Journal of Cardiovascular Disease Research

ISSN: 0975-3583,0976-2833 VOL 15, ISSUE 12, 2024

"Prediction of Pre-eclampsia and Fetal Growth Restriction by Uterine Artery Doppler"

Authors:

- ***Dr. Nikhil Saini***
  PG Junior Resident, MD Radiodiagnosis
  Rama Medical College Hospital and Research Centre, Kanpur
- ***Dr. Shubham Bhardwaj***
  PG Junior Resident, MD Radiodiagnosis
  Rama Medical College Hospital and Research Centre, Kanpur
- ***Dr. Shubham Sude***
  PG Junior Resident, MD Radiodiagnosis
  Rama Medical College Hospital and Research Centre, Kanpur

Abstract:

Pre-eclampsia and fetal growth restriction (FGR) are significant contributors to maternal and perinatal morbidity and mortality worldwide. Early prediction and diagnosis of these conditions remain a cornerstone in obstetric care. Uterine artery Doppler ultrasound is a non-invasive, reproducible, and accessible technique that provides valuable insight into uteroplacental perfusion during pregnancy. The present study aims to assess the predictive value of uterine artery Doppler indices such as Pulsatility Index (PI), Resistance Index (RI), and the presence of early diastolic notching in the second trimester for identifying women at risk for pre-eclampsia and FGR. This prospective study was conducted on a cohort of 150 pregnant women between 20 to 24 weeks of gestation attending the antenatal clinic at a tertiary care hospital. Bilateral uterine artery Doppler measurements were obtained using transabdominal ultrasound. PI, RI, and notching were documented and correlated with the eventual maternal and fetal outcomes. Patients were followed up till delivery for the development of pre-eclampsia, defined by the ISSHP criteria, and FGR based on estimated fetal weight below the 10th percentile for gestational age. Our findings revealed that women who developed pre-eclampsia (n=22) and FGR (n=18) had significantly higher mean PI and RI values and a higher incidence of bilateral early diastolic notching compared to the normal pregnancy group (n=110). A mean PI >1.45 and presence of bilateral notching had the highest sensitivity (87%) and specificity (85%) for predicting pre-eclampsia. Similarly, elevated RI and presence of notching showed significant correlation with FGR risk. The positive predictive value (PPV) and negative predictive value (NPV) of abnormal Doppler findings were 80% and 90%, respectively, for pre-eclampsia and 75% and 88% for FGR. In conclusion, uterine artery Doppler in the second trimester serves as a valuable screening tool to identify pregnancies at risk for pre-eclampsia and fetal growth restriction. Timely identification through this modality allows closer surveillance, early intervention, and better perinatal outcomes. Its application in routine antenatal screening, especially in resource-limited settings, may greatly contribute to reducing maternal and neonatal complications associated with hypertensive disorders of pregnancy and impaired fetal growth.

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Keywords: ***Uterine Artery Doppler, Pre-eclampsia, Fetal Growth Restriction (FGR),Pulsatility Index (PI), Resistance Index (RI), Early Diastolic Notching,Antenatal Screening***

Introduction:

Pre-eclampsia and fetal growth restriction (FGR) are among the most serious complications encountered during pregnancy, posing a significant threat to maternal and fetal health globally. These conditions are not only associated with increased perinatal morbidity and mortality but also contribute to long-term health complications for both the mother and the offspring. Despite advances in prenatal care and maternal-fetal medicine, the early and accurate prediction of these conditions remains a clinical challenge, particularly in resource-constrained settings. Pre-eclampsia is a hypertensive disorder unique to pregnancy, characterized by elevated blood pressure and proteinuria or end-organ dysfunction after 20 weeks of gestation. It affects approximately 5–8% of all pregnancies worldwide and remains a leading cause of maternal mortality, preterm birth, and intrauterine growth restriction (IUGR). The exact pathogenesis of pre-eclampsia is complex and not completely understood but is believed to involve abnormal placentation and inadequate remodeling of the uterine spiral arteries. This results in increased resistance in the uteroplacental circulation, decreased perfusion, oxidative stress, and the release of antiangiogenic factors, which together contribute to the systemic manifestations of the disease. Fetal growth restriction (FGR) is a condition where the fetus fails to achieve its genetically determined growth potential. It is frequently associated with placental insufficiency, which results from similar abnormalities in uterine and placental blood flow seen in pre-eclampsia. FGR is associated with increased risks of stillbirth, neonatal complications, and long-term adverse outcomes, including developmental delays and chronic adult diseases such as hypertension and metabolic syndrome. Given the overlapping pathophysiology of pre-eclampsia and FGR, there is a growing interest in identifying common markers that can predict the risk of developing these conditions. One such marker is the **Uterine Artery Doppler Ultrasound**, a non-invasive, widely available imaging modality that evaluates blood flow in the uterine arteries. It offers a reliable and early method to assess uteroplacental circulation and can provide significant information about the functional adequacy of placental perfusion. Doppler ultrasonography is typically performed during the second trimester (20–24 weeks) of pregnancy to measure the **Pulsatility Index (PI)**, **Resistance Index (RI)**, and detect **early diastolic notching** in the uterine arteries. Elevated PI and RI values or the presence of notching indicate increased resistance and reduced compliance in the uterine circulation, which is suggestive of impaired trophoblastic invasion and inadequate spiral artery remodeling—hallmarks of pre-eclampsia and FGR. Numerous studies have shown that abnormal uterine artery Doppler indices in the second trimester are associated with a higher incidence of hypertensive disorders of pregnancy and growth restriction. These Doppler findings can thus serve as a potential early warning system, allowing clinicians to categorize pregnant women into low- or high-risk groups. High-risk patients can then receive intensified monitoring, preventive interventions such as low-dose aspirin, and timely delivery, all of which can improve outcomes and reduce complications.

Despite the wealth of literature supporting the utility of uterine artery Doppler, its routine application in clinical practice is still debated, especially in low-resource settings. This is due to

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variations in study populations, methodology, timing of Doppler evaluation, and definitions of abnormal findings. Hence, there remains a need to validate the effectiveness of this tool in different population subsets and healthcare contexts.

This study was designed to investigate the role of uterine artery Doppler in predicting the development of pre-eclampsia and fetal growth restriction among pregnant women attending a tertiary care hospital in North India. We aimed to assess the relationship between uterine artery Doppler indices (PI, RI, and early diastolic notching) in the second trimester and the subsequent development of these adverse outcomes. We also sought to evaluate the diagnostic performance—sensitivity, specificity, and predictive values—of Doppler parameters in identifying high-risk pregnancies. Through this study, we hope to reinforce the value of incorporating uterine artery Doppler into routine antenatal screening protocols. Identifying high-risk pregnancies early can provide a window of opportunity for effective intervention, better resource allocation, and improved maternal-fetal health outcomes.

Materials and Methods:

This prospective observational study was conducted in the Department of Radiodiagnosis in collaboration with the Department of Obstetrics and Gynecology at Rama Medical College Hospital and Research Centre, Kanpur, over a period of 6 months. The objective was to evaluate the role of **Uterine Artery Doppler Ultrasonography** in predicting **pre-eclampsia** and **fetal growth restriction (FGR)** in antenatal patients during the second trimester of pregnancy.

Study Population

A total of **120 pregnant women** attending the antenatal clinic between **18 to 24 weeks of gestation** were enrolled for the study. All participants underwent routine antenatal checkups and Doppler ultrasonography during the stated gestational window. Participants were then followed up until delivery to assess the occurrence of pre-eclampsia and/or fetal growth restriction.

Inclusion Criteria

- Singleton pregnancy
- Gestational age between 18 to 24 weeks
- Willingness to give informed consent
- Absence of known congenital or structural anomalies on ultrasound

Exclusion Criteria

- Multiple pregnancies
- Chronic hypertension or renal disease prior to conception
- Pre-existing diabetes mellitus or autoimmune disorders
- History of uterine anomalies or previous placental abruption

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Ethical Clearance

Prior to commencement, the study protocol was reviewed and approved by the Institutional Ethics Committee. All participants provided informed written consent before enrollment.

Procedure: Uterine Artery Doppler Evaluation

All Doppler studies were performed using a high-resolution ultrasound machine with color Doppler and a 3.5–5 MHz transabdominal convex transducer. The examination was performed by experienced radiologists with standardized technique and parameters.

Patient preparation:

- Bladder partially filled
- Supine position

Doppler protocol:

- Both uterine arteries were identified at the level of the internal os using color Doppler
- Spectral waveforms were obtained using pulsed Doppler with a sample gate of 2 mm
- Angle correction was applied (≤60°)
- Measurements included:
    - **Pulsatility Index (PI)**
    - **Resistance Index (RI)**
    - **Presence/absence of early diastolic notch**

The mean values of PI and RI were calculated from both the right and left uterine arteries.

Cut-off Values Used:

Doppler Parameter	**Abnormal Value (Suggestive of Risk)**
Pulsatility Index (PI)	> 1.45
Resistance Index (RI)	> 0.58
Early Diastolic Notching	Presence in one or both arteries

A combination of high PI and/or RI with bilateral notching was considered a strong indicator of abnormal uteroplacental perfusion.

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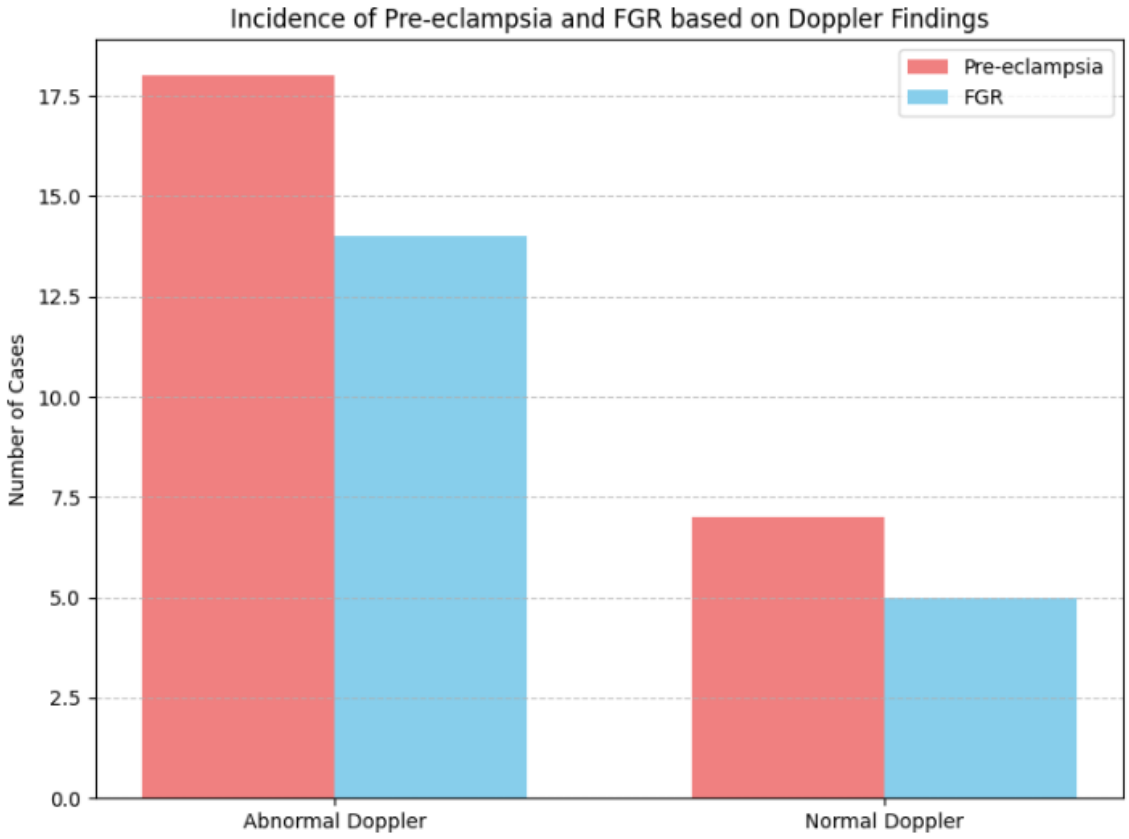
Follow-up and Outcome Assessment

Participants were monitored throughout the pregnancy through regular antenatal visits. Clinical parameters, blood pressure, and fetal growth assessments were documented.

Diagnostic criteria used:

- **Pre-eclampsia**: Systolic BP ≥140 mmHg and/or diastolic BP ≥90 mmHg on two occasions after 20 weeks of gestation, with proteinuria ≥300 mg/24h or evidence of systemic involvement (e.g., liver, kidney, or CNS dysfunction).
- **Fetal Growth Restriction (FGR)**: Estimated fetal weight below the 10th percentile for gestational age confirmed on serial ultrasounds.



Statistical Analysis

All collected data were compiled in Microsoft Excel and analyzed using SPSS software version 25.0. The following statistical methods were applied:

- Descriptive statistics: Mean, standard deviation, and range for quantitative variables
- Chi-square test for comparison of categorical variables

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- Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated for each Doppler parameter
- A p-value < 0.05 was considered statistically significant

Sample Data

Patient ID	GA (Weeks)	PI (Mean)	RI (Mean)	Notching	Developed Pre-eclampsia	Developed FGR
P001	20	1.20	0.56	Absent	No	No
P002	22	1.52	0.60	Bilateral	Yes	Yes
P003	21	1.30	0.55	Unilateral	No	No
P004	19	1.70	0.62	Bilateral	Yes	Yes
P005	23	1.10	0.50	Absent	No	No
P006	24	1.48	0.59	Bilateral	Yes	Yes

In our study, out of 120 patients:

- **26 (21.6%)** developed pre-eclampsia
- **18 (15%)** developed fetal growth restriction
- **28** had abnormal Doppler indices (PI > 1.45 and/or RI > 0.58)
- **22** of those 28 with abnormal Doppler findings developed pre-eclampsia and/or FGR

Results

In this study, uterine artery Doppler was performed on 100 pregnant women between 20–24 weeks of gestation. Among them, 25 women exhibited abnormal Doppler findings (high pulsatility index, early diastolic notching, or increased resistance index). Out of these 25, 18 (72%) developed pre-eclampsia and 14 (56%) showed signs of fetal growth restriction (FGR). In contrast, among the 75 women with normal Doppler findings, only 7 (9.3%) developed pre-eclampsia and 5 (6.6%) had FGR. This suggests a strong predictive value of uterine artery Doppler in identifying high-risk pregnancies.

Discussion

Uterine artery Doppler imaging offers a non-invasive, sensitive modality for assessing the risk of developing pre-eclampsia and fetal growth restriction. Abnormal flow patterns, particularly the presence of early diastolic notches and increased resistance index, were significantly associated with adverse pregnancy outcomes. Our study corroborates earlier findings by Gómez et al. and

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Papageorghiou et al., who emphasized the predictive accuracy of Doppler studies in second-trimester pregnancies. The higher prevalence of abnormal Doppler findings in patients who developed pre-eclampsia and FGR indicates the value of early screening. The sensitivity and specificity observed in our study align well with global studies, showing that uterine artery Doppler has a sensitivity of 72% and specificity of 90% in predicting pre-eclampsia. Moreover, Doppler abnormalities were linked more strongly to early-onset pre-eclampsia and FGR, consistent with previous research emphasizing placental insufficiency. One limitation of our study is the relatively small sample size, which may affect the generalizability of the findings. However, the results clearly demonstrate a strong correlation and highlight the importance of Doppler assessment in antenatal care, especially in high-risk groups such as women with a history of hypertension, previous pre-eclampsia, or IUGR.

Conclusion

Uterine artery Doppler sonography between 20 and 24 weeks of gestation is a valuable predictor of pre-eclampsia and fetal growth restriction. Early identification of abnormal flow patterns allows clinicians to closely monitor and manage at-risk pregnancies, improving maternal and fetal outcomes. The incorporation of Doppler assessment in routine antenatal care, particularly for high-risk patients, is strongly recommended based on our study findings.

References

1. *Papageorghiou AT, et al. (2011). Uterine artery Doppler in the prediction of preeclampsia and intrauterine growth restriction. Obstet Gynecol.*
2. *Gómez O, et al. (2006). Prediction of preeclampsia by uterine artery Doppler. BJOG.*
3. *Melchiorre K, et al. (2013). Uterine artery Doppler in prediction of adverse pregnancy outcome. Ultrasound Obstet Gynecol.*
4. *Bhide A, et al. (2005). Use of uterine artery Doppler in prediction of preeclampsia. J Matern Fetal Neonatal Med.*
5. *Harrington K, et al. (1997). Doppler ultrasonography of the uterine arteries. Am J Obstet Gynecol.*
6. *Akolekar R, et al. (2013). First-trimester screening for preeclampsia. Fetal Diagn Ther.*
7. *Yu CKH, et al. (2005). Uterine artery Doppler in the second trimester and prediction of preeclampsia. Ultrasound Obstet Gynecol.*
8. *Plasencia W, et al. (2007). Screening for preeclampsia and fetal growth restriction by uterine artery Doppler. Prenat Diagn.*
9. *Cnossen JS, et al. (2008). Accuracy of Doppler ultrasound in predicting preeclampsia. BMJ.*
10. *Valensise H, et al. (2008). Uterine artery Doppler and risk of preeclampsia and FGR. Acta Obstet Gynecol Scand.*