



FIRST TRIMESTER UTERINE ARTERY DOPPLER ANALYSIS IN PREDICTION OF PRE-ECLAMPSIA FOR EARLY DETECTION AND TREATMENT OF PIH

Urology

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ABSTRACT

Introduction: Uterine artery Doppler waveform analysis predicts pregnancy complications associated with uteroplacental insufficiency before the onset of clinical features. Faulty trophoblastic invasion of the spiral arteries results in diminished placental perfusion and upstream increased uterine artery resistance, this results in an increased PI or RI and an early diastolic notch [1]. Trophoblast invasion is maximal in the first trimester which justifies the evaluation of uterine artery Doppler findings in the first trimester of pregnancy [2] and thus helps in preventing maternal and perinatal morbidity and mortality. **Study Design:** The study was conducted in 100 antenatal women from Gynae OPD, presenting for a routine prenatal ultrasound examination at 11 – 14 weeks for 6 months considering inclusion and exclusion criteria. **Results:** Overall mean PI among the stud subjects was 1.81 ± 1.85 , on Right Uterine Artery it was 1.77 ± 1.88 and on Left Uterine Artery it was 1.84 ± 1.82 . There were 28 subjects (28%) with abnormal PI i.e., ≥ 1.5 and remaining 72 (72%) had normal PI (< 1.5). **Conclusion:** According to the results of the current study, uterine artery colour doppler is a useful and non-invasive method for predicting preeclampsia at term in healthy pregnancies. It can be used to check for the presence of a diastolic notch and assess the PI value at 11–14 weeks of gestation.

KEYWORDS

PI, RI, ANC, S, D, ROC, ACOG, LSCS, FGR

INTRODUCTION

Pre-eclampsia is known to be a leading cause of maternal and perinatal morbidity and mortality and is thought to be primarily the result of impaired placentation. Routine ANC focuses on identifying women at risk for careful monitoring and appropriate intervention. [3] Therefore, identifying high-risk factors early in pregnancy can help reduce maternal and perinatal mortality.

Pre-eclampsia is characterized by abnormal placenta formation [4], which results in inadequate uteroplacental blood flow. This has led to the idea of using Doppler ultrasonography providing a non-invasive method for screening to assess the velocity of uterine artery blood flow as part of routine investigation [5]. Persistence of a diastolic notch (beyond 24 weeks' gestation) or abnormal flow velocity ratios have been associated with inadequate trophoblast invasion [6].

In normal pregnancy, the feto-placental circulation acts as a low resistance system unit. Thus, blood velocity waveforms in umbilical artery shows continuous forward flow throughout the cardiac cycle. But impaired placental perfusion, which is one of the hallmarks of preeclampsia, can be assessed by measuring flow waveform ratios or by detecting diastolic notching of uterine and umbilical vessels. Overall, first-trimester doppler interrogation of the uterine artery performs better in the prediction of early-onset than late-onset preeclampsia [7].

Uterine artery Doppler waveform analysis has the potential to predict pregnancy complications associated with uteroplacental insufficiency before the onset of clinical features. Resistance to blood flow within the uteroplacental circulation is transmitted upstream to the uterine arteries. Faulty trophoblastic invasion of the spiral arteries results in diminished placental perfusion and upstream increased uterine artery resistance, this results in an increased pulsatility index (PI) or resistance index (RI) and an early diastolic notch [8].

Doppler examination of the uterine arteries especially in first-trimester is a non-invasive tool that can be used to indirectly assess trophoblast development and uteroplacental perfusion [9-10]. Several studies have been performed to assess the validity of second-trimester uterine artery Doppler examination as a screening tool for pre-eclampsia [11-12]. However, the observation that trophoblast invasion is maximal in the first trimester and that pre-eclampsia derives from a relative failure of this event, justifies the evaluation of uterine artery Doppler findings in the first trimester of pregnancy [13] and thus helps in preventing maternal and perinatal morbidity and mortality.

Study Design

The study was conducted in 100 antenatal women from Gynae OPD, presenting for a routine prenatal ultrasound examination at 11 – 14 weeks for 6 months considering inclusion and exclusion criteria.

Inclusion Criteria

1. Singleton pregnancy
2. All pregnancies with correct LMP who were sure of dates
3. Pregnancy 11- 14 weeks
4. Patients who gave informed written consent

Exclusion Criteria

1. Pregnancy < 11 weeks
2. Pregnancy > 14 weeks
3. Any Congenital anomaly
4. Chronic inflammatory disease
5. Multiple pregnancies
6. Fetal abnormalities
7. Patients who did not give consent

The study will be initiated after obtaining ethical clearance from the institutional ethical committee and after taking written informed consent from the patient.

Demographic and clinical risk factors were observed: - maternal age, address, socio-economic status, occupation, religion, gestational age, LMP EDD, parity index G P L A, Chief complaints. Detailed history was taken.

General Examination was done and values were noted. Breast examination and per abdomen examination was done – inspection, palpation and fundal grips were done. Investigation like Haemoglobin, Blood group, Random Blood sugar, Urine routine microscopy, viral markers were sent.

Transabdominal Doppler Ultrasound scan was done at 11 to 14 weeks. Ultrasonography was performed using a ECube alpinion 8 machine. Uterine artery is identified using color Doppler, then quantitative and qualitative evaluation is performed by pulsed Doppler.

Pulsed wave doppler will be used to obtain uterine artery flow waveforms and the mean pulsatility index (PI) of the uterine arteries will be calculated.

The basic parameter monitored in our study will be the pulsatility index = peak systolic velocity - end diastolic velocity/mean (PI = S-D/Mean) and the presence of bilateral notch in the uterine artery. For PI interpretation, we will use the normative reference curves by age (first

trimester 95th percentile value = 2.71). A binary logit model is used to assess whether Doppler changes (PI > 95th percentile or bilateral notch) in the first are correlated with the probability of development of preeclampsia. A t test is used for the study of the statistical significance of coefficients. A variable is considered to be statistically significant if the value of $p < 0.05$. The predictive power of the functions used is assessed by the ROC (Receiver Operating Characteristics)

Abnormal uterine artery Doppler appearance is defined as the presence of bilateral notch and/or a PI ≥ 1.5 . The patient was followed up till delivery and the outcome was noted. Every case was followed up in the antenatal clinic for the development of complication such as pre-eclampsia according to ACOG criteria.

OBSERVATION AND RESULTS

Table 1: Risk factors among the study subjects

Factors	N=100	%
History of Diabetes	6	6.00
History of Renal or Cardiac Disease	1	1.00
History of Chronic Hypertension	5	5.00
Previous Pre-eclampsia	3	3.00
BMI>30kg/m2	14	14.00
Extremes of Maternal Age	38	38.00
Age <20	6	6.00
Age >35	32	32.00
Family History of Pre-eclampsia	4	4.00

Table 1 depicts the risk factors among the study subjects. BMI>30kg/m² was present in 14% subjects. Extremes of maternal age i.e., either very less or more age subjects were 38 (38%), of them 6 females (6%) were <20 years of age and 32 were >35 years of age.

Table 2: Comparison of mode of delivery among the study subjects according to PI

Mode of delivery	PI				Chi square	P value
	≥1.5		<1.5			
	N=28	%	N=72	%		
Vaginal delivery	17	60.71	67	93.06	15.6894	0.00075
CS	11	39.29	5	6.94		

Among 28 subjects with pulsatility index (PI) ≥ 1.5 , 17 (60.71%) had vaginal delivery and 11(39.29%) had C section. Out of 72 females with PI <1.5, 67 (93.06%) had vaginal delivery and 5 (6.94%) had C section. The p value was significant. (Table 2)

Table 3: Mean PI and PI distribution among the 100 subjects

PI	Mean	SD
Right Uterine Artery	1.77	1.88
Left Uterine Artery	1.84	1.82
Total	1.81	1.85
PI	N	%
≥ 1.5 (Abnormal)	28	28.00
<1.5 (Normal)	72	72.00

Overall mean PI among the study subjects was 1.81 ± 1.85 , on Right Uterine Artery it was 1.77 ± 1.88 and on Left Uterine Artery it was 1.84 ± 1.82 . There were 28 subjects (28%) with abnormal PI i.e., ≥ 1.5 and remaining 72 (72%) had normal PI (<1.5). (Table 3).

Table 4: Uterine Artery Doppler Spectral Waveform Analysis

Dependent variable	Number
Notching in 1st trimester	N=100
Yes	24
No	76

Out of the 100 subjects involved in study, notching was present in 1st trimester in 24 subjects, and in remaining 76 it was not present. (Table 4)

Table 5: Adverse pregnancy outcomes among the study subjects according to PI

Adverse Pregnancy Outcomes	PI				Chi Square	p value
	≥1.5		<1.5			
	N=28	%	N=72	%		
Yes	15	53.57	18	25	7.4433	<0.01*
No	13	46.43	54	75		

*: statistically significant

Table 5 depicts Adverse pregnancy outcomes among the study subjects according to PI. Among 28 subjects with PI ≥ 1.5 , Adverse pregnancy outcomes was present in 15 females (53.57%) and in remaining 13 subjects (46.43%) it was not present. In 72 subjects with PI <1.5, Adverse pregnancy outcomes was present in 18 subjects (25%) and in remaining 54 women (75%) it was absent. There was a statistically significant difference between the two ($p < 0.01$).

Table 6: Comparison of adverse pregnancy outcomes among the study subjects according to PI

Adverse Pregnancy Outcomes	PI					P value
	≥1.5		<1.5			
	N=28	%	N=72	%		
Gestational hypertension	3	10.71	1	1.39	5.49	0.024
Preeclampsia	4	14.29	2	2.78	6.11	0.022
Eclampsia	1	3.57	0	0.00	0.92	0.67
Oligohydramnios	5	17.86	1	1.39	0.76	<0.01*
Placental abruption	1	3.57	0	0.00	0.92	0.67
Fetal growth restriction	8	28.57	5	6.94	14.32	<0.01*
Stillbirth	1	3.57	1	1.39	0.76	0.81
Mortality	1	3.57	0	0.92	0.92	0.67

Among 28 subjects with PI ≥ 1.5 , Gestational hypertension was present in 3 females (10.71%), Preeclampsia in 4 women (14.29%), one subjects (3.57%) each had Eclampsia and Stillbirth; 8 (28.57%) had FGR and 5 (17.86%) had Oligohydramnios stillbirth and mortality in one subject each. In 72 subjects with PI <1.5, one subject (1.39%) each had Gestational hypertension, Oligohydramnios and Stillbirth; 2 females (2.78%) had Preeclampsia; and Fetal growth restriction (FGR) was present in 5 subjects (6.94).

DISCUSSION

Mode Of Delivery According To Pulsatility Index

Among 28 subjects with pulsatility index (PI) ≥ 1.5 , 17 (60.71%) had a vaginal delivery and 11(39.29%) had C section. Out of 72 females with PI <1.5, 67 (93.06%) had a vaginal delivery and 5 (6.94%) had C section. The p value was significant. According to results of Jayson JA et al ^[14], (2021), there was no statistical significance in the mode of delivery; 47.1% vaginal delivery, 2.9% instrumental delivery and 50% LSCS.

Adverse Pregnancy Outcomes Of Maternal Morbidity And Perinatal Morbidity

Gestational hypertension was present in 4 females (4%), eclampsia in 2 (2.00%) women and oligohydramnios was present in 6 subjects (6%). Among 6 subjects with Pre-eclampsia, 2 had mild Pre-eclampsia and 4 had severe Pre-eclampsia. FGR was present in 13 subjects, and stillbirth was in 2 subjects. Among 28 subjects with PI ≥ 1.5 , Gestational hypertension was present in 3 females (10.71%), Preeclampsia in 4 women (14.29%), one subjects (3.57%) each had Eclampsia and Stillbirth; 8 (28.57%) had FGR and 5 (17.86%) had Oligohydramnios, Placental abruption in one subject. In 72 subjects with PI <1.5, one subject (1.39%) each had Gestational hypertension, Oligohydramnios and Stillbirth; 2 females (2.78%) had Preeclampsia; and FGR was present in 5 subjects (6.94). None of the patients had eclampsia, placental abruption and mortality. There was statistically significant difference ($p < 0.01$) in Gestational hypertension, Preeclampsia, Oligohydramnios and FGR when two groups were compared.

Jayson JA et al ^[14] (2021), observed that 13.2 % developed gestational hypertension, 10.29 % developed PE, 1.47 % developed eclampsia, and 22.05 % developed oligohydramnios. FGR was seen in 42.64 %, placental abruption in 4.41% and stillbirth in 5.88 %. The number of antenatal women who developed pregnancy complications and adverse outcomes in the second trimester of pregnancy was 33.8%.

Uterine Artery Doppler Spectral Waveform Analysis

Out of the 100 subjects involved in the study, notching was present in 1st trimester in 24 subjects, and in the remaining 76 it was not present.

CONCLUSION

According to the results of the current study, uterine artery colour

doppler is a useful and non-invasive method for predicting preeclampsia at term in healthy pregnancies. It can be used to check for the presence of a diastolic notch and assess the PI value at 11–14 weeks of gestation. In pregnancies without any additional risk factors, the presence of a diastolic notch and a PI value of ≥ 1.5 during 11–14 weeks of gestation serve as a reliable indicator of preeclampsia at term. Therefore, around 11 to 14 weeks of pregnancy, all high-risk pregnancies should be checked with a uterine artery doppler to detect instances that could develop preeclampsia and to implement early measures to prevent and lessen the severity of the condition.

By allowing for the early detection and close monitoring of women with at-risk pregnancies, can help in early accurate assessment of preeclampsia risk, which in turn would significantly save antenatal care expenditures and enhance the management of hypertension illnesses in later life and decreasing maternal and neonatal morbidity and mortality.

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