Biomedical and Biopharmaceutical Research
Abbreviation: Biomed. Biopharm. Res.
Volume: 22: Issue: 01 |Year: 2025
Page Number: 481-485

Colour Doppler Evaluation in High-Risk Pregnancies and Its Predictive Value for Adverse Perinatal Outcomes: A Prospective Observational Study

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Article Received:29-06-2025

Article Accepted:20-07-2025

Abstract

Objective: To determine the role of Third Trimester Color Doppler in high risk pregnancies and their fetomaternal outcomes in form of different abnormal flow patterns in colour doppler,to decide time of delivery, mode of delivery and Neonatal outcomes in terms of : APGAR score, Birth weight, duration of NICU stay.

Methods: A prospective observational study of n = 350 high-risk singleton pregnancies (>32 weeks) underwent systematic Doppler evaluation of uterine, umbilical, and middle cerebral arteries. Measured indices included resistance index (RI), pulsatility index (PI), and systolic/diastolic (S/D) ratio. Doppler findings were classified as normal or abnormal based on established cutoffs for each vessel. Outcomes tracked included mode of delivery, gestational age at birth, birth weight, Apgar scores, NICU admissions, maternal complications (e.g. preeclampsia escalation), and perinatal morbidity/mortality

Results:

Umbilical artery PI > 1.5 showed 80% sensitivity and 88% specificity, observed in 25% of cases; linked to growth restriction, preterm birth, and NICU admissions.

Uterine artery RI > 0.55, seen in 28% of pregnancies, had moderate sensitivity (75%) and high specificity (82%), and correlated with PIH, IUGR, and fetal distress.

MCA PI < 1.2, seen in 20.6%, indicated the brain-sparing phenomenon, with 72% sensitivity and 85% specificity.

The most severe abnormality—A/REDF in the umbilical artery—occurred in 10% of cases and significantly predicted severe IUGR and perinatal death.

Abnormal Doppler findings correlated with a 60% cesarean rate, >55% NICU admissions, 40% low birth weight, and 44.9% preterm deliveries.

Conclusions: Third-trimester colour Doppler assessment offers a valuable, noninvasive window into fetomaternal
well-being in high-risk pregnancies. Abnormal Doppler parameters are strongly predictive of adverse fetomaternal outcomes, Integrating these indices into clinical practice enables timely interventions, optimizes delivery planning,and may significantly reduce perinatal morbidity and mortality.

Key words : High risk pregnancies, Colour Doppler, Uterine artery, Umbilical artery, Middle cerebral artery, IUGR, PIH, Brain Sparing effect, Perinatal outcome, NICU admission, Abnormal Doppler indices

INTRODUCTION

High-risk pregnancies—due to factors such as pregnancy-induced hypertension (PIH), intrauterine growth restriction (IUGR), anemia, diabetes, or placental insufficiency—are associated with increased perinatal complications.
Traditional monitoring tools often fail to detect early fetal compromise. Colour Doppler ultrasonography enables real-time assessment of maternal and fetal hemodynamics and allows timely interventions. This study evaluates the

correlation between abnormal Doppler indices and perinatal outcomes, aiming to reinforce its clinical utility in high-risk pregnancies.

Role of Colour Doppler: Color Doppler ultrasonography has revolutionized fetal surveillance by providing real-time, non-invasive assessment of maternal and fetal circulation. It allows visualization and quantitative measurement of blood flow velocities in key vessels such as the uterine arteries, umbilical artery, middle cerebral artery (MCA), and ductus venosus. Color Doppler indices such as the Systolic/Diastolic (S/D) ratio, Pulsatility Index (PI), and Resistance Index (RI) are essential in assessing placental resistance and fetal well-being.
Abnormal blood flow patterns, such as increased resistance in the uterine or umbilical arteries, can indicate placental insufficiency, while changes in cerebral blood flow reflect fetal adaptation to hypoxia predicting fetal distress and guide timely interventions.[3]. Such findings help clinicians predict and manage complications like IUGR, preterm delivery, and perinatal asphyxia[10].

Normal Colour Doppler Indices:

VESSEL	DOPPLER INDEX	NORMAL VALUES
UMBILICAL ARTERY	S/D Ratio	~2.6
	PI	1.5-1.0
	RI	0.45-0.7
MIDDLE CEREBRAL ARTERY	S/D	2.5-3.5
	PI	~0.83
	RI	~0.92
UTERINE ARTERY	S/D Ratio	2.0-3.0
	PI	1.45-1.65
	RI	0.45-0.55

MATERIALS AND METHODS
Study Design: This was a prospective observational study conducted over a one-year period (July 2023 to June 2024) at Pacific Medical College & Hospital, Udaipur, Rajasthan.

Sample Size: 350

Inclusion Criteria: Women with singleton pregnancy beyond 32 weeks of gestation, with high-risk conditions such as PIH, anemia, GDM, hypothyroidism, Rh incompatibility, IUGR, oligohydramnios, etc

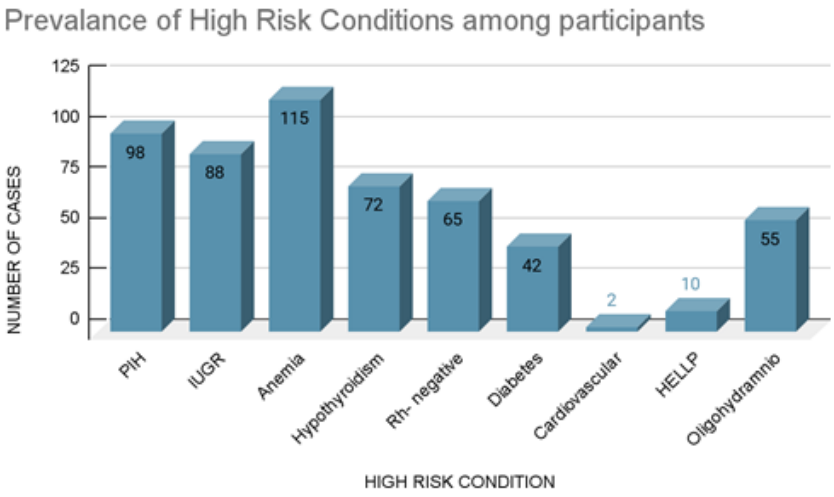
Exclusion Criteria: Women with congenital fetal anomalies, uncomplicated pregnancies, gestation <32 weeks, or those who did not consent.
Doppler Indices Evaluated: Umbilical artery, Middle cerebral artery (MCA), and Uterine artery using PI, RI, and S/D ratio.

Outcome Measures: Gestational age at delivery, mode of delivery, birth weight, NICU admission, and perinatal mortality.

Statistical Analysis: Chi-square test, logistic regression, and sensitivity/specificity analysis were used to assess associations.

RESULTS

1) Prevalence of High-Risk Conditions Among Participants

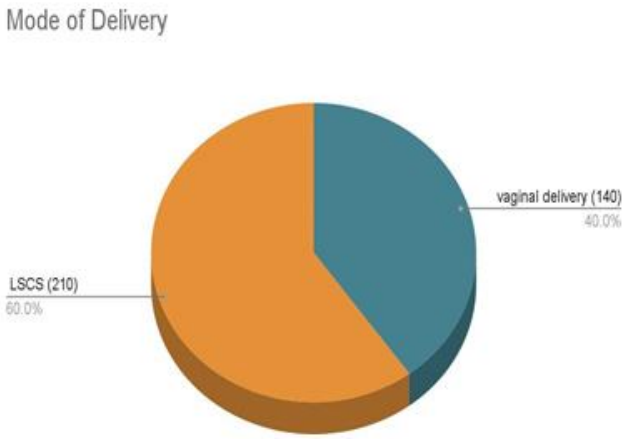


2) Correlation Between Doppler Abnormalities and Adverse Perinatal Outcomes

Doppler Abnormality	Associated Condition	Number of Cases	Percentage (%)
High Uterine Artery RI (>0.55)	PIH, IUGR, Fetal Distress	98	28%
Elevated Umbilical Artery PI (>1.5)	Placental Insufficiency, LBW, Preterm Birth	88	25%
Low Middle Cerebral Artery PI (<1.2)	Brain Sparing, Hypoxia	72	20.60%
Absent/Reversed End-Diastolic Flow	Severe IUGR, Fetal Mortality	35	10%

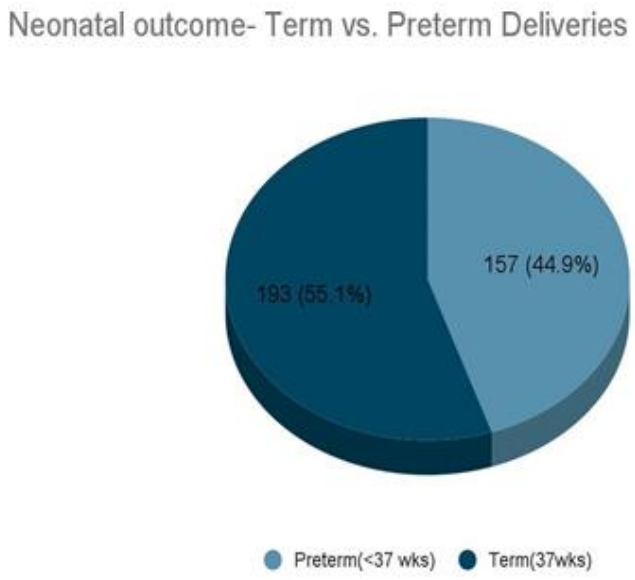
Out of 350 high risk pregnancies, 293 had abnormal doppler indices. High-resistance uterine artery flow (>0.55) was observed in 28% of cases. Elevated umbilical artery PI (>1.5) was linked to 25% of pregnancies.A low middle cerebral artery PI (<1.2) was found in 20.6% of cases.Absent or reversed end-diastolic flow in the umbilical artery, occurred in 10% of cases..

2) Mode of Delivery



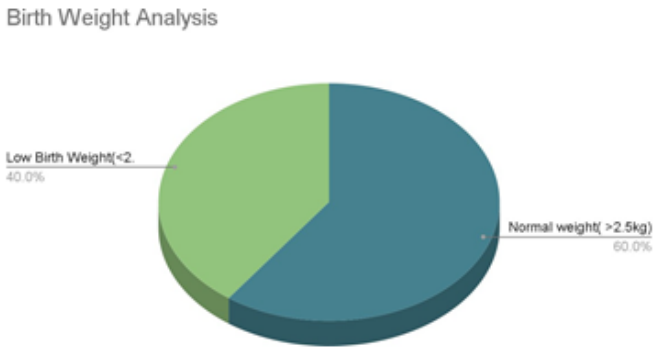
The study findings indicate that out of 350 deliveries,210 were cesarean deliveries which account for 60% of cases, and 140 were normal vaginal deliveries which were 40% of the total.

3) Percentage of Preterm vs. Term Deliveries



Preterm deliveries account for 44.9% (193)of cases. In contrast, 55.1% (157) of cases resulted in term deliveries

4) Birth Weight Analysis



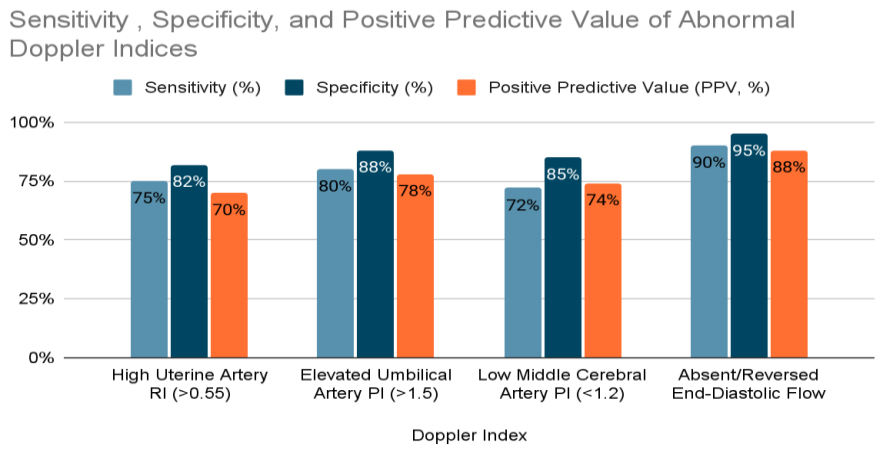
Neonatal birth weight data shows among 350 neonates 210 had normal birth weight(> 2.5 kg) and 40% i.e. 140 neonates had low birth weight

5) Incidence of RDS, MAS, HIE & Ventilatory Support

Neonatal Complication	Number of Cases	Percentage (%)
Respiratory Distress Syndrome (RDS)	70	20%
Meconium Aspiration Syndrome (MAS)	58	16%
Hypoxic-Ischemic Encephalopathy (HIE)	42	12%

Out of 350, 170(48%) needed NICU admission. Respiratory distress syndrome (RDS) in 20% of cases, and 40% of those needed ventilatory support. Meconium aspiration syndrome (MAS) occurred in 16%.. Hypoxic-ischemic encephalopathy (HIE) grade 1 affected 12% of neonates.

6) Sensitivity Specificity and Positive Predictive values of Doppler Indices



DISCUSSION

This study demonstrates that Colour Doppler ultrasonography is an effective tool for identifying fetal compromise in high-risk pregnancies. Abnormal Doppler findings—especially elevated umbilical artery PI and absent/reversed end-diastolic flow—were significantly associated with IUGR, low birth weight, NICU admissions, and perinatal mortality.

The brain-sparing effect indicated by decreased MCA PI further confirmed fetal adaptation to chronic hypoxia. Doppler indices were also highly predictive of LSCS requirements due to fetal distress. These results align with previous studies, including those by Alfirevic et al. and Khandelwal et al., which support the integration of Doppler into third-trimester antenatal care.By offering timely and non-invasive detection of compromised fetal status, Colour Doppler enables clinicians to optimize delivery timing, reducing the risk of adverse perinatal outcomes.

CONCLUSION

Colour Doppler ultrasonography is a valuable diagnostic tool in the surveillance of high-risk pregnancies. Its ability to detect abnormal blood flow patterns and predict adverse perinatal outcomes makes it indispensable for improving fetal care. Routine use in antenatal care can help reduce perinatal morbidity and mortality through timely interventions.

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