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Original Research Article

Prediction of preeclampsia by uterine artery Doppler velocimetry between 16-28 weeks

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ABSTRACT

Background: Prediction of preeclampsia by uterine artery Doppler velocimetry helps in reducing perinatal, maternal mortality and morbidity by individualizing treatment methods and prophylactic measures to prevent preeclampsia.

Methods: A study of 100 singleton pregnancies was conducted in a tertiary care centre and the study population was subjected to uterine artery Doppler study at 16 to 28 weeks, uterine artery pulsatility index, resistance index and persistence of diastolic notch was obtained and the outcome of preeclampsia was studied.

Results: Out of 100 women, when uterine artery notching at 16-28 weeks alone was considered, 46.15% of women developed preeclampsia and detection rate increased upto 87.51% when $RI > 0.65$ was also included along with uterine artery diastolic notching.

Conclusions: This study concludes that uterine artery Doppler, being non-invasive can be included during routine sonography to identify patients at risk of developing preeclampsia.

Keywords: Preeclampsia, Screening, Ultrasound, Uterine artery Doppler, Uterine artery notching

INTRODUCTION

Preeclampsia and fetal growth restriction are important causes of maternal and perinatal morbidity and mortality.^{1,2} According to national centre for health statistics in 2023, preeclampsia was identified in 2.7 million/year or 10.3% of all pregnancies that ended in live births. As per WHO, 19% of maternal deaths are due to hypertension. Hypertension in pregnancy is also responsible for fetal (more than 19 weeks of gestation) and infant mortality as well as 46% of infants born as small for gestation.³ In this context there is a definitive need for early and universal screening. To avoid serious sequelae, early screening for preeclampsia is essential for vigilant antenatal surveillance and appropriate timing of delivery.

Preeclampsia is characterised by an imbalance between prostacyclin and thromboxane A2 production as well as

failure of the second wave trophoblastic invasion of the endometrio-myometrial vasculature.⁴ The result is abnormal uteroplacental blood flow and this leads to the idea of using Doppler assessment of uterine artery velocimetry waveforms as a method of screening for this antenatal complication.⁵

Various biochemical tests used for preeclampsia screening in high-risk population have lower positive predictive values and are expensive with poor patient compliance. Doppler is a non-invasive method for evaluation of fetoplacental circulation without any disturbance to human pregnancy.⁶ A high resistance index, pulsatility index and persistent uterine artery notching in uterine artery Doppler wave form has been shown as the best screening test. Thus, we have conducted this study to find out the predictive value of uterine artery Doppler in early pregnancy at 16-28 weeks of gestation for the prediction of preeclampsia and subsequent perinatal outcome.

METHODS

An observational study was conducted over a period of one year among 100 singleton pregnant women attending the out-patient department for antenatal care at Theni Government Medical College and Hospital, during the period of June 2022 to May 2023.

Inclusion and exclusion criteria

Singleton pregnancies with gestational age between 16-28 weeks and high-risk pregnancies like hypertension, diabetes mellitus, renal disease, thyroid disease, obesity or any other medical complication, previous history of pre-eclampsia, family history of pre-eclampsia, bad obstetric history were included in the study. Multiple pregnancy, confirmed case of preeclampsia, molar pregnancy and congenital anomalies of fetus were excluded.

After obtaining informed written consent from the pregnant women, preliminary data was collected regarding gestational age and high-risk factors. At 16-28 weeks of gestation, a Doppler ultrasound of uterine artery waveform was performed. At the uterocervical junction where it appears to cross the external iliac artery, both side uterine arteries were identified and RI, mean PI, presence or absence of early diastolic notch were recorded. All pregnant women under study were followed up regularly and her blood pressure, weight gain, fundal height was measured, urinary protein analysis and ultrasound was done at each antenatal visit. Preeclampsia was considered if her blood pressure was 140/90 or more with proteinuria >0.3 gm/24 hours.

Statistical analysis was done using descriptive statistical methods like mean, percentages and proportions. Chi-square test was used to find the association between two attributes and unpaired t-test was used to find the association between two variables. P value <0.05 was considered to be significant.

RESULTS

In this study, 52% of women were in the age group 21-30 years (Table 1) and 54% were primigravida. About 27% of women developed preeclampsia. At 16-28 weeks, 39% of women had B/L uterine artery notching (Table 2). In preeclamptic women, mean RI was 0.57 and mean PI was 0.89 at 16-28 weeks (Table 3). When uterine artery notching at 16-28 weeks alone was considered, 46.15% of women developed preeclampsia (Table 4). Detection rate increased up to 87.51% when RI>0.65 was also included along with uterine artery diastolic notching (Table 5). Uterine artery notching alone at 16-28 weeks gestation had 64.29% sensitivity, 84.62% specificity, 54.55% PPV and 70.51% NPV. Both notch and RI>0.65 when considered together, sensitivity was increased to 85.71%, specificity was 84.62%, PPV was 37.5% and NPV was 98.25% (Table 6).

Table 1: Age distribution.

Age in years	High risk	Low risk
Less than 20	19	24
21-30	29	26
More than 30	2	0
Total	50	50

Table 2: Uterine artery notching at 16-28 weeks.

Notching at 16-28 weeks	High risk	Low risk
Present	23	16
Absent	27	34
Total	50	50

Table 3: Mean Doppler indices.

Doppler indices	Min.	Max.	Mean±SD
RI (high risk)	0.50	0.68	0.574±0.0371
PI (high risk)	0.82	1.08	0.896±0.0625
RI (low risk)	0.42	0.66	0.4728±0.06264
PI (low risk)	0.57	1.06	0.6478±0.13898

Table 4: Uterine artery notching and preeclampsia.

	Notch at 16-28 weeks		Preeclampsia	
	Present	Absent	Present	Absent
High risk	23	27	12	5
Low risk	16	34	6	4
Total	39	61	18	9
p value	0.001 significant			

Table 5: Association of uterine artery notching and RI in preeclampsia.

RI at 16-28week	Uterine artery notching (n=39)			
	Preeclamptic women (n=18)		Non preeclamptic women (n=21)	
	n	%	n	%
0.50-0.55	3	16.67	6	28.57
0.56-0.60	3	16.67	15	71.43
0.61-0.65	5	27.78	0	0.00
0.66-0.70	7	38.89	0	0.00
Total	18	100.00	21	100.00

Table 6: Comparison of notch only and notch with RI in prediction of preeclampsia.

Indicator	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Notch only	64.29	84.62	54.55	70.51
Notch + RI	85.71	84.62	37.5	98.21

Table 7: Preeclampsia and IUGR.

Preeclampsia	IUGR (number of cases)	Significant
Yes (27)	4	
No (73)	0	
P value	0.004	

Mean gestation age at delivery was 38+1 weeks, 65% had full term vaginal delivery, 16% had preterm vaginal delivery and 19% had cesarean delivery. About 16 babies were delivered preterm, mean birth weight was 2.5 kg, mean Apgar at 1 minute was 7 and at 5 minute was 8. In preeclamptic women 4 babies were associated with IUGR, IUFD in 1 woman (Table 7). Mean duration of ICU stay was 2 days.

Table 8: Pulsatility index and preeclampsia.

Pulsatility index		
Pulsatility indices	In preeclamptic women (n=27)	In non-preeclamptic women (n=73)
Gestational age 16-28 weeks	Mean±SD	Mean±SD
High risk	0.957±0.0854	0.873±0.0287
Low risk	0.826±0.063	0.724±0.032

P value <0.001 significant

DISCUSSION

Uterine artery flow velocity waveforms recorded in an early pregnancy has diastolic notch which represents increased impedance to blood flow during early diastole in normal pregnancy. The early diastolic notch persists until approximately 16 weeks of gestation during which second wave of trophoblastic invasion would have completed resulting in vessels of minimal resistance, no elastic property and vigorous diastolic flow.

Impedance to blood flow in the uterine artery may increase in pregnancy complicated by hypertension as shown by Fleschier et al, when uterine artery S/D ratio was more than 2.6 during third trimester, the birth weight at delivery was lower than normal.⁷ Impaired uterine artery flow velocity can be identified by persistent abnormal index, persistent notch and significant difference between the indices in the two vessels. Campbell et al first showed that compared to pregnancies with normal uterine artery waveforms, pregnancies with abnormal uterine artery Doppler waveforms were associated with more proteinuric hypertension, required more anti-hypertensive therapy and also resulted in lower birth weights in younger gestational ages at birth.⁸ Thus, the capability of this potentially safe non-invasive prospective means of analyzing uterine artery blood flow

during pregnancy was realized and set-off a wave of interest and research over the ensuing years.

In our observational study done over a period of one year, 100 women attending antenatal OPD for antenatal care at Government Theni Medical College and Hospital were analysed for uterine artery Doppler changes at 16-28 weeks of gestation using ultrasound. They were followed up till delivery and details of pregnancy events, delivery and neonatal outcomes were noted. Uterine artery Doppler assessment for presence of diastolic notch, RI and PI values at 16-28 weeks were studied.

Out of the 100 women studied, 27% women developed preeclampsia thus prevalence is similar to Gupta et al (20%) and high prevalence compared to that quoted by Bewley et al in 1991 (4.6%) and Irion et al in 1998 (4%).^{9,10} Among 100 women, 39% had notching at 16-28 weeks which is more as compared to Harrington et al described preeclampsia in 15.16% of the women with bilateral notching.¹¹ In our study, in 27% of preeclampsia women, mean RI at 16-28 weeks is 0.574 which is statistically significant as compared to non-preeclamptic group (p<0.0001) and hence this will help in the prediction of preeclampsia when combined with uterine notching similar to Gupta et al where mean RI in 37.5% was 0.60.⁹

Table 9: Comparison of our study with previous studies for preeclampsia with uterine artery Doppler.

Author	Outcome	Indicator	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Gupta et al ⁵	Preeclampsia	Notch + RI>95 th	68.7	66.6	31.43	90.5
Bewley et al ⁹	Preeclampsia	RI>95 th	24	95	20	96
Irion et al ¹⁰	Preeclampsia	SD>90 th + notch	26	88	7	
Bower et al ¹³	Preeclampsia	RI>95 th ± notch	7.5	86	12	99
North et al ¹⁴	Preeclampsia	RI>95 th	27	89	8	97
Chan et al ¹⁵	Preeclampsia	RI>95 th	22	97	36	94
Kurdi et al ¹⁶	Preeclampsia	RI>95 th	62	89	11	99
Our study	Preeclampsia	Notch only	64.29	84.62	54.55	70.51
Our study	Preeclampsia	Notch + RI	85.71	84.62	37.5	98.21

When uterine artery notch at 16-28 weeks alone is considered, 46.15% of women developed preeclampsia. Detection rate increased up to 87.51% when RI>0.65 was also included along with uterine artery Doppler diastolic notching. Hence prediction of preeclampsia has increased when bilateral uterine artery notching is combined with RI of uterine artery Doppler which is similarly described by Gupta et al.⁹

Mean PI in our study was 0.89 at 16-28 weeks. In preeclampsia mean PI at 16-28 weeks was 0.9573 which was statistically significant ($p<0.0001$) as compared to non-preeclamptic women (Table 8). Hence this will help in prediction of preeclampsia when combined with uterine artery notching similar to Gomez et al.¹² The sensitivity of bilateral uterine artery notching was 64.29%, specificity was 84.62% positive predictive value was 54.55% and negative predictive value was 70.51% in prediction of preeclampsia similar to Gupta et al (Table 9).⁹

The study was conducted in a single locality and the sample size may not represent the entire population. Only Doppler waveform changes were considered and other biochemical tests were not included in the study.

CONCLUSION

Early prediction of preeclampsia is vital in the prevention of its development and its associated complications. Uterine artery Doppler diastolic notching along with RI>95th centile at 16-28 weeks of gestation has shown higher sensitivity in prediction of preeclampsia. Uterine artery Doppler being noninvasive can be used in routine ultrasonography to identify the patients with risk of developing preeclampsia.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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