ORIGINAL ARTICLE

PREDICTIVE VALUE OF SCREENING UTERINE ARTERY DOPPLER ULTRASOUND FOR PRE-ECLAMPSIA IN HIGH RISK PREGNANCY

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PJR April - June 2016; 26(2): 81-85

ABSTRACT

BACKGROUND: Pre-eclampsia is a pregnancy specific heterogenous systemic disorder, affecting both the mother and the foetus. Pre-eclampsia and intrauterine growth restriction remain important causes of maternal and perinatal morbidity and mortality. Sonography is a worldwide method of choice for non-invasive examination of pregnancy. Doppler velocimetry is a suitable non-invasive method for evaluation of pathological haemodynamic changes in uteroplacental circulation. Abnormal uterine artery waveforms especially pulsatility index, alone or combined with notching, is the most predictive Doppler index. **OBJECTIVE:** To determine the positive predictive value of Screening Doppler ultrasound in the detection of pre-eclampsia during the first and second trimesters in high risk pregnancies by taking 24 hours proteinuria as the gold standard. **METHOD:** Total 350 patients of high risk group were examined at 11-14 weeks and 20-24 weeks of gestation. Color and pulse Doppler Ultrasound was performed trans-abdominally, serial longitudinal and transverse images were assessed on GE Voluson with a convex probe. Pulsatility index >1.1 was considered abnormal. Sensitivity, specificity, PPV, NPP, and diagnostic accuracy were calculated taking 24 hours proteinurea as gold standard. The data were analyzed using SPSS. **RESULTS:** Age distribution of the patients was done which shows majority of the patients between 20-45 years i.e. 33.43% (n=117); mean and SD was calculated as 28.98 (5.32 years, frequency of pre-eclampsia on 24 hours proteinuria (gold standard) was recorded in 8.29% (n=29), diagnostic accuracy of Doppler Ultrasound for the prediction of pre-eclampsia (taking 24 hours proteinuria as gold standard) revealed 7.14% (n=25) true positive, 1.71% (n=6) false positive, 90% (n=315) true negative and 1.14% (n=4) had false negative, while 86.21% sensitivity, 98.13% specificity, 80.65% positive predictive value, 98.75% negative predictive and diagnostic accuracy was recorded in 97.14% of the patients. **CONCLUSION:** The results of the study revealed a significantly higher positive productive value of Doppler ultrasound in the detection of pre-eclampsia during the first and second trimester in high risk pregnancy by taking 24 hours proteinuria as gold standard.

Keywords: Pre-eclampsia, diagnosis, Doppler ultrasound, 1st trimester, 2nd trimester, diagnostic accuracy

Introduction

Pre-eclampsia is one of the serious complications of pregnancy that is associated with high morbidity and mortality. Although the precise etiology of these conditions remains poorly understood, there is substantial evidence that failure of trophoblastic invasion of maternal spiral arteries is a common underlying cause.[1,3]

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Submitted 24 September 2015, Accepted 21 October 2015

The uteroplacental circulation can be assessed by Doppler ultrasonography of the uterine arteries. This technique has the potential value to identify pregnancies at risk for pre-eclampsia.[2,3] The blood vessel is identified with the use of colour Doppler, subsequently pulsed-wave Doppler is used to obtain waveforms. Resistance index, pulsatility index, presence or absence of an early diastolic notch in the waveform or absence/reverse diastolic waveform can be assessed and calculated for predicting the level of risk for pre-eclampsia.

Uterine artery Doppler assessment, for the prediction of pre-eclampsia is done in high-risk pregnancies.[4,5] The combination of uterine artery Doppler screening with maternal history improves the detection rate of pre-eclampsia requiring delivery before 34 weeks. As the women are referred for routine ultrasound pregnancy assessment, it is easy to perform Doppler study at the same time, which is non-invasive, takes an additional 2-5 minutes, does not entail extra cost and the technique is generally acceptable to the patients.[6,7] There might be apprehensions associated with being labeled as at-risk for pre-eclampsia; however the uterine artery Doppler assessment forms the basis of designing a plan for antenatal care of women.[8]

The usage of Doppler Ultrasound allows clinicians to make rational choices in directing the use and frequency of foetal and maternal monitoring resources and the possibility of low-dose aspirin therapy which is inexpensive and readily available, from which these women can benefit. Hence this technique is considered in routine antenatal care and expertise is developed for it to be implemented in routine obstetric ultrasound practices.[9]

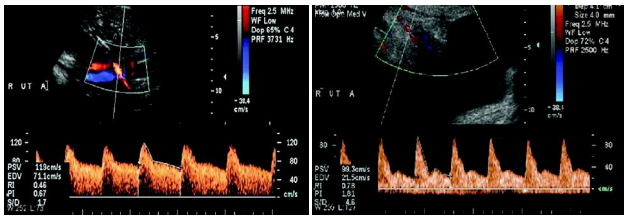

Figure 1: Normal resistance uterine artery waveform in the midtrimester (Left). Abnormal uterine artery vascular resistance, showing increased pulsatility and the presence of an early diastolic notch (Right).

Material and Methods

A cross sectional survey was done for a sample size of 350 patients. Patients were examined at 11-14 weeks and at 20-24 weeks of gestation which fulfilled the definition of high risk group that included the patients with first pregnancy, with history of chronic hypertension, family h/o pre-eclampsia in a sister or mother and with previous h/o pre-eclampsia. Proper antenatal record was maintained and followed uptill the delivery. Both color and pulse Doppler Ultrasound of the patients was performed on GE Voluson 730 PROv using 3.75 MHz convex probe abdominally, serial longitudinal and transverse images were assessed.

Doppler indices were obtained as pulsatility index, resistive index, Doppler waveform and diastolic notch. Results were tabulated using pulsatility index alone or combined with diastolic notch. Values of PI > 1.1 were considered abnormal. Diastolic notch is a normal phenomenon in the velocity waveform before the 25 weeks of gestation. Its persistence is considered abnormal after 25 weeks. The results were compiled and correlated taking 24 hour proteinuria as gold standard.

The statistical analysis was conducted on SPSS Windows package version 10. Quantitative variables like age and blood pressure were presented in the form of mean ± S.D.

Qualitative variables like Pre-eclampsia are presented in the form of frequency and percentages. PPV was calculated in the form of frequency and percentages of Doppler Ultrasound in the diagnosis of pre-eclampsia by taking 24 hours proteinuria as gold standard.

Results

A total of 350 patients fulfilling the inclusion/exclusion criteria were enrolled to determine the positive predictive value of Doppler Ultrasound in the detection of pre-eclampsia during the first and second trimester in high risk pregnancy by taking 24 hours proteinuria as gold standard.

Age distribution of the patients showed majority of patients between 20-25 years i.e. 33.43% (n=117), 28% (n=98) between 26-30 years, 23.14% (n=81) between 31-35 years, 14% (n=49) between 36-40 years and only 1.43% (n=5) between 41-45 years of age, mean and SD was calculated as 28.98 ± 5.32 years. (Tab. 1).

Frequency of pre-eclampsia on 24 hours proteinuria (gold standard) was recorded in 8.29% (n=29) while 91.71% (n=321) had no indication of pre-eclampsia (Tab. 2).

Diagnostic accuracy of Doppler Ultrasound by taking pulsatility index for the prediction of pre-eclampsia

revealed 7.14% (n=25) true positive, 1.71% (n=6) false positive, 90% (n=315) true negative and 1.14% (n=4) false negative, while 86.21% sensitivity, 98.13% specificity, 80.65% positive predictive value, 98.75% negative predictive and diagnostic accuracy was recorded in 97.14% of the patients (Tab. 3).

Age in years	No. of patients	Percentage
20-25	117	33.43
26-30	98	28
31-35	81	23.14
36-40	49	14
41-45	5	1.43
Total	**350**	**100**
Mean and SD	**28.98 ± 5.32**	

Table 1: Age distribution of patients (n=350)

Pre-eclampsia	No. of patients	Percentage
Yes	29	8.29
No	321	91.71
Total	**350**	**100**

Table 2: Frequency of pre-eclampsia on 24 hours proteinuria(gold standard) (n=350)

Doppler Ultrasound	Pre-eclampsia		Total
	Positive	Negative	
Positive	True positive (a) 25 (7.14%)	False positive (b) 6 (1.71%)	a + b 31 (8.85%)
Negative	False negative (c) 4 (1.14%)	True negative (d) 315 (90%)	c + d 319 (91.14%)
Total	**a + c 29 (8.29%)**	**b + d 321 (91.71%)**	**350 (100%)**

Sensitivity	= a / (a + c) x 100 = 86.21%
Specificity	= d / (d + b) x 100 = 98.13%
Positive predictive value	= a / (a + b) x 100 = 80.65%
Negative predictive value	= d / (d + c) x 100 = 98.75%
Accuracy rate	= a+d / (a+d+b+c) x 100 = 97.14%

Table 3: Diagnostic accuracy of doppler ultrasound in the detection of pre-eclampsiataking 24 hours proteinuria (gold standard) (n=350)

Discussion

Pre-eclampsia and intrauterine growth restriction remain important causes of maternal and perinatal morbidity and mortality. Maternal complications of pre-eclampsia include coagulopathy, renal and liver failure, and stroke. Adults who were affected by intrauterine growth restriction in utero are at increased risk for cardiovascular disease, hypertension and type 2 diabetes.[6] Abnormal Doppler indices and waveforms are a better predictor of pre-eclampsia than of intrauterine growth restriction. The pulsatility index, alone or combined with notching, is the most predictive Doppler index. These indices should be used in clinical practice. Future research should also concentrate on combining uterine artery Doppler Ultrasonography with other tests.[10]

The usage of Doppler ultrasound would allow clinicians to make rational choices in directing the use and frequency of fetal and maternal monitoring resources and the possibility of low-dose aspirin therapy which is inexpensive and readily available, from which these women can benefit.[11]

The results of the current study revealed that diagnostic accuracy of Doppler ultrasound for the prediction of pre-eclampsia 7.14% (n=25) true positive, 1.71% (n=6) false positive, 90% (n=315) true negative and 1.14% (n=4) had false negative, while 86.21% sensitivity, 98.13% specificity, 80.65% positive predictive value, 98.75% negative predictive and diagnostic accuracy was recorded in 97.14% of the patients.

Previous reviewers have reported that uterine artery Doppler Ultrasonography has limited accuracy in predicting pre-eclampsia and intrauterine growth restriction.[8-10] However, these reviews were restricted in terms of the thresholds and Doppler indices they reviewed or they reported independently pooled likelihood ratios, which is now discouraged.[11] Two reviews reporting on pre-eclampsia, intrauterine growth restriction and perinatal death were limited to articles retrieved through MEDLINE: one review[12] was based on a search of articles published before January 1997, and the other[13] included patients with unspecified risk in articles up to 2001. A third review,[14] on pre-eclampsia, has been criticized for its methodology.[15] A fourth review[16] concluded that Doppler assessment identified high-risk women in whom acetylsalicylic acid therapy resulted in a significant reduction in pre-eclampsia. Since these reviews were published, substantial new evidence has emerged allowing for more robust and specific inferences for clinical practice.

In 2008 a large systematic review was published wherein nearly 80,000 women were screened for pre-eclampsia and over 40,000 women were screened for Intrauterine Growth Retardation (IUGR) with the use of Doppler measurements.[17] In low risk women the overall risk for pre-eclampsia was best predicted by second trimester measurement: pulsatility index with presence of bilateral notching: high specificity 99% and moderate sensitivity of 23%. In high risk women, the overall risk for pre-eclampsia was best predicted by uterine artery (UA) pulsatility index and bilateral notching in the second trimester: specificity 99%, sensitivity 19%. Increased UA pulsatility index and bilateral notching was also the best predictor for severe and overall IUGR with specificity of 99% and 98% and sensitivity of 12% and 23% respectively; the results are in agreement with the results of the current study by showing a higher diagnostic accuracy.

Routine use of Doppler US screening seems considering the overall test characteristics with high false positive rates and the absence of adequate therapy not (yet) a useful option, however its high negative predictive values might identify a low risk population which can be excluded from increased surveillance.[18] This technique may therefore be considered in routine antenatal care and expertise should be developed for it to be implemented in routine obstetric ultrasound practices.

Conclusion

The results of the study revealed a significantly higher positive predictive value of Doppler Ultrasound in the detection of pre-eclampsia during the first and second trimester in high risk pregnancy by taking 24 hours proteinuria as gold standard.

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