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Original Research Article

The role of first trimester uterine artery pulsatility index as a predictor of hypertensive disorders of pregnancy in the department of obstetrics and gynaecology, Sawai Man Singh Medical College, Jaipur

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ABSTRACT

Background: This study was conducted to assess the relationship between mean uterine artery pulsatility index at 11+0 to 13+6 weeks and the development of hypertensive disorders of pregnancy.
Methods: This prospective study was carried out on 320 pregnant women. In all subjects mean uterine artery PI was calculated at 11+0 to 13+6 weeks and association of value of uterine artery PI and development of hypertensive disorder of pregnancy were compared by receiver operative curve analysis.
Results: The ROC curve analysis shows that at the cut-off value of 1.62, overall sensitivity, specificity, positive predictive value, and negative predictive value of PI for prediction of hypertensive disorder of pregnancy in our study was 82.1% (95% CI- 63.1-93.9%), 57.4% (95% CI- 51.5-63.2%), 15.7% (95% CI- 13.1-18.9%) and 97.1% (95% CI- 93.7-98.7%) respectively. When we evaluate 11+0 to 13+6 weeks UtA PI value with hypertensive disorders of pregnancy and early-onset hypertensive disorders of pregnancy by AUC curve, we found that the area under curve was 0.73 (95% CI 0.64-0.81) and 0.78 (95% CI 0.69-0.86) respectively.
Conclusions: Uterine artery pulsatility index at 11+0 to 13+6 weeks is significantly higher in women who develop hypertensive disorder in pregnancy. Our study also shows that 11±0 to13±6 weeks uterine artery pulsatility index was a more significant predictor of early onset pre-eclampsia. It is a simple, non-invasive, reliable test which can be performed as an adjunct to routine ultrasound examination to predict hypertensive disorders.

Keywords: Hypertensive disorders, Pre-eclampsia, Pulsatility index, Uterine artery

INTRODUCTION

Hypertensive disorders represent the second most common cause of maternal death, affecting 5-10% of pregnancies worldwide.[1] The primary concern about elevated blood pressure relates to harmful effect on both mother and fetus. Maternal complications include pulmonary edema, cerebrovascular accidents, abruption, acute left ventricular failure, acute renal failure, etc. Fetal complications include intrauterine death, IUGR, prematurity, asphyxia.

The current American College of Obstetricians and Gynecologists (ACOG) classified HTN during pregnancy into 4 categories: 1) preeclampsia-eclampsia; 2) chronic HTN; 3) chronic HTN with superimposed preeclampsia; and 4) gestational HTN.[2]

Implantation and trophoblastic invasion of the placenta plays a crucial role in its development as an organ for the transport of nutrients and oxygen to the fetus.

Placental remodelling occurs in two stages. In the first stage, between 8- and 12-weeks' gestation, trophoblastic cells invade the intradecidual portion of the spiral arteries. This is followed by a deeper trophoblastic invasion into the myometrial segments of the spiral arteries from 14 weeks' gestation. The loss of smooth muscle and elasticity from the spiral arteries converts the uteroplacental circulation into a low resistance, high capacitance system.[3,4] Placental remodelling is completed by 16-18 weeks' gestation. Although the first stage proceeds normally, the second stage of invasion (myometrial segment) does not occur in preeclampsia.

The key to prevention is prediction so the early prediction of HDP before the 2nd wave give us an opportunity to start low dose aspirin for prevention.

Direct assessment of trophoblastic invasion is not possible so uterine artery (UtA) Doppler is a validated non-invasive method to find out this trophoblastic invasion and placental perfusion.[5,6]

In a clinical setting, reference ranges for UtA Doppler ultrasound during pregnancy are recommended and used for the appropriate analysis of impedance to blood flow. In this regard, the pulsatility index (PI) has been advocated as the best Doppler index in several studies.[7]

In this study, we have identified the high-risk group in 11+0 to 13+6 weeks by this screening test so that we will identify a cohort of the patient who will benefit most from increased surveillance during pregnancy and preventive treatment.[8]

METHODS

This prospective study was conducted on 320 pregnant women with singleton viable pregnancy between 11+0 to 13+6 weeks of gestation attending ANC clinic in the Department of Obstetrics and Gynaecology, SMS Medical College and associated Hospitals, Jaipur, from May 2019 to May 2020 for determining the association of uterine artery PI and development of hypertensive disorders of pregnancy. Approval of the Local Ethics Committee was obtained before beginning this study.

Pregnant women not giving written and informed consent, BMI>30 kg/m², on treatment of hypertension disorders, risk factor for vascular disorders (pregestational diabetes mellitus, immune diseases, renal diseases) and with fetal abnormalities were excluded from study.

Pregnant women were informed about the study, and their consent were obtained. The detailed medical history of the cases was received. Crown-rump length (CRL), UtA PI, and nuchal translucency (NT) were measured in viable pregnancy by the transabdominal ultrasound. Routine investigations CBC, RBS, HIV, HBsAg, VDRL, serum TSH, urine complete and microscopy were done. For UtA pulsatility index measurement by Doppler ultrasound, the sagittal cross-section of the uterus was taken, and cervical canal and internal cervical os were defined. Both uterine arteries were defined by using colour mapping while the transducer was directed from one side to another side of the cervix at the internal os level. Pulsed wave Doppler was carried as insonation angle being below 50°, and sampling interval including entire vessel by 2 mm. Mean left and right UtA PI values were calculated. Hypertensive disorder of pregnancy is defined by the current American college of obstetricians and gyanecologist classification. Early preeclampsia and late preeclampsia were defined as the preeclampsia developing before and after 34 weeks of gestation, respectively.

Pregnant women were carefully monitored till delivery for the development of hypertensive disorder of pregnancy. Pregnant women were divided as: group A- pregnant women who did not develop hypertensive disorder of pregnancy, group B- pregnant women who developed hypertensive disorder of pregnancy. The value of uterine artery PI (11+0 to 13+6 weeks) was compared between these two groups.

Statistical analysis

Continuous variables were summarised as mean and standard deviation whereas nominal/categorical variables as proportion. Unpaired t-test and other appropriate parametric test were used for continuous variables while chi-square test and Fisher-Exact test was used for nominal/ categorical test. P value <0.05 was considered significant. Medcalc 16.4 version software was used for all statistical calculations.

RESULTS

A total of 320 women with singleton viable pregnancy were included in this study. The study subjects were divided into two groups- group A (292) who did not develop HDP and group B (28) who developed HDP. Pregnant women in both groups were similar in demographic features. Mean uterine artery PI in group A was 1.57±0.49 while in group B, mean PI was 1.96±0.45 which was significantly higher than group A (Table 1). The minimum PI value in group A was 0.45 and in group B was 1.23. The ROC curve analysis shows that at the cut-off value of 1.62, overall sensitivity, specificity, positive predictive value, and negative predictive value of PI for prediction of hypertensive disorder of pregnancy in our study was 82.1% (95% CI- 63.1-93.9%), 57.4% (95% CI - 51.5-63.2%), 15.7% (95% CI- 13.1-18.9%) and 97.1% (95% CI- 93.7-98.7%) respectively (Table 2).

Table 1: Comparison of uterine Doppler parameter between group A and group B.

	Group A (n=292)	Group B (n=28)	P value
Mean PI	1.57±0.49	1.96±0.45	<0.01
Minimum-maximum	0.45-2.8	1.23-2.80	

Table 2: Sensitivity, specificity, positive predictive value, and negative predictive value of pulsatility index to differentiate hypertensive disorders of pregnancy from group A.

	Value
Cut off value	1.62
AUC (95% CI)	0.73 (0.64-0.81)
Std. error	0.04
Sensitivity (%) (95% CI)	82.1 (63.1-93.9)
Specificity (%) (95% CI)	57.4 (51.5-63.2)
Positive predictive value (%) (95% CI)	15.7 (13.1-18.9)
Negative predictive value (%) (95% CI)	97.1 (93.7-98.7)
LR +ve (95% CI)	1.93 (1.55-2.4)
Accuracy	59.6 (54.0-65.1)

In our study, out of 28 study subjects, 42.9% (12) developed early-onset and 57.11% (16) developed a late-onset hypertensive disorder of pregnancy (Table 3). In group B pregnant women with PI<1.62, 20% developed early-onset and 80% developed late-onset hypertensive disorder of pregnancy and pregnant women with PI>1.62, 47.8% developed early-onset and 52.1% developed late-onset hypertensive disorder of pregnancy (Table 4).

Table 3: Onset of hypertensive disorder of pregnancy in group B.

The onset of hypertensive disorder during pregnancy	No.	%
Early-onset (<34 weeks)	12	42.9
Late-onset (>34 weeks)	16	57.l1

Table 4: Association of PI with early and late-onset hypertensive disorder of pregnancy.

PI	Early-onset hypertensive disorder of pregnancy		Late-onset hypertensive disorder of pregnancy		Total (n=28)	
	No.	%	No.	%	No.	%
<1.62	1	20.0	4	80.0	5	17.9
>1.62	11	47.8	12	52.1	23	82.1

When we evaluated 11+0 to 13+6 weeks UtA PI value with hypertensive disorders of pregnancy and early-onset hypertensive disorders of pregnancy by AUC curve, we found that the area under curve was 0.73 (95% CI 0.64-0.81) and 0.78 (95% CI 0.69-0.86) respectively (Table 5). So, we conclude that 11+0 to 13+6 weeks UtA PI is a better predictor for early onset HDP.

Table 5: Comparison of sensitivity, specificity, positive predictive value and negative predictive value of pulsatility index between hypertensive disorders of pregnancy and early onset hypertensive disorders of pregnancy.

	Hypertensive disorders of pregnancy	Early onset hypertensive disorders of pregnancy
Cut off value	1.62	1.62
AUC (95% CI)	0.73 (0.64-0.81)	0.78(0.69-0.86)
STD error	0.04	0.04
Sensitivity (%) (95% CI)	82.1 (63.1-93.9)	83.3 (51.6-97.9)
Specificity (%) (95% CI)	57.4 (51.5-63.2)	55.4 (49.6-61.1)
Positive predictive value (%) (95% CI)	15.7 (13.1-18.9)	6.9 (5.3-8.9)
Negative predictive value (%) (95% CI)	97.1 (93.7-98.7)	98.8 (95.9-99.7)
LR +ve (95% CI)	1.93 (1.55-2.4)	1.87 (1.41-2.48)
Accuracy	59.6 (54.0-65.1)	56.5 (50.8-62)

DISCUSSION

In this study, our findings showed that first trimester UtA PI value in cases with HDP were significantly higher than the cases without HDP. In our study mean uterine artery PI in group A was 1.57±0.49 while in group B mean PI was 1.96±0.45 similar to study by Narang et al, the mean PI of the women who developed preeclampsia and related complications was 1.94±0.55 and that of women who did not develop complications was 1.42±0.44.[9]

UtA PI threshold value in our study for prediction of hypertensive disorder of pregnancy was 1.62. At cut-off value of 1.62, we found that the area under curve was 0.73 overall sensitivity, specificity, positive predictive value and negative predictive value of PI to diagnose pregnancy induced hypertension in our study was 82.1% (95% CI-63.1-93.9%), 57.4% (95% CI- 51.5-63.2%), 15.7% (95% CI- 13.1-18.9%) and 97.1% (95% CI- 93.7-98.7%) respectively, similar to study by Narang et al. [9] The AUC (area under curve) of the mean PI ROC was 0.787 (95%

CI =0.675-0.900) for a cut off of 1.7. The sensitivity of mean PI at 11-14 weeks of pregnancy for predicting complications was 75.9% and specificity was 79.6%. Erdogdu et al studied that in predicting preeclampsia, the sensitivity, positive predictive value, and negative prediction value of UtA PI at 2.56 threshold value for 5% false positivity were found as 45.5%, 50%, and 94.4%, respectively.[11]

In our study, out of 28 study subjects, 42.9% developed early-onset and 57.11% developed a late-onset hypertensive disorder of pregnancy. In similar study Sharma et al shows that out of 57 patients 25 developed early-onset and 32 developed late-onset.

When we evaluate 11+0 to 13+6 weeks UtA PI value with hypertensive disorders of pregnancy and early-onset hypertensive disorders of pregnancy by AUC curve, we found that the area under curve was 0.73 (95% CI 0.64-0.81) and 0.78 (95% CI 0.69-0.86) respectively. So, we concluded that 11+0 to 13+6 weeks UtA PI is a better predictor for early onset HDP.

Plasencia et al studied that, the area under the influence of ROC curve for the performance of first trimester UtA PI in preeclampsia screening was found as 0.677 and 0.895, respectively for PE and early-onset preeclampsia. Similar to our study, it was reported that UtA PI analysis was more significant in the early-onset PE screening.[12] Napolitano et al studied that receiver-operating characteristics (ROC) curve analysis for prediction of preeclampsia and early preeclampsia for UtA PI, the area under curve was 0.556 and 0.78, respectively.

CONCLUSION

Uterine artery pulsatility index at 11+0 to 13+6 weeks is significantly higher in women who develop hypertensive disorder in pregnancy. Our study also shows that 11+0 to 13+6 weeks uterine artery pulsatility index is a more significant predictor of early onset pre-eclampsia. It is a simple, non-invasive, reliable test which can be performed as an adjunct to routine ultrasound examination to predict hypertensive disorders.

As its positive predictive value is low hence our data don't support its use as a sole predictor test so it can be combined with other predictors for improving accuracy. High negative predictive value of this screening test may be used to identify a low-risk group in terms of perinatal complications.

However, we need more studies on larger population to validate the finding of our study.

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

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