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Original Research Article

FIRST TRIMESTER AND MID TRIMESTER UTERINE ARTERY DOPPLER SONOGRAPHY IN PREDICTING PREECLAMPSIA IN A TERTIARY CARE HOSPITAL IN RURAL INDIA

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Abstract

Background: Hypertensive disorders complicate 5 to 10% of all pregnancies and it forms one member of the deadly triad along with haemorrhage and infection, which contribute greatly to maternal morbidity and mortality. **Materials and Methods:** This prospective longitudinal study aimed at evaluating the potential of first and mid trimester uterine artery Doppler ultrasonography for the early prediction of pre-eclampsia was conducted in the Department of Radiodiagnosis, Mata Gujri Memorial Medical College, Kishanganj from 1st September 2022 to 30th April 2024 .120 pregnant women with risk factors for PE were included in the study. The potential of Pulsatility index and diastolic notch were assessed as a tool for preeclampsia screening. **Result:** Increased pulsatility index with notching in second trimester predicted overall preeclampsia in high risk and low risk patients. **Conclusion:** The results showed that abnormal uterine artery Doppler has a good predictive value in predicting women who developed preeclampsia, more so in the high risk group and that pulsatility index is a better Doppler index in the prediction of preeclampsia. This was in accordance to various other studies.

INTRODUCTION

Hypertensive disorders in pregnancy vary from mildly elevated blood pressure to severe hypertension with multi organ dysfunction. Of these disorders the preeclampsia syndrome, either alone or superimposed on chronic hypertension and its associated maternal mortality is the most dangerous and it accounts for 16% and is preventable.[1] The incidence of preeclampsia varies between 8-10% of all pregnancies. This is responsible for 29,000 maternal deaths per year worldwide.[2] Intensive maternal and fetal monitoring in such high risk patients would lead to an earlier diagnosis of the clinical signs of the disease and the associated fetal growth restriction and avoid the development of serious complications such as placental abruption, eclampsia, intrauterine death.

Uterine Doppler provides a non-invasive assessment of uteroplacental circulation, by comparing systolic and diastolic waveforms, as a direct assessment of trophoblast invasion, which is not normally discernable. In the non-pregnant state uterine artery Doppler shows low peak flow velocity and early diastolic notch. At 18 to 20 weeks, there is high flow with no diastolic notch. Impaired uterine artery flow is considered when there are high resistance uteroplacental waveforms and the presence of diastolic notch which is the manifestation of arterial vessel tone and represents elasticity of the vessel and vasospasm. It disappears in the second trimester. A high resistance pattern is associated with higher rate of pregnancy complication with a 70% chance of developing proteinuric hypertension. Varying sensitivities are obtained depending on the type of Doppler used, the sampling site, the definition of abnormal uterine artery resistance, gestational age of assessment and different end points. This study helps to evaluate the usefulness of first and mid trimester uterine artery Doppler study in both high risk and low risk women in prediction of pre-eclampsia.

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MATERIALS AND METHODS

This is a prospective clinical study that was conducted in the department of Radiodiagnosis at Mata Gujri Memorial Medical College and Lions Seva Kendra, Kishanganj, Bihar, India, between first of September 2022 and thirtieth of April 2024.One hundred twenty (120) patients were included in this study.

Written informed consent was obtained from the patients when they came for the antenatal check-up. Real time B –mode ultrasonography was carried out on a gray scale imaging unit (GE Healthcare Voluson S10 Ultrasound system having colour Doppler facility.

The uterine artery originates from the internal iliac artery and meets the uterus just above the cervix. Uterine artery was examined with the probe kept 3 cm medial to anterior superior iliac spine and directed towards the lateral wall of the uterus. The crossover of the uterine artery and the external iliac artery was identified and the sample site was chosen. Waveforms were recorded from both uterine arteries.

Inclusion Criteria
• All pregnant women attending antenatal checkup in MGM medical college between 11 - <13wks + 6 days and 20-26 weeks, were included in this study.

Exclusion Criteria
• Missed abortion cases.
• Patients not consenting
• Patients of Chronic Hypertension

Impaired uterine artery flow was considered in the following
• Persistent diastolic notch upto second trimester- unilateral or bilateral in the main uterine artery.
• Elevated mean PI > 95th centile- The 95th percentile of the mean Uterine artery PI based on the 95th percentile- Choorakuttil & Nirmalan, 2022[3] reference for each gestational week was used to determine abnormal Uterine artery PI (>95th percentile) at each gestational week of interest.
• Both of the above.

All pregnant women under study were carefully followed up regularly and the blood pressure, weight gain, fundal height was measured and urinary protein analysis was done at each antenatal visit. The patient was followed up till delivery and the outcome was noted with respect to the gestational age at delivery, birth weight and the perinatal events.

Ideally as gestation increases the pulsatility index decreases.

RESULTS

The maximum no. of cases was found in the age group 18-29 years and minimum in more than 40 years of age.

The mean systolic and diastolic blood pressure (mean±SD) in the third trimester of pregnancy was 132.5±12.8 mmHg and 88.7±10.52 mmHg respectively.
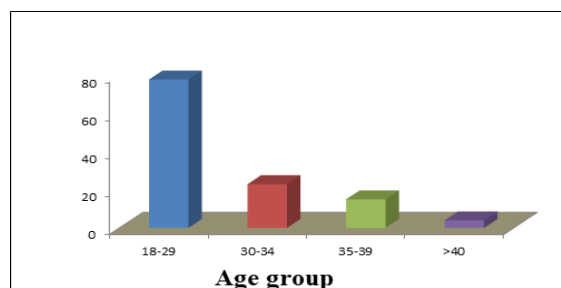

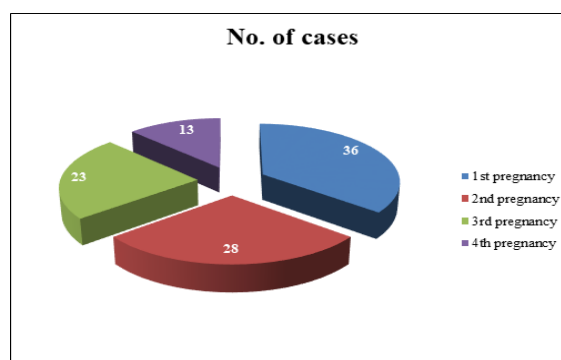**Figure 1: Age distribution of cases**

Figure 2: Parity distribution of cases

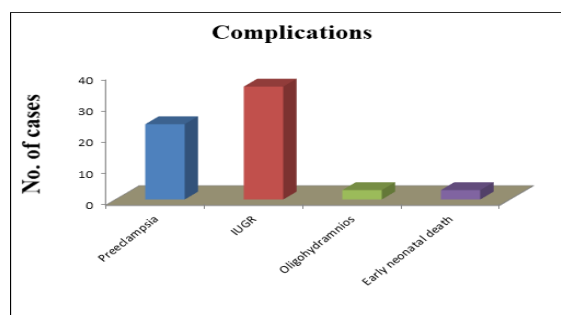Majority of patients were primigravida.

Figure: 3. Complications in the study group

77% of the population delivered at term and 75% of the population delivered babies weighing more than 2500g. 20% patients developed pre-eclampsia, and 2 patients who developed pre-eclampsia had an IUFD.

Table 1: Association between various risk factors and development of preeclampsia.

Risk factors	No. of women(29)	Preeclampsia
Age <20	7	2(28%)
Age>35	4	1(25%)
h/o diabetes	1	0
h/o chronic hypertension	4	2(50%)

h/o chronic renal disease	1	0
Past h/o pre-eclampsia, IUGR, IUFD	12	5(42%)

Among the 29 high risk patients 12 developed pregnancy induced hypertension, out of which Gestational hypertension was seen in 4 (33%) and Preeclampsia was seen in 8 patients(67%).

Table 2: Complications in the study group (N=120)

Complications	No. of cases	Percentage
Preeclampsia	24	20%
IUGR	36	30%
Oligohydramnios	3	2.5%
Early neonatal death	3	2.5%

Table 3: Mean pulsatility index (Pl) for each trimester

Variable	Mean	Range
First Trimester	±1.5	0.8-2.3
Second Trimester	±1.06	0.6-1.6

Table 4: Pregnancy outcome

Outcome	Cases
Gestational age at delivery	
<37 weeks	28(23%)
>37 weeks	92(77%)
Birth weight	
<2500g	30(25%)
>2500g	90(75%)
Developed Preeclampsia	24(20%)
Intrauterine fetal death	2(1.6%)

Table 5: In the first trimester screening in 42 patients who had PI> 95th centile, 10 patients developed preeclampsia and 32 patients had no preeclampsia.

Test	Present	N0	Absent	N0	Total
Positive	True Positive	a=10	False Positive	c=32	a + c = 42
Negative	False Negative	b=12	True Negative	d=66	b + d = 78
Total		a + b = 22		c + d = 98	120
Results					
Statistic		**Value**		**95% CI**	
Sensitivity		45.45%		24.39% to 67.79%	
Specificity		67.35%		57.12% to 76.48%	
Positive Likelihood Ratio		1.39		0.81 to 2.39	
Negative Likelihood Ratio		0.81		0.54 to 1.22	
Disease prevalence (*)		18.33%		11.86% to 26.43%	
Positive Predictive Value (*)		23.81%		15.42% to 34.88%	
Negative Predictive Value (*)		84.62%		78.57% to 89.19%	
Accuracy (*)		63.33%		54.05% to 71.94%	

The sensitivity was 45.45%, Specificity was 67.35% and Accuracy was 63.33%.

Table 6: In the second trimester screening in 36 patients who had PI> 95th centile, 10 patients developed preeclampsia and 26 patients had no preeclampsia.

Test	Present	No	Absent	No	Total
Positive	True Positive	a=10	False Positive	c=26	a + c = 36
Negative	False Negative	b=13	True Negative	d=71	b + d = 84
Total		a + b = 23		c + d = 97	120
Results					
Statistic		**Value**		**95% CI**	
Sensitivity		43.48%		23.19% to 65.51%	
Specificity		73.20%		63.24% to 81.68%	
Positive Likelihood Ratio		1.62		0.92 to 2.87	
Negative Likelihood Ratio		0.77		0.53 to 1.13	
Disease prevalence (*)		19.17%		12.56% to 27.36%	
Positive Predictive Value (*)		27.78%		17.86% to 40.49%	
Negative Predictive Value (*)		84.52%		78.91% to 88.85%	
Accuracy (*)		67.52%		58.35% to 75.77%	

The sensitivity was 43.48%, Specificity was 73.20% and Accuracy was 67.52%.

Table 7: In the first trimester screening 35(29%) patients had diastolic notching on Doppler study.

Test	Present	No	Absent	No	Total
Positive	True Positive	a=14	False Positive	c=21	a + c = 35
Negative	False Negative	b=10	True Negative	d=75	b + d = 85
Total		a + b = 24		c + d = 96	120
Results					
Statistic	**Value**		**95% CI**		
Sensitivity	58.33%		36.64% to 77.89%		
Specificity	78.12%		68.53% to 85.92%		
Positive Likelihood Ratio	2.67		1.61 to 4.43		
Negative Likelihood Ratio	0.53		0.33 to 0.87		
Disease prevalence (*)	20.00%		13.25% to 28.28%		
Positive Predictive Value (*)	40.00%		28.65% to 52.54%		
Negative Predictive Value (*)	88.24%		82.20% to 92.41%		
Accuracy (*)	74.17%		65.38% to 81.72%		

The sensitivity was 58.33%, Specificity was 78.12% and Accuracy was 74.17%.

Table 8: In the second trimester screening 28(23%) patients had diastolic notching on Doppler study.

Test	Present	n	Absent	n	Total
Positive	True Positive	a = 19	False Positive	c = 9	a + c = 28
Negative	False Negative	b = 5	True Negative	d = 87	b + d = 92
Total		a + b = 24		c + d = 96	120
Results					
Statistic		**Value**	**95% CI**		
Sensitivity		79.17%	57.85% to 92.87%		
Specificity		90.62%	82.97% to 95.62%		
Positive Likelihood Ratio		8.44	4.39 to 16.26		
Negative Likelihood Ratio		0.23	0.11 to 0.50		
Disease prevalence (*)		20.00%	13.25% to 28.28%		
Positive Predictive Value (*)		67.86%	52.31% to 80.25%		
Negative Predictive Value (*)		94.57%	88.83% to 97.44%		
Accuracy (*)		88.33%	81.20% to 93.47%		

The sensitivity was 79.17%, Specificity was 90.62% and Accuracy was 88.33%.

DISCUSSION

Preeclampsia is a multiorgan disorder leading to maternal-fetal morbidity and mortality across the globe. IUGR and other fetal complications are caused by diminished uteroplacental blood flow as a sequence of improper trophoblastic infiltration of the placental vascular bed. Apart from its most dreaded complication of progressing into eclampsia, preeclampsia by itself can result in substantial perinatal and maternal morbidity. In addition, women with preeclampsia deliver infants with lower APGAR scores than those of healthy women. Currently, the implementation of low-dose aspirin, before 16 weeks of gestation, has reduced the incidence of early-onset preeclampsia, by more than 60%. Therefore, screening for preeclampsia and preventive treatment are likely to be effective for the mother and infant.

Early screening for pre-eclampsia by uterine artery doppler has been formulated based on the concept that the pathogenic mechanisms of pre-eclampsia can be modified if prophylactic therapies are initiated early in pregnancy.[4]

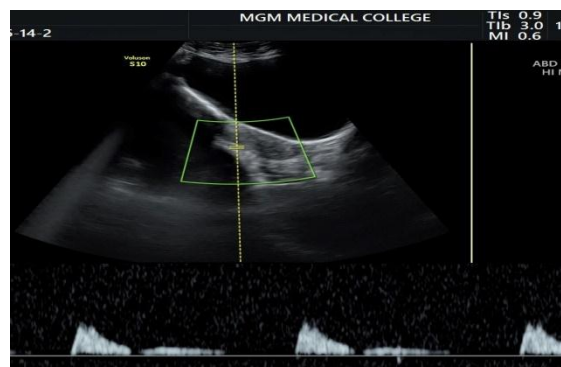Uterine artery Doppler wave forms in our study

Figure 4: Non pregnant patient-There is rapid rise and fall in uterine artery flow velocity during systole and a 'notch' in the descending waveform in early diastole.
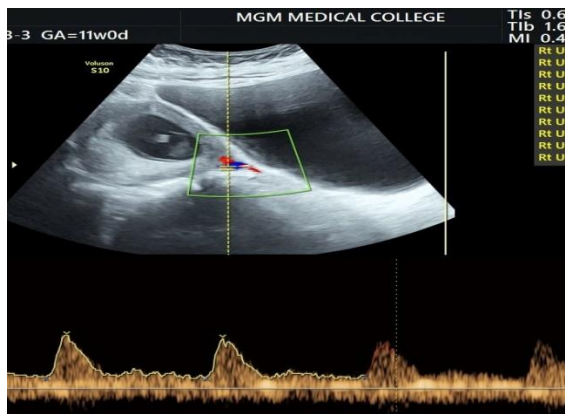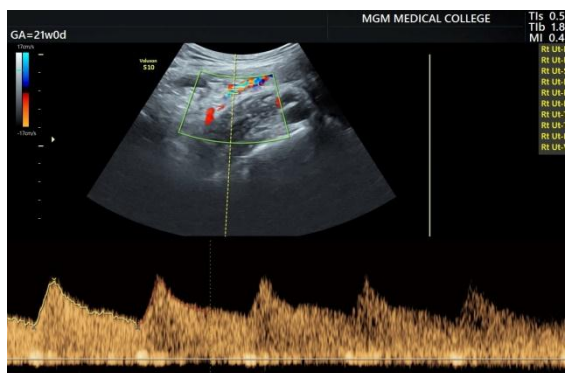
Figure 5: First trimester.
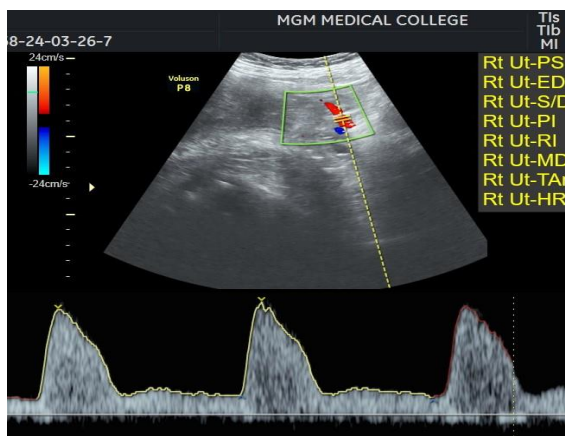

Figure 6: Second trimester

Figure 7: Abnormal uterine artery Doppler wave form demonstrating high resistance

An abnormal uterine artery wave is characterized by a high resistance waveform and or an early diastolic notch.

Preeclampsia is more common in extremes of age group. Pregnant women below 20 years and above 35 years are at an increased risk, and in the latter group preeclampsia superimposed on chronic hypertension is seen. In our study majority (89%) of the patients who developed preeclampsia were between the ages of 18 and 34 years. Data suggests that the risk of pre-eclampsia increases by 30% for every additional year over the age of 34. In our study age, therefore, did not play a role as a risk factor for preeclampsia.

15 (62%) patients out of the 24 who developed preeclampsia were primigravida, thus indicating that gravidity is a strong predisposing factor for the disease which is corroborating with the study done by Duckitt K.[5]

Table 9: Uterine artery Doppler Indices (50th centile-current Study)

Current study	50th centile
1st trimester (Pl)	1.4
2ndtrimester (Pl)	1.06

The mean values in this study were similar to the values obtained by Cavoretto et al,[6] and Choorakuttil & Nirmalan, 2022. It is seen that the mean Pl values decreased as gestation increased as is to be expected in a normal pregnancy.

The mean systolic blood pressure in the in the third trimester of pregnancy was 132.5±12.8 mmHg. The diastolic blood pressure (mean±SD) was 88.7±10.52 mmHg. The raised blood pressure in preeclampsia is due to release of placental anti angiogenic factors and other factors which causes maternal endothelial cell activation/ endothelial dysfunction.

The mean ±standard deviation of birth weight was 2.522±0.655kg. In our study since more number of high risk patients had abnormal uterine artery doppler and subsequently intrauterine growth restriction, the birth weight had a statistically significant p value.

77% of the population delivered at term, and 75% of the population delivered babies weighing more than 2500g. 20% patients developed pre-eclampsia, and 2 patients who developed pre-eclampsia had an IUFD at twenty eight weeks gestation.

In our study when the predictive value of pulsatility index in 1st trimester was evaluated, the sensitivity and specificity were 45.45 % and 67.35 % respectively in the 1st trimester which was similar to the studies by Coleman et al,[7] and Caforio et al.[8] Dascau et al,[9] conducted Uterine Artery Doppler in pregnant women during 11- 13+6 days of gestation the mean PI was 1.63 which are comparable to present study where PI was 1.4.

In 2nd trimester, the sensitivity and specificity for the uterine artery pulsatility index were 43.48% and 73.20% respectively which was similar to studies by Papageorghiou et al.[10] The present study has the positive and negative predictive value similar to studies by Ratanasiri et al.[11]

In 1st trimester, the sensitivity and specificity for the uterine artery diastolic notch were 58.33 and 78.12 % as the abnormal Doppler study criteria which was lower to the study by Cnossens et al.[12] The positive and negative likelihood ratio of the present study were 2.67 and 0.53.

In 2nd trimester, the sensitivity and specificity for the uterine artery diastolic notch were 79.17 and 90.62% as the abnormal Doppler study criteria which was higher to the study by Cnossens et al. The positive and negative likelihood ratio of the present study were 8.44 and 0.23.

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The findings of our study thus concur with the findings by Mcleod,[13] who states that the presence of an early diastolic notch is associated with adverse pregnancy outcomes.

In the current study 16 out of the 24 patients who developed pre-eclampsia had abnormal Doppler waveforms which were evident from as early as the first trimester. The findings of our study are corroborating the findings by Mcleod, who states that the presence of an early diastolic notch is associated with adverse pregnancy outcomes. Our study also supports the findings of Kurdi,[14] who found that women with notching are at an increased risk of developing complications. Screening with uterine artery doppler helps in reducing operative delivery for fetal distress, NICU admission rates which is corroborating with the study done by Masihi et al.[15] The study thus demonstrated that an abnormal uterine artery waveform with early diastolic notching could predict 66% of cases that developed Preeclampsia from as early as the 1st trimester.

CONCLUSION

Hypertensive disorders of pregnancy are on the rise in India, and they contribute to maternal and perinatal morbidity and mortality in a significant manner. From this study, we emphasize the need of using uterine artery doppler monitoring to predict preeclampsia thereby preventing the maternal and fetal morbidity and mortality associated with it.

The potential advantage of earlier screening is that prophylactic intervention can be more undertaken. Low dose aspirin administration is effective when started in the first trimester, before the secondary wave of trophoblast invasion has begun. Mid trimester uterine artery Doppler velocimetry can be used as a reliable screening test for prediction of preeclampsia especially in the high risk group and it helps to reduce maternal and fetal complications by elective delivery. As this is a study done in a small population, the usefulness of the uterine artery doppler study has to be evaluated using a large cohort.

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