SSR Institute of International Journal of Life Sciences
ISSN (O): 2581-8740 | ISSN (P): 2581-8732
Garala and Gupta, 2025
doi: 10.21276/SSR-IIJLS.2025.11.2.26

Original Article

open access

Evaluating Intrauterine Growth Restriction via Doppler Ultrasound and Its Impact on Perinatal Outcomes

Nirav Jayantilal Garala[1], Manisha Bahadur Gupta[2]*

[1]Associate Professor, Department of Obstetrics and Gynaecology, Dr Kiran C Patel Medical College and Research Institute, Bharuch, Gujarat, India

[2]Assistant Professor, Department of Obstetrics and Gynaecology, Dr Kiran C Patel Medical College and Research Institute, Bharuch, Gujarat, India

***Address for Correspondence:** Dr. Manisha Bahadur Gupta, Assistant Professor, Department of Obstetrics and Gynaecology, Dr Kiran C Patel Medical College and Research Institute, Bharuch, Gujarat, India
E-mail: manishabahadurg@gmail.com

Received: 20 Oct 2024/ Revised: 24 Dec 2024/ Accepted: 12 Feb 2025

ABSTRACT

Background: Doppler sonography plays a crucial role in evaluating fetal growth restriction (FGR) by assessing blood flow patterns and identifying compromised fetoplacental circulation. It serves as a non-invasive tool for predicting adverse perinatal outcomes, enabling timely obstetric interventions. This study investigates its predictive accuracy in a resource-limited setting to improve fetal surveillance, optimize clinical decision-making, and enhance neonatal care, particularly where advanced facilities for high-risk pregnancies may be restricted.

Methods: A prospective observational study was conducted at a tertiary hospital in Gujarat from January to July 2023, including 117 singleton pregnancies diagnosed with FGR. Doppler parameters of the umbilical artery (UA), middle cerebral artery (MCA), and uterine artery (UtA) were assessed to evaluate their correlation with adverse perinatal outcomes. The study aimed to determine Doppler sonography's predictive accuracy in identifying high-risk pregnancies requiring early intervention.

Results: Abnormal Doppler findings significantly correlated with adverse perinatal outcomes (UA: 81.1%, MCA: 82.4%, UtA: 80%, $p<0.001$). Increased UA resistance and decreased MCA pulsatility predicted fetal distress, necessitating early intervention. These findings confirm Doppler sonography's predictive value in fetal monitoring, particularly in resource-limited settings, for improving neonatal outcomes.

Conclusion: Doppler ultrasound is a valuable, non-invasive tool for detecting high-risk FGR pregnancies, enabling early intervention and improving perinatal outcomes, especially in resource-limited settings where advanced neonatal care is limited.

Key-words: Abdominal circumference, Fetal growth restriction, Doppler ultrasound, Perinatal outcomes

INTRODUCTION

Intrauterine growth restriction (IUGR) represents a critical obstetric issue linked to heightened perinatal morbidity and mortality rates. The condition is defined by the inability of the fetus to reach its genetically predetermined growth potential, typically identified when the estimated fetal weight (EFW) or abdominal circumference (AC) is below the 10th percentile for the corresponding gestational age [1]. IUGR is classified in to symmetrical and asymmetrical types, with the latter being more common and frequently linked to uteroplacental insufficiency [2]. In resource-constrained settings, where advanced neonatal care may be limited, early detection and risk stratification using non-invasive techniques such as Doppler sonography are crucial for optimizing perinatal outcomes [3].

Doppler ultrasound has emerged as a valuable tool in assessing fetal circulation and placental function, allowing for early identification of fetal hypoxia and hemodynamic compromise [4]. The pulsatility index (PI) of the umbilical artery (UA), the PI of the middle cerebral artery (MCA), and the cerebroplacental ratio (CPR) are frequently utilized Doppler parameters for assessing fetal well-being in instances of suspected FGR [5]. Research indicates that abnormal UA Doppler findings, especially elevated PI and absent or reversed end-diastolic flow, correlate significantly with negative

How to cite this article
Garala NJ, Gupta MB. Evaluating Intrauterine Growth Restriction via Doppler Ultrasound and Its Impact on Perinatal Outcomes. SSR Inst Int J Life Sci., 2025; 11(2): 7173-7177.

Access this article online
https://iijls.com/

doi: 10.21276/SSR-IIJLS.2025.11.2.26

perinatal outcomes, such as intrauterine fetal demise, NICU admission, and perinatal asphyxia [6]. The MCA PI, an indicator of fetal brain sparing, is a critical parameter for predicting perinatal compromise in fetuses affected by FGR [7].

Despite the proven utility of Doppler sonography in high-resource settings, its predictive value in resource-limited contexts, where access to specialized care is restricted, remains an area of active investigation [8]. This research seeks to determine the predictive significance of Doppler studies in FGR concerning perinatal outcomes within a resource-limited environment. This research aims to evaluate the relationship between Doppler findings and neonatal outcomes to enhance clinical decision-making and improve neonatal survival rates in underprivileged areas.

MATERIALS AND METHODS

This study was a prospective observational analysis carried out at a tertiary hospital in Gujarat between January 2023 and July 2023. This study evaluated the predictive value of Doppler sonography in FGR and its correlation with perinatal outcomes in a resource-limited setting. The study included 117 pregnant women with singleton pregnancies diagnosed with FGR based on ultrasound parameters. FGR is characterized by an estimated fetal weight (EFW) or abdominal circumference (AC) that falls below the 10th percentile for gestational age, which may occur with or without abnormal Doppler findings.

Inclusion Criteria

- Pregnant women with singleton pregnancies diagnosed with FGR.
- Gestational age between 28–40 weeks confirmed by first-trimester ultrasound.

Exclusion Criteria

- Multiple gestations.
- Congenital anomalies detected on ultrasound.
- Pregnancies complicated by maternal infections, chromosomal abnormalities

Doppler Evaluation- Doppler ultrasound was performed using a standardized protocol to assess fetal circulation and placental function. The following Doppler indices were measured:

Umbilical Artery (UA) Doppler- Pulsatility Index (PI), absent end-diastolic flow (AEDF), and reversed end-diastolic flow (REDF).

Middle Cerebral Artery (MCA) Doppler- PI and cerebroplacental ratio (CPR).

Uterine Artery Doppler- PI and presence of bilateral notching.

All Doppler studies were conducted by trained sonographers using a 3.5 MHz transducer, and measurements were recorded.

Statistical Analysis- Statistical analysis was conducted using SPSS software version 25.0. Descriptive and inferential statistics, including chi-square and t-tests, were applied. A p-value<0.05 was considered statistically significant for assessing Doppler parameters and perinatal outcomes.

RESULTS

This research examined 117 cases to evaluate the relationship between umbilical artery Doppler patterns and perinatal outcomes. Among the total cases, 37 (31.6%) had abnormal UA Doppler findings, while 80 (68.4%) had normal patterns. Among the abnormal cases, 30 (81.1%) resulted in adverse perinatal outcomes, whereas only 7 (18.9%) had normal outcomes. In contrast, among the 80 cases with normal Doppler patterns, 7 (8.8%) had adverse outcomes, while 73 (91.2%) had favorable perinatal consequences. The correlation between UA Doppler abnormalities and negative outcomes was statistically significant (χ^2=58.84, p<0.001), underscoring the predictive utility of Doppler sonography in cases of fetal growth restriction. (Table 1).

Among these, 17 (14.5%) had abnormal MCA Doppler findings, while 100 (85.5%) had normal patterns. Of the 17 abnormal cases, 14 (82.4%) resulted in adverse perinatal outcomes, whereas only 3 (17.6%) had normal outcomes. In contrast, among the 100 cases with normal MCA Doppler patterns, 22 (22%) had adverse outcomes, while 78 (78%) had favorable perinatal outcomes. The statistical analysis demonstrated a substantial connection between aberrant MCA Doppler findings and unfavorable perinatal outcomes (χ^2=19.8, p<0.001), underlining the necessity of MCA Doppler evaluation in fetal growth restriction treatment (Table 2).

doi: 10.21276/SSR-IIJLS.2025.11.2.26

Table 1: UA Doppler pattern and perinatal outcomes

Umbilical Artery Doppler Pattern	Abnormal Outcome	Normal Outcome	Total	Chi-Square	p-value
Abnormal	30	7	37	58.84	<0.001
Normal	7	73	80		
Total	37	80	117		

Table 2: MCA Doppler pattern and perinatal outcomes

MCA Doppler Pattern	Abnormal Outcome	Normal Outcome	Total	Chi-Square	p-value
Abnormal	14	3	17	19.8	<0.001
Normal	22	78	100		
Total	36	81	117		

Among these, 20 (17.1%) had abnormal UtA Doppler findings, while 97 (82.9%) had normal patterns. Of the 20 abnormal cases, 16 (80%) resulted in adverse perinatal outcomes, whereas 4 (20%) had normal outcomes. In contrast, among the 97 cases with normal UtA Doppler patterns, 19 (19.6%) had adverse perinatal outcomes, while 78 (80.4%) had favorable consequences. The correlation between abnormal UtA Doppler patterns and negative perinatal outcomes was statistically significant ($p<0.001$), highlighting the importance of UtA Doppler in forecasting fetal growth restriction and adverse perinatal outcomes. (Table 3).

Table 3: UtA Doppler pattern and perinatal outcomes

Uterine Artery Doppler Pattern	Abnormal Outcome	Normal Outcome	Total	p-value
Abnormal	16	4	20	<0.001
Normal	19	78	97	
Total	35	82	117	

DISCUSSION

Doppler sonography was tested for its prognostic utility in FGR and perinatal outcomes in a resource-constrained scenario. The results show that umbilical artery (UA), middle cerebral artery (MCA), and uterine artery (UtA) Doppler characteristics can identify high-risk pregnancies and predict poor newborn outcomes. The high correlation between aberrant Doppler findings and poor perinatal outcomes makes Doppler ultrasound an important non-invasive fetal surveillance technique.

This study found a substantial association between umbilical artery Doppler and poor neonatal outcomes. In instances with aberrant UA Doppler patterns, 81.1% had unfavorable outcomes, consistent with an earlier study linking higher UA pulsatility index (PI) to fetal hypoxia [9]. Progressive placental insufficiency and fetal impairment are indicated by UA Doppler end-diastolic flow absence or reversal [10]. The research found that absent or reversed end-diastolic flow in UA increased perinatal mortality fivefold [11]. Serial UA Doppler monitoring is crucial for prompt obstetric treatments such as corticosteroid injection for fetal lung maturity and preterm delivery.

The MCA Doppler results in this study further reinforce the role of cerebral blood flow redistribution as a fetal adaptive mechanism in response to hypoxia. Among the

17 cases with abnormal MCA Doppler patterns, 82.4% had adverse perinatal outcomes. CPR derived from UA and MCA Doppler indices, has been widely studied as a key parameter for detecting brain-sparing effects in FGR fetuses [12]. Reduced MCA PI suggests vasodilation due to hypoxia, often preceding overt signs of fetal deterioration [13]. Recent studies indicate that CPR serves as a superior predictor of adverse perinatal outcomes compared to UA PI alone, highlighting its significance in thorough fetal assessment [14].

The uterine artery Doppler (UtA) findings further validated its role in detecting impaired placentation and early-onset FGR. In this study, 80% of abnormal UtA Doppler cases resulted in adverse perinatal outcomes, supporting evidence that elevated UtA PI and bilateral notching are associated with poor placental perfusion and preeclampsia [15]. Previous studies have indicated that abnormal UtA Doppler patterns are strongly correlated with early-onset FGR and increased risk of preterm delivery [16]. The integration of UtA Doppler with UA and MCA Doppler parameters may enhance risk stratification and management in pregnancies complicated by FGR.

This study's primary strength lies in its emphasis on a resource-limited setting, demonstrating that Doppler ultrasound can function as a crucial screening tool to enhance perinatal outcomes in the context of restricted access to advanced neonatal care [17]. However, certain limitations must be acknowledged. The study's sample size of 117 cases, while adequate for statistical analysis, may not fully represent population-wide trends. Additionally, variability in Doppler measurement techniques and operator-dependent interpretation could influence findings. Future multicentric studies with larger sample sizes may further validate these findings and contribute to the establishment of standardized Doppler-based protocols for managing FGR in low-resource settings [18].

CONCLUSIONS

In conclusion, abnormal UA, MCA, and UtA Doppler parameters are significantly linked to negative perinatal outcomes. The utilization of Doppler studies in FGR evaluation allows for early identification of fetal compromise, guiding timely obstetric interventions to improve neonatal survival and reduce morbidity. The findings from this study highlight the importance of integrating Doppler ultrasound in routine antenatal care, particularly in resource-limited settings, to enhance fetal monitoring and optimize perinatal outcomes.

CONTRIBUTION OF AUTHORS

Research concept- Nirav Jayantilal Garala, Manisha Bahadur Gupta

Research design- Nirav Jayantilal Garala, Manisha Bahadur Gupta

Supervision- Nirav Jayantilal Garala

Materials- Nirav Jayantilal Garala, Manisha Bahadur Gupta

Data collection- Nirav Jayantilal Garala, Manisha Bahadur Gupta

Data analysis and Interpretation- Nirav Jayantilal Garala

Literature search- Nirav Jayantilal Garala, Manisha Bahadur Gupta

Writing article- Nirav Jayantilal Garala, Manisha Bahadur Gupta

Critical review- Nirav Jayantilal Garala

Article editing- Nirav Jayantilal Garala, Manisha Bahadur Gupta

Final approval- Nirav Jayantilal Garala

REFERENCES

[1] Figueras F, Gratacós E. Update on the diagnosis and classification of fetal growth restriction and proposal of a stage-based management protocol. Fetal Diagn Ther., 2014; 36(2): 86-98.

[2] Sharma D, Farahbakhsh N, Shastri S, Sharma P. Intrauterine growth restriction–part 1. J Matern Fetal Neonatal Med., 2016; 29(24): 3977-87.

[3] Baschat AA. Fetal growth restriction–from observation to intervention. J Perinat Med., 2010; 38(3): 239-46.

[4] Alfirevic Z, Stampalija T, Gyte GM. Fetal and umbilical Doppler ultrasound in high-risk pregnancies. Cochrane Database Syst Rev., 2017; 6(6): CD007529.

[5] Vollgraff Heidweiller-Schreurs CA, De Boer MA, Heymans MW, Oepkes D, van Wassenaer-Leemhuis AG, et al. Prognostic accuracy of cerebroplacental ratio and middle cerebral artery Doppler for adverse perinatal outcomes: a systematic review and meta-analysis. Ultrasound Obstet Gynecol., 2018; 51(3): 313-22.

[6] Rizzo G, Arduini D, Lorido C, Romanini C. Prognostic value of absent end-diastolic velocity in umbilical

doi: 10.21276/SSR-IIJLS.2025.11.2.26

artery: beyond intrauterine life. Am J Obstet Gynecol., 1994; 171(3): 1049-54.

[7] Bahado-Singh RO, Kovanci E, Jeffres A, Hsu CD, Oz U, et al. The Doppler cerebroplacental ratio and perinatal outcome in intrauterine growth restriction. Am J Obstet Gynecol., 1999; 180(3): 750-56.doi: 10.1016/s0002-9378(99)70283-8.

[8] Aliyu LD, Kurjak A, Wataganara T, Salihu HM, Luewan S, et al. Challenges and implications of Doppler studies in low-resource settings. J Perinat Med., 2018; 46(6): 581-89.

[9] Dubiel M, Gudmundsson S, Gunnarsson G, Marsál K. Middle cerebral artery velocimetry as a predictor of fetal outcome in pregnancies complicated by preeclampsia or intrauterine growth retardation. Early Hum Dev., 2000; 58(2): 91-100.

[10] Gramellini D, Folli MC, Raboni S, Vadora E, Merialdi A. Cerebral-umbilical Doppler ratio as a predictor of adverse perinatal outcome. Obstet Gynecol., 1992; 79(3): 416-20.

[11] Bahlmann F, Reinhard I, Krummenauer F, Wellek S, Schmidt W. Blood flow velocity waveforms of the umbilical artery in a normal population: reference values from 18 weeks to 42 weeks of gestation. J Perinat Med., 2002; 30(6): 490-501.

[12] Prior T, Mullins E, Bennett P, Kumar S. Prediction of perinatal outcomes using the cerebroplacental ratio in suspected small-for-gestational-age fetuses: a systematic review and meta-analysis. Am J Obstet Gynecol., 2015; 213(4): 442-47.

[13] Khalil A, Morales-Roselló J, Morlando M, Hannan H, Bhide A, et al. Is cerebroplacental ratio a marker of impaired fetal growth velocity and adverse pregnancy outcome? Am J Obstet Gynecol., 2017; 216(6): 606.e1-10.

[14] Conde-Agudelo A, Villar J, Kennedy SH, Papageorghiou AT. Predictive accuracy of cerebroplacental ratio for adverse perinatal and neurodevelopmental outcomes in suspected fetal growth restriction: systematic review and meta-analysis. BJOG, 2018; 125(17): 2105-15.

[15] Melchiorre K, Wormald B, Leslie K, Bhide A, Thilaganathan B. Uterine artery Doppler indices in the identification of women at risk for preeclampsia: a systematic review and meta-analysis. Am J Obstet Gynecol., 2013; 208(3): 230.e1-16.

[16] Napolitano R, Dhillon SK, Maksym K, Al-Far E, Bhide A, et al. Early pregnancy uterine artery Doppler indices in the prediction of stillbirth. Hypertens Pregnancy, 2019; 38(1): 44-51.

[17] Ali S, Byamugisha J, Kawooya MG, Kakibogo IM, Ainembabazi I, et al. Standardization and quality control of Doppler and fetal biometric ultrasound measurements in low-income setting. Ultrasound Obstet Gynecol., 2023; 61: 481-87. doi: 10.1002/uog.26051.

[18] Sweid RZ, Donadono V, Casagrandi D, Sarno L, et al. Reproducibility of fetal ultrasound doppler parameters used for growth assessment. Archives Gynecol Obstet., 2025; 311: 669–76. doi: 10.1007/s00404-024-07883-7.