ORIGINAL ARTICLE

Prediction of Preeclampsia by Midtrimester Uterine Artery Doppler Velocimetry in High-Risk and Low-Risk Women

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Abstract

Objective To observe the role of uterine artery Doppler flow velocimetry at midtrimester in prediction of preeclampsia.
Method 179 women carrying <16 weeks of pregnancy, with singleton fetus and without any fetal anomaly were recruited and were divided in high-risk and low-risk group. Doppler velocimetry of uterine artery was done at 24–26 weeks. Any notch in uterine artery, unilateral or bilateral, or RI > 0.6, was considered abnormal. Women were followed up and development of preeclampsia noted.
Result Sensitivity and specificity of abnormal uterine artery Doppler study for prediction of preeclampsia were 73.33 and 86.48 % in high-risk and 57.14 and 95.83 % in low-risk group, respectively. Relative risk with 95 % confidence interval was 5.427 (2.272–12.958) in high-risk and 13.65 (5.669–32.865) in low-risk women.
Conclusion Doppler velocimetry of uterine artery at 24 weeks can be used as a reliable screening test for prediction of preeclampsia in both high-risk and low-risk women.

Keywords Doppler velocimetry of uterine artery ·
Preeclampsia · Screening test ·
High-risk and low-risk women

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Introduction

Even in the era of modern obstetrics, preeclampsia remains as a major complication of pregnancy which can lead to significant incidences of maternal and neonatal mortality and morbidity. Despite advances in medical research, reliable screening test for prediction of this adverse complication is still lacking.

The fundamental cause of preeclampsia is thought to be the abnormal uteroplacental circulation resulting from the failure of second wave of trophoblastic invasion into spiral arterioles. This will result in increased resistance to flow within the uterine arteries and decreased placental perfusion. This concept has led to the idea of using Doppler assessment of uterine artery flow velocity waveform as a screening test for predicting preeclampsia. Persistence of high impedance to flow in the uterine arteries constitutes an indirect evidence of abnormal placentation.

The aim of this study is to observe whether uterine artery Doppler study at the second trimester can be used as a reliable screening test for prediction of preeclampsia in our high-risk (HR) and low-risk (LR) antenatal women.

Materials and Methods

This prospective study was done in our teaching Institute from August 1, 2007 to July 31, 2008 after Institutional Review Board approval. We recruited consecutive 200 unselected women attending antenatal OPD every Monday and carrying less than 16 weeks of pregnancy. Ultrasonography was done in each of them at 16–18 weeks to confirm the gestational age and to exclude any fetal anomaly. Inclusion criteria—a singleton intrauterine pregnancy with correct LMP. Exclusion criteria: (1) multiple pregnancies, and (2) any fetal anomaly. Informed consent was taken from antenatal mothers willing to participate, and thorough history taking and clinical examination were done. Based on the following risk factors, the women were categorized into two groups—HR and LR.

Criteria for inclusion in the HR group are the following (modified from Zimmermann et al.) [1]: H/o chronic hypertension, diabetes, renal disease; obesity (BMI > 30); age < 20 or >35 years (in primi); past bad obstetric history of—preeclampsia, IUGR, and IUFD; family h/o preeclampsia or IUGR in mother or sister.

At 24–26 weeks, a Doppler ultrasound (with 3.5 MHz curvilinear probe) of uterine artery velocity waveform was performed on a woman using an ultrasound machine (M/S Shimadzu India Ltd.). The woman was examined in a semi-recumbent position after 10 min of bed rest. Under real-time ultrasonography, uterine artery of each side was identified at the uterocervical junction where it appeared to cross the external iliac artery. Using color Doppler imaging, flow velocity waveforms of both uterine arteries were recorded. Persistence of an early diastolic notch, unilateral or bilateral in the main uterine artery, or elevated resistance index or RI > 0.6 [2], or both was considered as abnormal flow velocity waveform. An early diastolic notch was defined as a V-shaped deflection toward the baseline in early diastole. Resistance index $(RI) = $ systolic peak velocity $-$ diastolic peak velocity/systolic peak velocity or $(S - D)/S$.

Follow Up

All pregnant women were followed up carefully with special reference to blood pressure, weight gain, fundal height, and urinary protein analysis at each antenatal visit. Obstetric complications, the mode of delivery, and perinatal outcome were noted. Preeclampsia was considered when the blood pressure was 140/90 mm of Hg or more on at least two occasions—six hours apart, associated with proteinuria >0.3 gm/24 h.

Statistics

The performance of the screening test was evaluated by calculating the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) from 2×2 contingency table. Relative risk with 95 % confidence interval was also calculated from software by DJR Hutchon. Software was used for two-proportion z test and P value—Graph Pad Software (Quick Calcs).

Result and Analysis

This study was started with 200 women, from which 21 women were excluded (multiple pregnancies—2, fetal anomaly—1, 5 did not come for screening test, 5 delivered before 28 weeks, and in 8 women pregnancy outcome was not known). Therefore, 179 women were selected, who completed the study. These women were divided into HR and LR groups according to the risk factors already mentioned. 52 (29.05 %) and 127 (70.95 %) were in HR and LR groups, respectively. Table 1 shows the distribution of HR women according to the risk factors, and the association between various risk factors and development of preeclampsia.

Table 2 shows distribution according to age and gravidity in two groups. 12 (23.08 %) women of <20 years were put in HR group. The percentage of multigravida was more in HR than in LR group, as multi with past bad obstetric outcome attended the hospital more for better

Table 1 Distribution of high risk women according to risk factors and development of preeclampsia in each group

Risk factors	No. of women ($n = 52$)*	Preeclampsia (15)[†]
Age < 20	12	3 (25 %)
Age > 35 (primigravida)	6	3 (50 %)
Obesity BMI > 30	3	2 (66.66 %)
H/O chronic hypertension	3	2 (66.66 %)
H/O chronic renal disease	1	1 (100 %)
H/O diabetes	1	Nil
Past h/o preeclampsia, IUGR, IUFD	26	6 (23.08 %)
H/O smoking	2	Nil
H/O alcohol	Nil	Nil
Family h/o preeclampsia/IUGR	4	1 (25 %)

* Six women had more than one risk factor

[†] Three women developing preeclampsia had more than one risk factor

Table 2 Profile of women in high risk and low risk group

Characteristics	High risk ($n = 52$)	Low risk ($n = 127$)
Age in years		
<20	12 (23.08 %)	Nil
20–24	15 (28.84 %)	81 (63.77 %)
25–29	14 (26.92 %)	30 (23.62 %)
30–34	5 (9.62 %)	12 (9.44 %)
35 and above	6 (11.54 %)	4 (3.14 %)
Gravida		
Primigravida	24 (46.15 %)	87 (68.5 %)
Multigravida	28 (53.85 %)	40 (31.5 %)

Table 3 Pregnancy outcomes in high risk and low risk women

Complication	HR ($n = 52$)	LR ($n = 127$)	Z value (95 % CI)	P value
Preeclampsia	15 (28.85 %)	10 (7.87 %)	3.439	0.0006 HS
IUGR	19 (36.54 %)	15 (11.81 %)	3.62	0.0003 HS
Abruptio placentae	4 (7.69 %)	1 (0.79 %)	2.044	0.041 S
Stillborn	3 (5.77 %)	1 (0.79 %)	1.49	0.1362 NS
Early neonatal death	4 (7.69 %)	3 (2.36 %)	1.245	0.2131 NS

HS high significant, *S* significant, *NS* non significant

Table 4 Performance of uterine artery Doppler velocimetry in predicting preeclampsia

	Preeclampsia	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
High risk ($n = 52$)	15	73.33	86.48	68.74	88.88
Abnormal UAD (16)	11				
Normal UAD (36)	4				
Low risk ($n = 127$)	10	70	94.87	53.84	97.37
Abnormal UAD (13)	7				
Normal UAD (114)	3				

UAD uterine artery Doppler

Table 5 Relative risk (RR) of development of preeclampsia in abnormal uterine artery Doppler velocimetry

	RR with 95 % CI
High risk women	5.427; 2.272–12.958
Low risk women	13.65; 5.669–32.865

outcome. Mean Gestational ages in HR and LR groups were 35.4 ± 1.6 and 39.4 ± 2.1 weeks, respectively ($P = 0.2467$, not statistically significant), and mean birth weight in HR women was 2.25 ± 0.58 kg and that in LR women was 2.9 ± 0.9 kg ($P = 0.6560$, not statistically significant).

Pregnancy outcomes in both groups of women are shown in Table 3. In HR women, 15 (28.84 %) developed preeclampsia, whereas in LR group, 10 women (7.87 %) developed this complication ($P = 0.0006$). Other adverse outcomes such as IUGR and abruptio placentae were also significantly high in HR group.

Analysis of Screening Tests: In HR Women

Out of 52 HR women, 15 women developed preeclampsia. In this group, 16 women (30.76 %) showed abnormal uterine artery Doppler study, and out of whom 11 developed preeclampsia. In 36 women, with normal uterine artery Doppler study, preeclampsia was found in four women. Using 2×2 table, the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of abnormal uterine artery Doppler velocimetry become 73.33, 86.48, 68.75, and 88.88 %, respectively (Table 4). In this group, uterine notch was found in five women, and all of them developed preeclampsia. Relative risk of developing preeclampsia with abnormal Doppler study was 5.427 (95 % CI 2.272–12.958).

Low-Risk (LR) Women (127 Women)

In this group, 10 women developed preeclampsia. Uterine artery velocimetry showed increased RI (>0.6) in 13 women (10.24 %), and among them, seven developed preeclampsia. No notching was found in any of them. Therefore, the sensitivity, specificity, PPV, and NPV of abnormal uterine artery velocimetry become 70, 94.87, 53.84, and 97.37 %, respectively. in LR women (Table 5). Relative risk was 13.65 (95 % CI 5.669–32.865).

Discussion

In our study, 15 (28.84 %) of HR women and 10 (7.87 %) of LR women developed preeclampsia (Table 3). Therefore, in the HR group, there is a 3.7-fold increased risk of developing preeclampsia.

Performance of Screening Test

The application of uterine artery Doppler velocimetry is now being considered as a useful adjunct to screening programs for prediction of adverse pregnancy outcome.

In our study, an abnormal uterine artery flow velocity was associated with an increased relative risk of pre-eclampsia both in HR and LR women (Table 5). The sensitivity and specificity of uterine artery Doppler velocimetry were also found to be high in both groups (Table 4). Our result corresponds to the results of most of the other studies.

Konchak et al. [3] showed that an elevated uterine resistance index and a uterine artery notch both were associated with increased relative risk of preeclampsia. The sensitivity, specificity, PPV, and NPV of a uterine notch were found to be 83.3, 95.6, 55.6, and 98.9 %, respectively, in their study.

Coleman et al. [4] in their study of uterine artery Doppler screening in HR women showed the sensitivity and specificity of RI > 0.58 for preeclampsia to be 91 and 42 %, respectively. Among women with RI ≥ 0.7, 58 % developed preeclampsia.

Schwarze et al. [5] found that in LR pregnancies, the sensitivity of uterine artery notching for prediction of pre-eclampsia was 88 %. In our study, in LR group, the sensitivity and specificity of increased uterine artery RI for prediction of preeclampsia were 70 and 94.87 %, respectively.

Conclusion

Thus, in conclusion, we find that the study of mid trimester uterine artery Doppler velocimetry can be used as a reliable screening test for prediction of preeclampsia. In cases where the test proves be abnormal, increased surveillance and delivery in a well-equipped set up is necessary to reduce the maternal and fetal complications. However, this study was done in a small group of women, and so further study in a large cohort is necessary to validate the results of this study.

References

1. Zimmermann P, Eirio V, Koskinen J, et al. Doppler assessment of the uterine and uteroplacental circulation in the second trimester in pregnancies at high risk for pre-eclampsia and/intrauterine growth retardation: comparison and correlation between different Doppler parameters. Ultrasound Obstet Gynecol. 1997;9:330–8.
2. Chung JE, Cho JS, Han SS, et al. Uterine artery Doppler velocimetry in the prediction of adverse obstetric outcome in unexplained MSAFP elevation. Yonsei Med J. 2000;41:17–21.
3. Konchak PS, Bernstein IM, Capeless EL. Uterine artery Doppler velocimetry in the detection of adverse obstetric outcomes in women with unexplained elevated maternal serum alpha-fetoprotein levels. Am J Obstet Gynecol. 1995;173:1115–9.
4. Coleman MAG, Mc Cowan LME, North RA. Mid trimester uterine artery Doppler screening as a predictor of adverse pregnancy outcome in high risk women. Ultrasound Obstet Gynecol. 2000;15:7–12.
5. Schwarze A, Nelles I, Krapp M, et al. Doppler ultrasound of the uterine artery in the prediction of severe complications during low risk pregnancies. Arch Gynecol Obstet. 2005;271:46–52.