Role of Second Trimester Uterine Artery Doppler in Predicting Pre-Eclampsia and Fetal Growth Restriction

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Abstract:

Hypertensive disorders of pregnancy (HDP) significantly contribute to maternal and perinatal morbidity and mortality, especially in developing countries. This paper examines the effectiveness of second trimester uterine artery Doppler in predicting pre-eclampsia and fetal growth restriction (FGR). Doppler ultrasounds performed at 20-24 weeks measured parameters like peak systolic velocity (PSV), end-diastolic velocity (EDV), pulsatility index (PI), and resistive index (RI), along with early diastolic notching. Results showed that increased impedance to uterine artery flow (PI > 1.45 or RI > 0.58) and early diastolic notching are significant predictors of pre-eclampsia and FGR, with negative predictive values of 91% and 90%, respectively, and sensitivities of 85% for pre-eclampsia and 71% for FGR. This paper highlights the importance of early detection and intervention in high-risk pregnancies and provides a comprehensive summary of methodologies, findings, and future research directions to aid fellow researchers in this field.

Keywords: Hypertensive Disorders of Pregnancy (HDP), Pre-eclampsia, Fetal Growth Restriction (FGR), Uterine Artery Doppler, Second Trimester Screening, Doppler Ultrasound Parameters, Pulsatility Index (PI), Resistive Index (RI), Early Diastolic Notching.

Introduction

Hypertension disorders of pregnancy (HDP) are a leading cause of maternal morbidity and mortality, especially in developing countries. Impaired placentation is a key factor. The second-trimester uterine artery Doppler study is a promising screening tool for predicting HDP and fetal growth restriction (FGR) [1][2].

The most accepted theory for HDP is "placental vascular disease." During pregnancy, spiral arteries transform to accommodate increased blood flow to the fetus and placenta [3]. This process, starting in the first trimester and completing by the early second trimester, involves significant changes in the arteries' structure and function. Doppler studies are typically conducted between 20-24 weeks, after this transformation. Failure in this transformation leads to increased vascular resistance, impacting placental blood supply. Uterine artery Doppler studies can detect these issues by measuring parameters like pulsatility index (PI) and resistive index (RI). High PI or RI and the presence of early diastolic notching are indicators of potential complications [4][5]. In developing countries, FGR is a critical problem that arises later in pregnancy, although its origins are in the first trimester [6]. Early Doppler studies showing high resistance and diastolic notching can predict FGR in the second trimester. Second-trimester uterine artery Doppler studies are effective in predicting severe cases of HDP and FGR, as they provide accurate assessment while maintaining low false-positive rates. This study aims to screen high-risk pregnant women at 20 weeks gestation using Doppler to determine the mean PI, RI, and presence of diastolic notching at 20-24 weeks, correlating these findings with adverse outcomes.

Methods

This prospective observational study was conducted at the Andhra Medical College, King George Hospital, Visakhapatnam, from September 2022 to August 2023. It included 100 pregnant women who were followed from recruitment to delivery.

Study Details

Design: Prospective observational study

Setting: Andhra Medical College, King George Hospital, Visakhapatnam

Sample Size: 100

Duration: 1 year (September 2022 - August 2023)

Inclusion Criteria

- Informed written consent
- Age 18-40 years
- Both primigravida and multigravida
- History of preeclampsia, abruption, small for gestational age, stillbirth, or bad obstetric history
- Multifetal gestation
- Chronic systemic diseases
- Family history of hypertension
- Elevated BMI

Exclusion Criteria

- Lack of consent
- Anomalous fetus
- Intrauterine fetal demise (IUFD)

Data Analysis: Data was collected and analyzed using Microsoft Excel, focusing on sensitivity, specificity, positive predictive value, and false-positive rates. Results were compared with previous studies.

Ethical Considerations

- Approved by the Institutional Ethics Committee, Andhra Medical College
- Written informed consent obtained
- Data confidentiality maintained

This study aims to screen high-risk antenatal women using uterine artery Doppler to determine mean pulsatility index (PI), resistance index (RI), and presence of diastolic notching at 20-24 weeks, correlating these findings with adverse pregnancy outcomes.

Results

Table 1: Cases with Doppler Abnormality

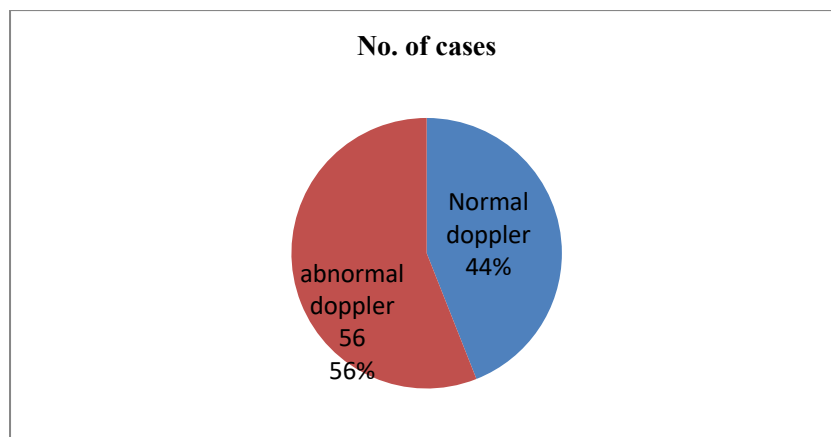| Doppler	Number of cases	Percentage
Normal	44	44%
Abnormal	56	56%
Total	**100**	

Figure 1: Doppler Abnormality Cases

Table 2: Age Distribution Cases with Doppler Abnormality

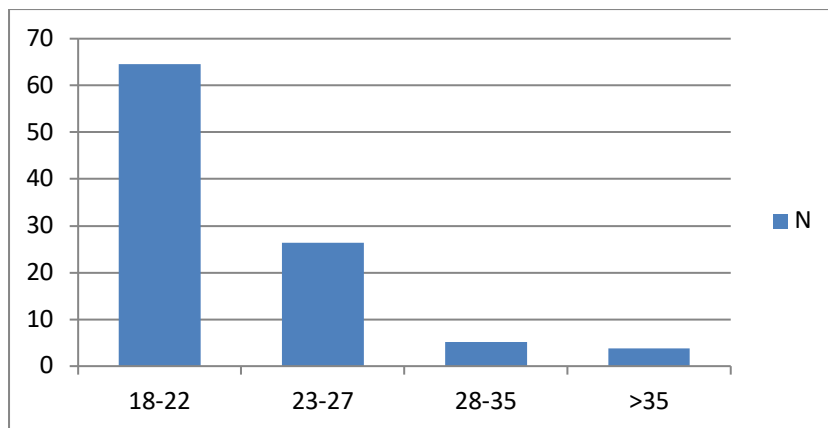| Age	Number of cases	Percentage
18-22	36	64.5%
23-27	15	26.4%
28-35	3	5.3%
>35	2	3.8%
Total	**56**	

Figure 2: Age distribution Cases with Doppler Abnormality

Table 3: Uterine Artery Resistance Index (RI)

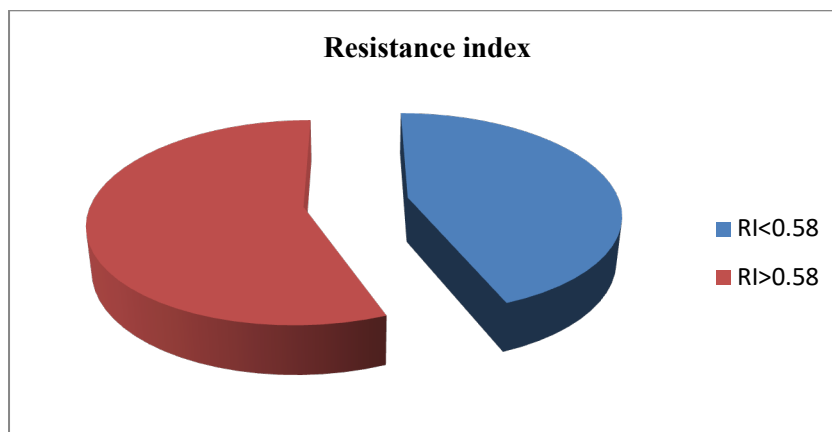| Ut. Artery RI	Number of cases	Percentage
<0.58	44	44%
>0.58	56	56%
Total	**100**	

Figure3: Uterine Artery Resistance Index (RI)

Table 4: Uterine Artery Pulsatility Index (PI)

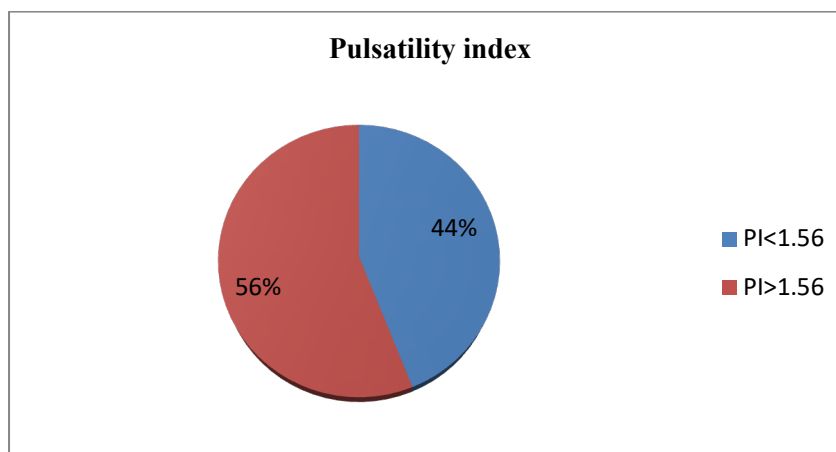| Ut. Artery PI	Number of cases	Percentage
<1.45	44	44%
>1.45	56	56%
Total	**100**	

Figure 4: Uterine Artery Pulsatility Index (PI)

Table 5: Incidence of Preeclampsia and FGR

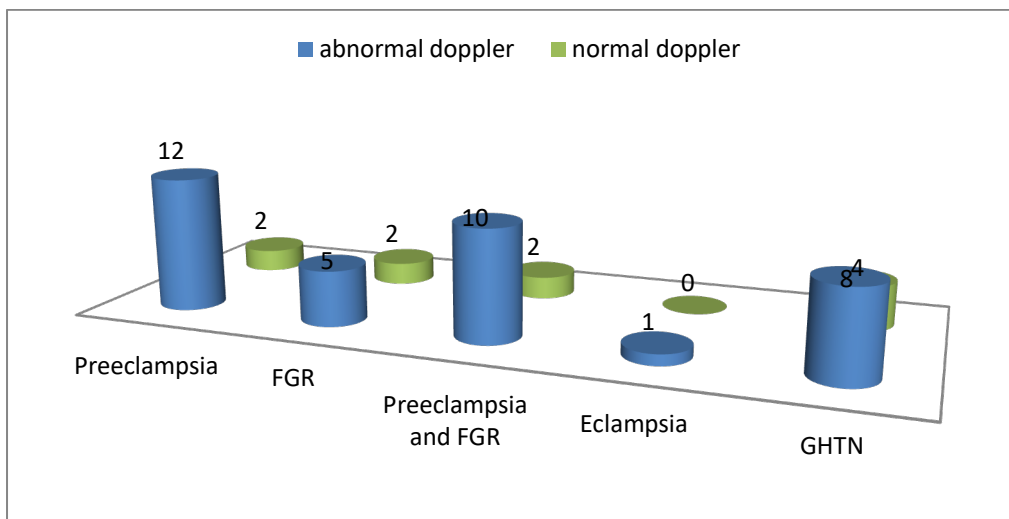| Risk factor Developed	Ut. Artery Developer Abnormal	Ut. Artery Developer Normal
Preeclampsia	12	2
FGR	5	2
Preeclampsia and FGR	10	2
Eclampsia	1	0
GHTN	8	4
Total	**36**	**10**

Figure5: Incidence of Preeclampsia and FGR

Table 6: Timing of Delivery with Doppler Abnormality

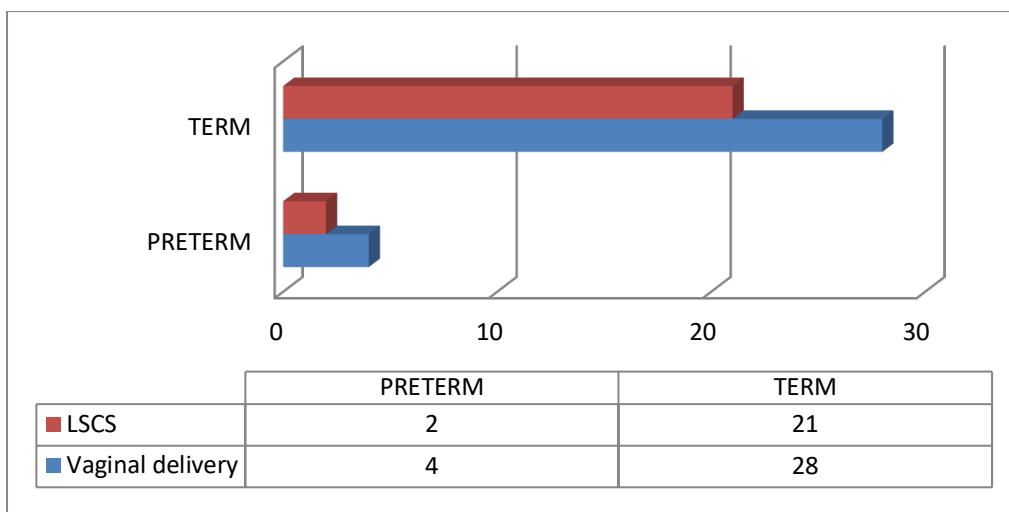| Doppler abnormality [56]	Vaginal delivery [32]	LSCS [23]
Preterm	4	2
Term	28	21

	PRETERM	TERM
■ LSCS	2	21
■ Vaginal delivery	4	28

Figure 6: Timing of Delivery with Doppler Abnormality

Table 7: Fetal Outcome

Fetal outcome	Abnormal doppler		Normal Doppler	
	Number	%	Number	%
FGR	10	18%	2	4.5%
Prematurity/RDS	6	10.9%	0	0%
Babies without risk	39	70%	42	95%
Total	**55**		**44**	
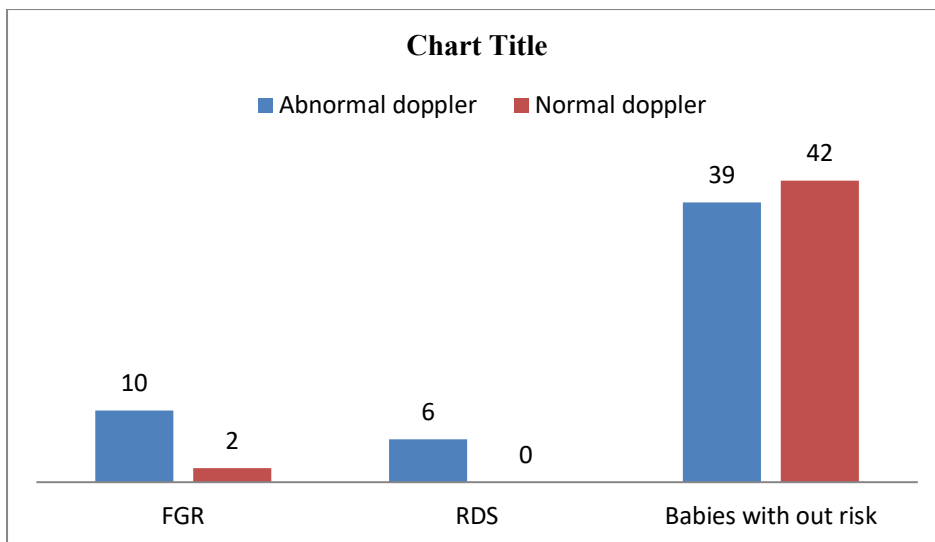
Figure 7: Fetal Outcome

Table 8: Maternal Mortality

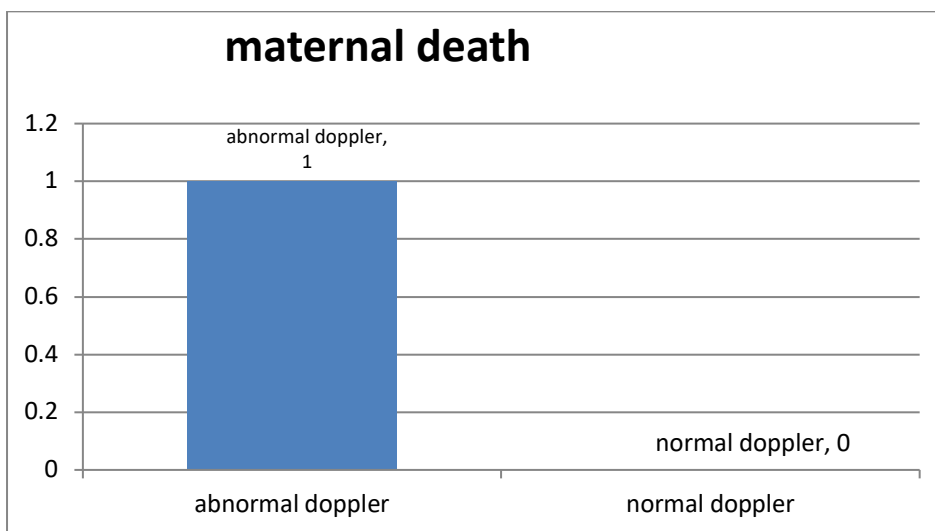|	Abnormal Doppler	Normal Doppler
Maternal Death	1[1.755%]	0

Figure 8: Maternal Mortality

Discussion

This prospective observational study was conducted at the Andhra Medical College, King George Hospital in Visakhapatnam from September 2022 to August 2023. It included 100 antenatal women with singleton pregnancies between 20-24 weeks of gestation. Doppler scans with TIFFA were performed to predict preeclampsia (PE) and fetal growth restriction (FGR).

Doppler Study Findings

Abnormal Doppler Results: 56 out of 100 cases showed abnormal uterine artery Doppler results.

Resistance Index (RI): A threshold of 0.58 was used, with values above this indicating increased risk. 56% of cases had an abnormal RI.

Sensitivity and Specificity

Preeclampsia:

- Sensitivity: 85%
- Specificity: 48%

FGR:

- Sensitivity: 71%
- Specificity: 45%

Preeclampsia and FGR Combined:

- Sensitivity: 83%
- Specificity: 47%

Predictive Accuracy

Positive Predictive Value (PPV):

- Preeclampsia: 40%
- FGR: 23%

Negative Predictive Value (NPV):

- Preeclampsia: 91%
- FGR: 90%

Combined Preeclampsia and FGR:

- PPV: 48%
- NPV: 86%

Key Findings

- Doppler studies effectively predict preeclampsia and FGR, with high sensitivity and NPV.
- The high sensitivity (85% for preeclampsia and 71% for FGR) and NPV (91% for preeclampsia and 90% for FGR) indicate the reliability of Doppler scans in identifying high-risk pregnancies.
- Moderate specificity values highlight the need for complementary diagnostic tools.

These findings underscore the importance of incorporating Doppler studies in routine antenatal care to enhance early detection and management of high-risk pregnancies.

Conclusion

In summary, this study highlights the significance of early identification and screening for preeclampsia and fetal growth restriction using Doppler studies. By evaluating high-risk pregnancies between 20-24 weeks, increased impedance to uterine artery flow was identified as a strong predictor of preeclampsia and FGR.

The study confirms that Doppler velocimetry has a high sensitivity and negative predictive value, making it an essential tool for early diagnosis and intervention. The findings emphasize the importance of incorporating Doppler studies in routine second-trimester screenings to reduce maternal and neonatal morbidity and mortality. Future research should focus on addressing the existing gaps and challenges to fully harness the potential of Doppler studies in improving obstetric outcomes.

References

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