was also included in the abnormal uterine artery waveforms. Increase in specificity from 66.4% to 84.7% and sensitivity from 68.75% to 87.5% in prediction of pre-eclampsia at 12-16 weeks of gestation was also observed by including RI (Table 5).

This table shows that the mean of various uterine artery indices showing resistance in uteroplacental circulation is higher in subject group than control group and this difference is statistically significant. The relationship between the mean of systolic velocity of subject group v/s control group was statistically insignificant.

Table 2. Association of uterine artery diastolic notch with development of pre-eclampsia.

Notch at 12-16 week	Pre-eclampsia		Notch at 24-26 week	Pre-eclampsia			
	No.	%		No.	%		
Notch absent	13	-	Absent	68	1	1.40%	
Unilateral	40	5	12.5%	Unilateral	10	6	60%
Bilateral	35	11	31.42%	Bilateral	10	9	90%

Above table shows that pre-eclampsia developed in 31.42% of the women with bilateral uterine artery notch and in 12.5% women with unilateral notch at 12-16 weeks. While relating with persistence of notch at 24-26 weeks, pre-eclampsia developed in 90% of the women with bilateral and 60% of the women with unilateral notch.

Table 3. Association of uterine artery notch and RI at 12-16 weeks of gestation in case and control group.

RI	Unilateral Notch (n=40)		B/L Notch (n=35)	
	Case (n=5)	Control (n=35)	Case (n=11)	Control (n=24)
0.55	1(6.25%)	25(35%)	3(18.75%)	15(20.83%)
0.6	1(6.25%)	8(11.11%)	6(37.55%)	5(6.94%)
0.65	3(18.75%)	2(2.77%)	2(12.5%)	3(4.15%)
0.70	0(0%)	0(0%)	0(0%)	1(1.38%)

Above table shows that maximum number (37.5%) of women who developed pre-eclampsia with bilateral uterine notch had a mean RI of 0.60 and maximum number (18.75%) of the women who developed pre-eclampsia with unilateral notches had a mean RI of 0.65.

Table 4. Comparison of bilateral uterine artery notch and bilateral notch and/or RI > 0.65 at 12-16 weeks with development of pre-eclampsia.

Abnormal uterine artery waveform at 12-16 weeks	Number	Pre-eclampsia Percentage
Bilateral Notch (n=35)	11	31.42%
Bilateral Notch and/or RI = 0.65 (n=25)	14	56%

Above table shows 31.42% of women with bilateral notch at 12-16 weeks developed pre-eclampsia and detection rate increased upto 56% when RI = 0.65 was also included in the abnormal uterine artery waveforms.

RI 0.65 at 12-16 weeks (Upper limit of normal outcome women).

Table 5. Statistical analysis of B/L notch and/or RI = 0.65 at 12-16 weeks in prediction of pre-eclampsia.

	Sensitivity	Specificity	Positive predictive value	Negative predictive value
B/L Notch at 12-16 weeks	68.75%	66.6%	31.42%	90.5%
B/L Notch and/or RI \geq 0.65	87.5%	84.72%	56%	96.8%

Above table shows that along with bilateral notch the inclusion of RI \geq 0.65 in abnormal uterine artery waveform increases the specificity from 66.6% to 84.72%, positive predictive value from 31.42% to 56%, negative predictive value from 90.5% to 96.8% and sensitivity from 68.75% to 87.5%, in the prediction of pre-eclampsia at 12 to 16 weeks of gestation.

Discussion

Pre-eclampsia is a complex clinical syndrome involving multiple organ systems and still remains the principal cause of maternal and perinatal mortality and morbidity. The search for an ideal predictive test and preventive measure remains challenging.

In our study, the mean of all uterine artery indices showing impedance to uteroplacental circulation (S/D, PI and RI) except mean systolic velocity were significantly higher in patients with pre-eclampsia than in those without it. This also shows that resistance to blood flow is a more important indicator than the actual blood flow. Same findings were reported by Lakhkar BN⁵.

Pre-eclampsia developed in 31.42% of the women with B/L notch at 12-16 weeks in our study. Harrington K et al⁴ described pre-eclampsia in 15.16% of the women with B/L notch at 12-16 weeks of gestation.

Table No.3 shows that with B/L notches pre-eclampsia developed even at lower RI (18.75% at RI = 0.55) suggesting that only one parameter may not be a good marker for the identification of women at risk of developing pre-eclampsia. Similar results have been described by Harrington K et al⁶. In high risk women, persistent B/L notch with mean RI 0.55 and unilateral notch with mean RI 0.65 at 20 weeks gestation identified majority of the women who developed complications related to uteroplacental insufficiency.

The prediction of pre-eclampsia improved when along with B/L notch there was inclusion of RI in abnormal uterine artery waveform i.e. sensitivity increased from

68.75% to 87.5% and specificity 66.6% to 84.72%. Harrington KF et al³ described that with the use of diastolic notch as well as elevated RI, the high sensitivity of 76% at 20 weeks is retained at 24-26 weeks, while specificity increases from 86% to 97%.

It is obvious that uterine artery Doppler studies between 12-16 weeks might help us to divide our patients into low risk (normal outcome) and high risk (abnormal outcome) so that proper vigilance may be done in high risk women. But in a country like ours, use of this method for routine screening does not appear to be economically viable and practical. It can be of more use in certain high risk population like that with history of chronic hypertension, diabetes, PIH/preeclampsia, IUGR etc. In those women showing high resistance, low dose aspirin can improve the outcome if started early in pregnancy as noted in the CLASP study¹ and EPREDA trial².

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