

## Research Article

# “ROLE OF ULTRASONOGRAPHY IN SCREENING HIGH RISK MOTHERS FOR DETECTION OF INTRAUTERINE GROWTH RESTRICTION”

Chandrashekhar Gattani<sup>1</sup>, Pavan Kumar<sup>2</sup>, Gavan Dhola<sup>3</sup>

Dr. Chandrashekhar Gattani, Professor and Head, Radiodiagnosis, Zydus Medical College and Hospital, Dahod, Gujarat, India.

Email: [drcmgattani30@gmail.com](mailto:drcmgattani30@gmail.com)

Dr. Pavan Kumar, Associate Professor, Radiodiagnosis, Zydus Medical College and Hospital, Dahod, Gujarat, India. Email:

[pavankumardhd@redffimail.com](mailto:pavankumardhd@redffimail.com)

Dr. Gavan Dhola, PG Resident, Radiodiagnosis, Zydus Medical College and Hospital, Dahod, Gujarat, India. Email Id:

[Gavandhola65@gmail.com](mailto:Gavandhola65@gmail.com)

### \*Corresponding Author

Gavan Dhola

Email Id: [Gavandhola65@gmail.com](mailto:Gavandhola65@gmail.com)

### Article History

**Received:** 25.01.2026

**Revised:** 15.02.2026

**Accepted:** 27.02.2026

**Published:** 15.03.2026

### Citations:

Gattani, C., Kumar, P., & Dhola, G. Role of ultrasonography in screening high risk mothers for detection of intrauterine growth restriction. *J Surg Radiol*, V(5) 19-24

**Abstract:** **Introduction:** Intrauterine growth restriction (IUGR) is a major contributor to perinatal morbidity and mortality, particularly in high-risk pregnancies. Early identification using ultrasonography and Doppler studies plays a crucial role in improving fetal outcomes. **Aim:** To evaluate the role of ultrasonography and Doppler velocimetry in screening high-risk pregnancies for detection of IUGR and prediction of adverse perinatal outcomes. **Materials and Methods:** This prospective observational study included 105 high-risk pregnant women with clinically suspected IUGR. All participants underwent detailed ultrasonographic evaluation, including fetal biometry and Doppler assessment of uterine, umbilical, and middle cerebral arteries. Doppler parameters such as pulsatility index (PI), S/D ratio, and cerebro-placental ratio (CPR) were analysed. Patients were followed until delivery, and perinatal outcomes were recorded. Statistical analysis was performed using SPSS version 26.0. **Results:** Doppler abnormalities were more frequently detected before 32 weeks (49.15%) compared to after 32 weeks (10.87%). Umbilical artery end-diastolic flow abnormalities were seen in 20.95% cases. Abnormal MCA PI (<5th percentile) was observed in 45.71% and was associated with increased NICU admissions, low birth weight, and perinatal mortality. CPR <1 showed high specificity (97.96%) and PPV (96.00%) for predicting adverse outcomes. Uterine artery abnormalities were present in 31.43% and were strongly associated with maternal hypertension. Perinatal complications included NICU admission (27.6%), stillbirth (10.5%), and perinatal mortality (14.3%). **Conclusion:** Doppler ultrasonography is a reliable tool for early detection of fetal compromise in high-risk pregnancies. Combined multi-vessel Doppler assessment, especially CPR, improves diagnostic accuracy and facilitates timely intervention, thereby reducing perinatal morbidity and mortality.

**Keywords:** IUGR, Doppler ultrasonography, cerebroplacental ratio, high-risk pregnancy, perinatal outcomes

## INTRODUCTION

Foetal growth restriction (FGR), also referred to as intrauterine growth restriction (IUGR), is a significant obstetric complication in which the fetus fails to achieve its genetically determined growth potential. It affects approximately 5–10% of pregnancies and is associated with increased perinatal morbidity and mortality, as well as long-term neurodevelopmental and metabolic disorders [1,2]. Neonates with IUGR are at higher risk of complications such as meconium aspiration syndrome, hypoglycaemia, hyaline membrane disease, early-onset sepsis, and intrapartum asphyxia [1,2].

High-risk pregnancies, including those complicated by maternal conditions such as hypertension, diabetes mellitus, renal disease, and previous history of IUGR, are particularly susceptible to adverse outcomes. In these cases, early detection of IUGR is crucial to reduce

complications such as preterm birth, placental insufficiency, and stillbirth [3,4].

Ultrasonography plays a pivotal role in the screening and monitoring of IUGR due to its non-invasive nature and ability to assess foetal biometry, amniotic fluid volume, and Doppler parameters. Serial ultrasound evaluation is essential in differentiating constitutionally small foetuses from pathological growth restriction and in guiding timely clinical interventions to improve perinatal outcomes [5,6].

The present study aims to evaluate the role of ultrasonography in detecting IUGR among high-risk pregnancies and its correlation with foetal parameters and perinatal outcomes.

## Materials and Methodology:

This prospective observational study was conducted at a tertiary care centre, Zydus Medical College and Hospital, Dahod, Gujarat, India from March 2024 to September 2025. A total of 105 pregnant women with high-risk factors and clinically suspected intrauterine growth restriction (IUGR) were included in the study after fulfilling the inclusion and exclusion criteria.

Ethical approval was obtained from the Institutional Ethics Committee prior to the commencement of the study. Written informed consent was obtained from all participants after explaining the purpose and procedures of the study, and confidentiality of patient data was strictly maintained.

Inclusion criteria comprised pregnant women with a known last menstrual period (LMP), gestational age between 18 and 41 weeks, and clinically suspected IUGR based on findings such as inadequate maternal weight gain, reduced or static abdominal girth, and decreased or absent increase in fundal height. Patients with known preeclampsia, chronic hypertension, or previous history of IUGR were also included.

Exclusion criteria included multiple gestations and pregnancies with diagnosed fetal congenital anomalies. All enrolled participants underwent detailed ultrasonographic evaluation and colour Doppler studies using PHILIPS ClearVue 350 and SAMSUNG Accuvix XG machines equipped with a 2–5 MHz curvilinear transducer. Fetal biometry and morphology scans were performed along with Doppler assessment of the uterine artery, umbilical artery, and middle cerebral artery (MCA).

For uterine artery Doppler, the transducer was placed in the longitudinal plane to identify the external iliac artery, and then angled medially to visualize the uterine artery at its crossover point. Doppler waveforms were obtained when at least three consecutive uniform waveforms were recorded, and indices were measured using automated or manual tracing methods.

Umbilical artery Doppler was performed by identifying a free loop of the umbilical cord under grey-scale imaging, followed by colour Doppler confirmation. Waveforms were recorded during fetal apnoea to avoid artefacts.

For MCA Doppler, a transverse section of the fetal head at the level of the biparietal diameter was obtained. The transducer was then adjusted to visualize the circle of Willis, and the MCA was identified as a major lateral branch. Pulsed Doppler sampling was performed at the proximal segment of the MCA to obtain flow velocity waveforms.

The Doppler parameters assessed included systolic/diastolic (S/D) ratio and pulsatility index (PI) of the umbilical artery, S/D ratio of the uterine artery, and PI of the MCA. Abnormal Doppler findings were defined as uterine artery S/D ratio above the 95th percentile with persistence of early diastolic notch; umbilical artery S/D ratio or PI above the 95th percentile, or presence of absent/reversed end-diastolic flow; and MCA PI below the 5th percentile. Values between the 90th–95th percentile for uterine and umbilical arteries and 5th–10th percentile for MCA were considered borderline.

All patients were followed up until delivery. Data regarding antenatal events, mode of delivery, and neonatal outcomes were recorded. Adverse pregnancy outcomes assessed included IUGR, intrauterine death (IUD), Apgar score at 5 minutes, NICU admission, and birth weight.

Statistical analysis was performed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean  $\pm$  standard deviation (SD), while categorical variables were presented as frequencies and percentages. The Student's t-test was used for comparison of continuous variables, and the Chi-square test was applied for categorical data. A p-value of  $<0.05$  was considered statistically significant.

## RESULTS

A total of 105 participants were included in the present study. Their baseline characteristics were as below.

**Table 1. Baseline Characteristics of Study Population (n = 105)**

Variable	Category	n (%) / Mean $\pm$ SD
Age	<20 years	19 (18.10%)
	21–30 years	79 (75.24%)
	31–40 years	7 (6.67%)
	Mean $\pm$ SD	24.09 $\pm$ 4.22
Parity	Multipara	62 (59.05%)
	Primigravida	43 (40.95%)
Hemoglobin	Severe anemia	20 (19.05%)
	Moderate anemia	43 (40.95%)
	Mild anemia	17 (16.19%)

	Normal	25 (23.81%)
	Mean $\pm$ SD	9.04 $\pm$ 2.40
<b>Blood Group</b>	B+	36 (34.29%)
	A+	27 (25.71%)
	O+	25 (23.81%)
	AB+	16 (15.24%)
	A-	1 (0.95%)
<b>Sickle Cell Status</b>	Negative	70 (66.67%)
	Positive	35 (33.33%)
<b>Hypertension</b>	Present	40 (38.10%)
	Absent	65 (61.90%)

The baseline characteristics of the study population (n = 105) demonstrated that the majority of participants were in the 21–30 years age group (75.24%), with a mean age of 24.09  $\pm$  4.22 years. Multiparous women constituted a higher proportion (59.05%) compared to primigravida (40.95%). A high prevalence of anaemia was observed, with most participants having moderate (40.95%) or severe anaemia (19.05%), and a mean haemoglobin level of 9.04  $\pm$  2.40 g/dL. Blood group B positive was the most common (34.29%), and the majority were Rh-positive. Sickle cell trait/disease was present in 33.33% of participants. Additionally, 38.10% of the study population had hypertension, indicating a substantial burden of high-risk factors.

**Table 2. Obstetric & Ultrasound Profile**

Parameter	Category	n (%) / Mean $\pm$ SD
<b>Gestational Age</b>	<32 weeks	59
	>32 weeks	46
<b>Doppler Abnormality</b>	<32 weeks	29 (49.15%)
	>32 weeks	5 (10.87%)
<b>AFI</b>	Oligohydramnios	33 (31.43%)
	Normal	72 (68.57%)
	Mean AFI	9.48 $\pm$ 3.33 cm

The obstetric and ultrasound profile showed that the majority of patients underwent Doppler evaluation before 32 weeks of gestation (59 cases), compared to 46 cases after 32 weeks. Doppler abnormalities were more frequently observed in the <32 weeks group (49.15%) than in the >32 weeks group (10.87%). Oligohydramnios was present in 31.43% of patients, while 68.57% had normal amniotic fluid levels, with a mean AFI of 9.48  $\pm$  3.33 cm, indicating a tendency toward reduced amniotic fluid in this high-risk population.

**Table 3. Umbilical Artery Doppler Findings**

Parameter	Value
PI	1.09 $\pm$ 0.63
RI	0.58 $\pm$ 0.13
S/D Ratio	3.05 $\pm$ 2.17
PI Percentile	48.84 $\pm$ 38.47

**The umbilical artery Doppler analysis demonstrated a mean pulsatility index (PI) of 1.09  $\pm$  0.63, resistance index (RI) of 0.58  $\pm$  0.13, and S/D ratio of 3.05  $\pm$  2.17. The mean PI percentile was 48.84  $\pm$  38.47, indicating considerable variability in placental vascular resistance among the study population, reflecting differing degrees of fetoplacental compromise.**

**Table 4. EDF Abnormalities**

Category	n (%)
Reduced EDF	11 (10.48%)
Absent EDF	6 (5.71%)
Reversed EDF	5 (4.76%)
<b>Total Abnormal</b>	<b>22 (20.95%)</b>

End-diastolic flow (EDF) abnormalities were observed in 22 (20.95%) cases, indicating significant placental insufficiency in a subset of the study population. Among these, reduced EDF was the most common finding (10.48%), followed by absent EDF (5.71%) and reversed EDF (4.76%). These progressive abnormalities reflect increasing severity of fetoplacental compromise and are associated with adverse perinatal outcomes.

**Table 5. MCA & CPR Analysis with Diagnostic Accuracy**

Parameter		Value	
<b>MCA Findings</b>	PI	1.37 ± 0.30	
	RI	0.68 ± 0.12	
	S/D Ratio	3.98 ± 1.30	
	PI Percentile	12.00 ± 19.12	
	Abnormal PI (<5th)	48 (45.71%)	
<b>MCA Diagnostic Accuracy</b>	Sensitivity	58.93%	
	Specificity	69.39%	
	PPV	68.75%	
	NPV	59.65%	
	LR+	1.92	
	LR-	0.59	
<b>CPR Findings</b>	Category	n (%)	
	<1	30 (28.6%)	
	=1	1 (0.95%)	
	>1	74 (70.5%)	
	<5th percentile	30 (28.57%)	
	Mean ± SD	24.8 ± 28.38	
<b>CPR Diagnostic Accuracy</b>	Sensitivity	42.86%	
	Specificity	97.96%	
	PPV	96.00%	
	NPV	60.00%	
	LR+	21.00	
	LR-	0.58	
<b>MCA vs Outcomes</b>	<b>Outcome</b>	Abnormal MCA	Normal MCA
	<b>LSCS</b>	19	25
	<b>NICU</b>	17	12
	<b>Perinatal death</b>	6	9
	<b>Apgar &lt;7</b>	20	20
	<b>LBW</b>	32	23

The MCA Doppler analysis showed a mean PI of 1.37 ± 0.30 with 45.71% of cases demonstrating abnormal PI (<5th percentile), indicating cerebral redistribution in a significant proportion of fetuses. Abnormal MCA PI was associated with higher rates of adverse outcomes, particularly low birth weight and NICU admissions. The diagnostic accuracy of MCA PI revealed moderate sensitivity (58.93%) and specificity (69.39%). In contrast, CPR <1 was observed in 28.6% of cases and demonstrated high specificity (97.96%) and PPV (96.00%) but lower sensitivity (42.86%), indicating strong predictive value for adverse outcomes when abnormal (Table 5). Overall, CPR showed superior rule-in capability, while MCA PI provided moderate predictive utility in assessing fetal compromise.

**Table 6. Uterine Artery Doppler & Correlation**

	Parameter	Mean ± SD	
<b>Doppler Indices</b>	Mean PI	0.84 ± 0.33	
	Mean RI	~0.47	
	Mean S/D	~2.20	
	PI Percentile	53.25 ± 32.80	
	PDN (total)	25 (23.81%)	
<b>Abnormalities</b>	Bilateral	17 (16.19%)	
	Unilateral	8 (7.62%)	
	PI <5th percentile	9 (8.57%)	
	Total abnormal	33 (31.43%)	
<b>Diagnostic Accuracy</b>	Sensitivity	81.48%	
	Specificity	37.50%	
	PPV	66.67%	
	NPV	57.14%	
	LR+	1.30	
	LR-	0.50	
	<b>Group</b>	<b>LSCS</b>	Adverse Outcome

<b>Correlation with Outcomes</b>	Hypertensive	12 (48.0%)	22 (88.0%)
	Normotensive	4 (50.0%)	5 (62.5%)

Uterine artery Doppler evaluation demonstrated a mean PI of  $0.84 \pm 0.33$  with 31.43% of cases showing abnormal findings, including pre-diastolic notch (23.81%) and low PI percentile (8.57%). The diagnostic performance showed high sensitivity (81.48%) but low specificity (37.50%), indicating good screening ability but limited specificity. Abnormal uterine Doppler findings were more strongly associated with adverse outcomes in hypertensive patients (88.0%) compared to normotensive patients (62.5%), highlighting the significant impact of maternal hypertension on fetoplacental compromise (Table 6).

**Table 7. Perinatal Outcomes**

Parameter	Category	n (%) / Mean $\pm$ SD
<b>Mode of Delivery</b>	Vaginal (<32 week)	16 (15.24%)
	LSCS (<32 week)	10 (9.52%)
	Vaginal (>32 week)	45 (42.86%)
	LSCS (>32 week)	34 (32.38%)
<b>Birth Weight (kg)</b>	Overall	$2.16 \pm 0.80$
	$\geq 32$ weeks	$2.45 \pm 0.52$
	<32 weeks	$0.84 \pm 0.43$
	p-value	<0.01
<b>APGAR Score</b>	1 min	$5.91 \pm 2.70$
	5 min	$7.70 \pm 3.20$
<b>NICU Admission</b>	Yes	29 (27.6%)
	No	76 (72.4%)
<b>PPV Required</b>	Yes	22 (21%)
	No	83 (79%)
<b>Stillbirth (IUFD)</b>	Yes	11 (10.5%)
	No	94 (89.5%)
<b>Perinatal Death</b>	Yes	15 (14.3%)
	No	90 (85.7%)

The perinatal outcomes showed that vaginal delivery was more common after 32 weeks (42.86%), while LSCS was also frequently performed in this group (32.38%). The mean birth weight was  $2.16 \pm 0.80$  kg, with significantly lower weights in <32 weeks ( $0.84 \pm 0.43$  kg) compared to  $\geq 32$  weeks ( $2.45 \pm 0.52$  kg) ( $p < 0.01$ ). The mean APGAR scores improved from  $5.91 \pm 2.70$  at 1 minute to  $7.70 \pm 3.20$  at 5 minutes. NICU admission was required in 27.6% of neonates, and 21% required PPV. The study also reported stillbirth in 10.5% and overall perinatal mortality in 14.3% of cases (Table 7).

## DISCUSSION

The present study evaluated the role of ultrasonography, particularly Doppler velocimetry, in the screening of high-risk pregnancies for intrauterine growth restriction (IUGR). The study population predominantly comprised young women with a mean age of  $24.09 \pm 4.22$  years, with a higher proportion of multiparous patients. A significant burden of risk factors was observed, including anaemia, hypertension, and sickle cell status, all of which are known contributors to placental insufficiency and fetal compromise.

In this study, Doppler abnormalities were more frequently detected before 32 weeks of gestation (49.15%) compared to later gestation (10.87%), suggesting that early Doppler assessment is more sensitive in identifying fetoplacental insufficiency. Similar findings have been reported in previous studies, emphasizing the importance of early surveillance in high-risk pregnancies.

Umbilical artery Doppler findings demonstrated significant variability, with 20.95% of cases showing end-diastolic flow (EDF) abnormalities. These findings, particularly absent and reversed EDF, are well-established indicators of severe placental resistance and were associated with adverse perinatal outcomes. Comparable observations were reported by Gattani et al. [5], who highlighted the predictive value of abnormal umbilical artery Doppler in identifying fetal compromise.

Middle cerebral artery (MCA) Doppler showed that 45.71% of fetuses had reduced PI (<5th percentile), indicating cerebral redistribution. These cases were associated with higher rates of low birth weight, NICU admission, and perinatal mortality, supporting the role of MCA Doppler as a marker of fetal hypoxia. However, its moderate sensitivity and specificity in this study suggest limited utility when used alone. Similar findings were reported by Malik et al. [48], who demonstrated that

MCA PI alone has lower diagnostic accuracy and should be interpreted in conjunction with other parameters.

The cerebro-placental ratio (CPR) emerged as a superior predictor of adverse outcomes, with high specificity (97.96%) and positive predictive value (96.00%). This indicates strong rule-in capability for fetal compromise, consistent with findings from previous studies where combined Doppler indices were found to be more reliable than individual parameters.

Uterine artery Doppler abnormalities were observed in 31.43% of cases and were strongly associated with maternal hypertension and adverse fetal outcomes. The high sensitivity (81.48%) suggests its usefulness as a screening tool, although low specificity limits its standalone predictive value. Bendary et al. [46] similarly reported that abnormal uterine artery Doppler findings are early indicators of placental insufficiency and IUGR.

The perinatal outcomes in the present study showed a significant association between Doppler abnormalities and adverse events, including low birth weight, NICU admission, and perinatal death. Birth weight was significantly lower in preterm deliveries (<32 weeks) ( $p < 0.01$ ), highlighting the combined impact of prematurity and growth restriction.

The findings of this study are consistent with the systematic review by Imdad et al. [47], which demonstrated that Doppler velocimetry significantly reduces perinatal mortality in high-risk pregnancies. Similarly, Alfirevic et al. [49] reported that umbilical artery Doppler surveillance leads to improved perinatal outcomes by enabling timely intervention.

Overall, the present study reinforces that Doppler ultrasonography, particularly when multiple parameters such as umbilical artery, MCA, and CPR are used together, is an effective tool for early detection of fetal compromise and prediction of adverse perinatal outcomes. Integration of Doppler assessment into routine evaluation of high-risk pregnancies can facilitate timely clinical decision-making and improve neonatal outcomes.

## CONCLUSION

Doppler ultrasonography is an effective tool for early detection of IUGR and prediction of adverse perinatal outcomes in high-risk pregnancies. Parameters such as CPR, MCA PI, and uterine artery Doppler show significant association with fetal compromise, with CPR <1 being the most specific indicator. Early and combined multi-vessel Doppler assessment improves diagnostic accuracy and supports timely intervention, thereby reducing perinatal morbidity and mortality.

## REFERENCES

1. Chew LC, Osuchukwu OO, Reed DJ, et al. Fetal Growth Restriction. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan- [cited 2025 Dec 8]. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK562268/>
2. Sharma D, Shastri S, Sharma P. Intrauterine Growth Restriction: Antenatal and Postnatal Aspects. *Clin Med Insights Pediatr*. 2016 Jul 14;10:67-83.
3. Mustary M, Ansariadi, Syam A, Riskiyani S, Erika KA, Moedjiono AI, et al. Preeclampsia: Etiology, Pathophysiology, Risk Factors, Impact and Prevention: A Narrative Review. *Iran J Public Health*. 2024 Nov;53(11):2392-403.
4. Recker F, Gembruch U, Strizek B. Clinical Ultrasound Applications in Obstetrics and Gynecology in the Year 2024. *J Clin Med*. 2024 Feb 22;13(5):1244.
5. Gattani CM, Pradeep R. Role of ultrasonography in screening high risk mothers for detection of IUGR. *Int J Res Rev*. 2021;8(11):106-12.
6. Kale RM, Tirupathi RG, Sheela SR. Role of Ultrasonography and Color Doppler in the Assessment of High-Risk Pregnancies and Their Accuracy in Predicting Fetal Outcome. *Cureus*. 2023 May 15;15(5):e39017.
7. Malik R, Saxena A. Role of Colour Doppler Indices in the Diagnosis of Intrauterine Growth Retardation in High-Risk Pregnancies. *J Obstet Gynecol India*. 2013;63:37-44.
8. Bendary AA, Elgazzar MA, El Hodiby ME. The newly proposed an ultrasound scoring system for early pre-diction of intrauterine growth restriction in high-risk pregnancy: A prospective cohort study. *Egypt J Radiol Nucl Med*. 2013 Dec;44(4):651-7.
9. Imdad A, Yakoob MY, Siddiqui S, et al. Screening and triage of intrauterine growth restriction (IUGR) in general population and high risk pregnancies: a systematic review with a focus on reduction of IUGR related stillbirths. *BMC Public Health*. 2011;11 Suppl 3:S1.
10. Alfirevic Z, Neilson JP. Doppler ultrasonography in high-risk pregnancies: systematic review with meta-analysis. *Am J Obstet Gynecol*. 1995 May 1;172(5):1379-87.