



ROLE OF COLOUR DOPPLER STUDIES IN HIGH-RISK PREGNANCY AND THEIR PERINATAL OUTCOME

Obstetrics & Gynaecology

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ABSTRACT

Background: High-risk pregnancies are associated with increased maternal and fetal morbidity and mortality, necessitating advanced diagnostic tools for better outcomes. Colour Doppler ultrasonography, a non-invasive imaging technique, provides critical insights into maternal and fetal hemodynamics. **Objective:** To analyze the role of Colour Doppler studies in predicting adverse perinatal outcomes in high-risk pregnancies. **Materials and Methods:** A prospective observational study was conducted at KD Medical College, Mathura, UP, over 12 months. A total of 100 pregnant women were included, categorized into high-risk (n=50) and normal pregnancies (n=50). Doppler indices of the middle cerebral artery (MCA), umbilical artery (UA), bilateral uterine arteries (UtA), and ductus venosus (DV) were assessed. Adverse fetal and maternal outcomes were recorded and statistically analyzed. **Results:** High-risk pregnancies had significantly higher adverse maternal outcomes (88% vs. 22%; $p<0.0001$) and fetal outcomes (86% vs. 26%; $p<0.0001$) compared to normal pregnancies. Specific Doppler parameters such as MCA S/D ratio (2.61 vs. 2.29; $p=0.0344$) and right uterine artery resistive index (0.81 vs. 1.03; $p=0.0483$) demonstrated significant predictive value for adverse outcomes. Preterm labor (62%), NICU admissions (38%), and low APGAR scores were notably higher in the high-risk group. **Conclusion:** Colour Doppler ultrasonography is an invaluable tool for identifying at-risk fetuses in high-risk pregnancies, enabling early intervention to mitigate adverse outcomes. Larger multicenter studies are required for standardization and validation of these findings.

KEYWORDS

High-risk pregnancy, Colour Doppler, Fetal outcomes, Maternal health, Hemodynamics.

INTRODUCTION

The journey of pregnancy, though natural and remarkable, can sometimes be fraught with complications that put both mother and child at risk. High-risk pregnancies, characterized by factors such as maternal age, pre-existing medical conditions, or fetal anomalies, require close monitoring and specialized care to achieve optimal outcomes. Our study highlights the critical role of Colour Doppler ultrasonography in managing high-risk pregnancies. This non-invasive imaging modality offers vital insights into utero-placental and fetal circulation, enabling early detection of complications such as placental insufficiency and guiding clinical decision-making to optimize perinatal outcomes.

Doppler ultrasonography measures shifts in the frequency of sound waves reflected by red blood cells, providing information on blood flow velocity and vascular resistance. Parameters such as the umbilical artery Doppler indices reveal placental resistance, while the middle cerebral artery assessment is crucial for detecting fetal anemia. The ductus venosus, known for its high diagnostic value, assists in determining the optimal timing for delivery in compromised fetuses.

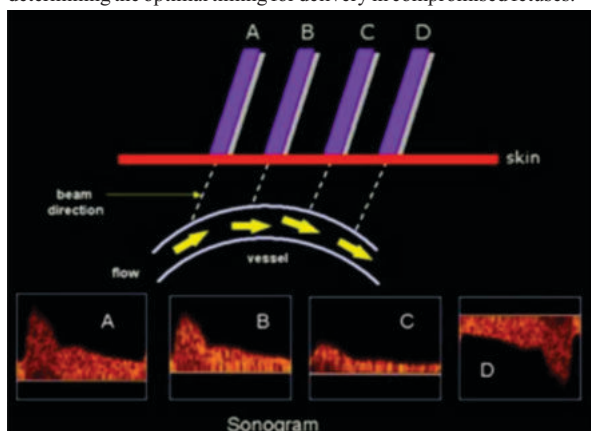


Fig. The impact of Doppler angle on the ultrasonography is depicted in this figure. The sonogram's Doppler angle effect. Diagram (A) illustrates that if beam is better aligned with the direction of flow, a higher-frequency Doppler signal is obtained. Beam (A) in the diagram produces higher-frequency Doppler signals because it is more aligned than beam (B). At (C), the beam/flow angle is nearly 90°, and the Doppler signal is quite weak. There is a negative signal at (D) and the flow is away from the beam.

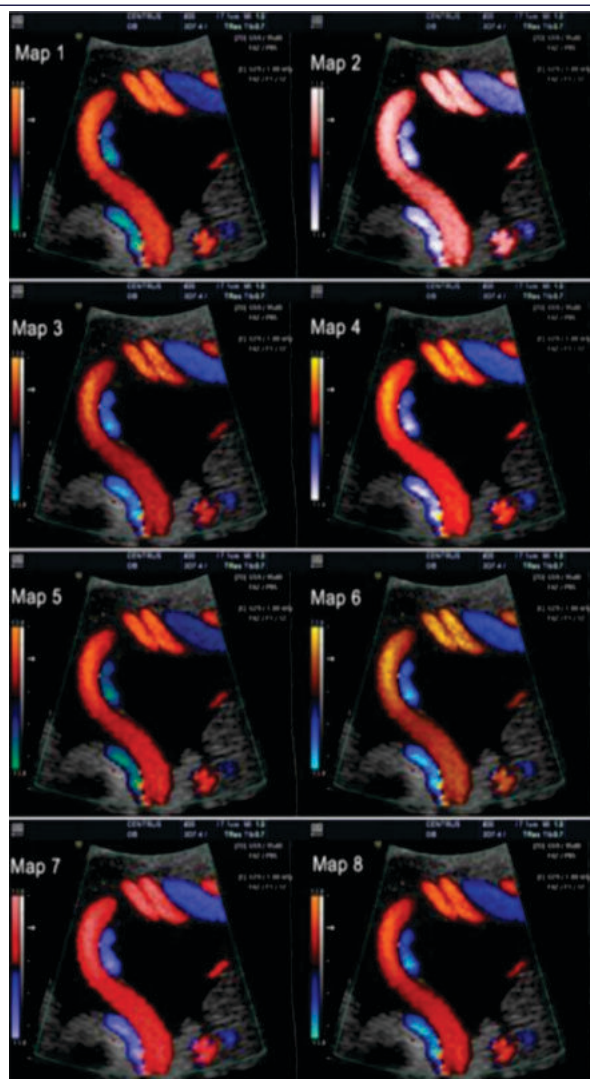


Fig. Color flow maps showing direction of blood flow

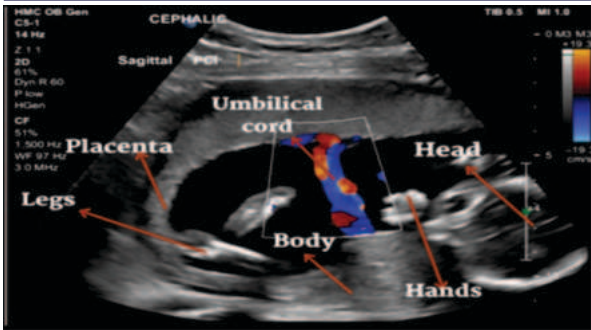


Fig. Utilizing Color Doppler Ultrasound for Fetal and Maternal Health Assessment in High-Risk Pregnancies

Our study evaluates the utility of Colour Doppler in identifying adverse fetomaternal outcomes in high-risk pregnancies. By analyzing key Doppler parameters and their correlation with clinical outcomes, this research aims to provide evidence-based insights for integrating Colour Doppler into routine prenatal care. The findings underscore its potential to significantly improve maternal and fetal health through early interventions and enhanced monitoring, advocating for its broader use in managing high-risk pregnancies.

MATERIALS AND METHODS

This prospective observational study was conducted at KD Medical College, Mathura, UP, over 12 months (2022–2023), following ethical approval and informed consent. A total of 100 pregnant women were categorized into 50 high-risk pregnancies (HRP) and 50 normal pregnancies.

Study Design

- **Type:** Prospective observational comparative study.
- **Sample Size:** 100 patients (50 HRP + 50 normal pregnancies).
- **Group Criteria:**
 - o **Group H:** Patients with high-risk features (e.g., anemia, hypertension, preeclampsia, GDM, IUGR, Rh isoimmunization).
 - o **Group N:** Patients with no high-risk features based on clinical and laboratory findings.

Selection Criteria

Inclusion: Pregnant women ≥18 years. High-risk pregnancies were identified based on specific conditions, including anemia, hypertension, and pre-eclampsia. Additional risk factors included teenage or elderly gravida, gestational diabetes mellitus, and clinically suspected intrauterine growth retardation (IUGR). Other criteria encompassed pregnancies complicated by oligohydramnios, polyhydramnios, Rh isoimmunization, thyroid disorders, liver disorders, a bad obstetric history, or a history of placenta accreta in previous pregnancies.

Exclusion: Exclusion criteria were also clearly defined to maintain the study's focus. These included participants unwilling to provide consent, pregnancies complicated by fetal congenital anomalies, twin pregnancies, or uterine anomalies. Furthermore, cases with an unreliable last menstrual period (LMP) or unconfirmed gestational age by early ultrasound were excluded to ensure accurate data collection and analysis.

Procedure

- **Screening & Grouping:** Participants were screened and categorized based on clinical and laboratory findings.
- **Assessment:** Baseline demographic and clinical data were collected. Fetomaternal outcomes and Doppler parameters (PI, RI, S/D ratio) were assessed for MCA, UA, uterine arteries, and ductus venosus using standard protocols.

Statistical Analysis

Data analysis used GraphPad Prism 8.4.2, SPSS v25, and MS Excel. Categorical data were analyzed with Fisher Exact and Chi-square tests, and continuous data with T-tests or non-parametric equivalents. Spearman's correlation assessed Doppler parameters' association with outcomes. Significance was set at $p < 0.05$.

RESULTS

Demographics and Clinical Characteristics

The study population included women with a mean age of 27.34 years

in the high-risk pregnancy (HRP) group and 27.04 years in the normal pregnancy group, with no statistically significant difference between the groups. The most common high-risk factors identified were pregnancy-induced hypertension (PIH) or preeclampsia (42%), followed by gestational diabetes mellitus (12%) and anemia (12%). These findings highlight the predominant role of hypertensive disorders as a leading contributor to high-risk pregnancies, consistent with the global prevalence of PIH as a significant obstetric complication.

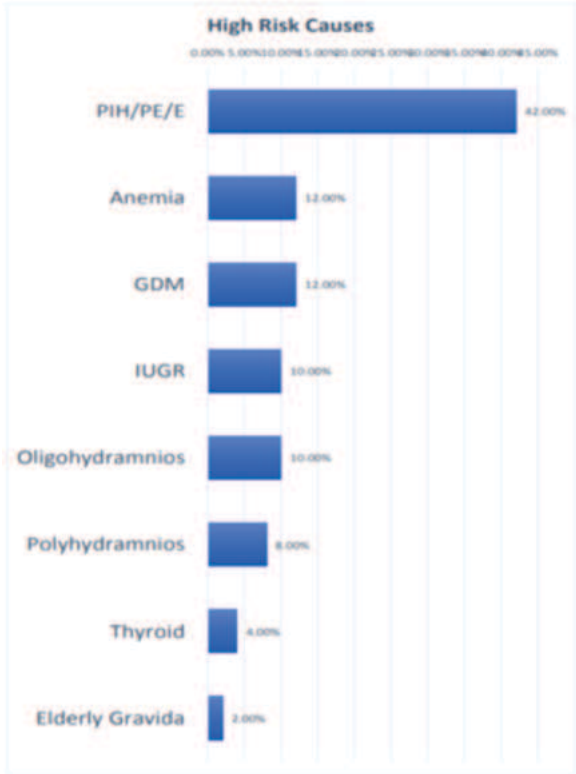


Fig. Cause of high-risk Pregnancy

Maternal Outcomes

High-risk pregnancies were associated with significantly higher adverse maternal outcomes, reported in 88% of cases compared to 22% in the normal pregnancy group ($p < 0.0001$). Preterm labor occurred in 62% of high-risk pregnancies versus only 10% in normal pregnancies ($p < 0.0001$), emphasizing the link between high-risk factors and premature birth. Cesarean section rates were also notably higher in the HRP group (34%) compared to the normal group (8%) ($p = 0.0015$), driven by complications such as fetal distress, placental insufficiency, or maternal hypertensive crises.

Table: Maternal Outcomes

Outcomes	HR	% HR	Normal	% Normal	P Value
Maternal Outcome (Overall)	44	88	11	22	<0.0001
Pre-term labor (<37 wks)	31	62	5	10	<0.0001
LSCS/ Assisted =1	17	34	4	8	0.0015
Prolonged obstructed labor	6	12	1	2	0.0512
Maternal mortality	1	2	0	0	0.3173

Explanation: The high prevalence of maternal complications in HRP underscores the critical need for close monitoring and intervention. The higher rate of preterm labor and cesarean deliveries reflects the severity of conditions such as PIH and IUGR, which often necessitate early delivery to prevent further maternal and fetal morbidity.

Fetal Outcomes

Adverse fetal outcomes were observed in 86% of HRP cases compared to 26% in the normal pregnancy group ($p < 0.0001$). These outcomes included NICU admissions (38% in HRP vs. 6% in normal pregnancies; $p = 0.0001$), low APGAR scores (<7 at 1 minute) (54% in HRP vs. 8% in normal pregnancies; $p < 0.0001$), and stillbirths. Such findings underscore the substantial impact of high-risk factors on neonatal health, with complications like intrauterine growth restriction and fetal hypoxia being the leading contributors.

Table: Fetal Outcomes

Outcomes	HR	% HR	Normal	% Normal	P Value
Fetal outcomes (Overall)	43	86	13	26	0.0001
Live/Death (Stillbirth)	4	8	0	0	0.0423
Low Birth Weight	18	36	5	10	0.0021
NICU admission	19	38	3	6	0.0001
APGAR <7 at 1 min	27	54	4	8	0.0001
APGAR <7 at 5 mins	11	22	2	4	0.0078
SGA	13	26	3	6	0.0066
Macrosomia	3	6	0	0	0.0802
Neonatal hyperbilirubinemia	15	30	5	10	0.0129
Metabolic Disorders	2	4	0	0	0.1552

Explanation: The increased rates of NICU admissions and low APGAR scores indicate a compromised neonatal status at birth, driven by factors such as poor placental perfusion and fetal growth restrictions. These findings emphasize the need for timely identification and management of high-risk pregnancies to improve neonatal outcomes.

Doppler Indices

Key Doppler parameters demonstrated significant predictive value for adverse outcomes. The MCA S/D ratio was higher in the HRP group (2.61) compared to the normal group (2.29) (p=0.0344), indicating increased cerebral blood flow redistribution in response to fetal hypoxia. The uterine artery resistive index was significantly lower in HRP cases (0.81) compared to normal pregnancies (1.03) (p=0.0483), suggesting reduced placental vascular resistance, a common finding in placental insufficiency.

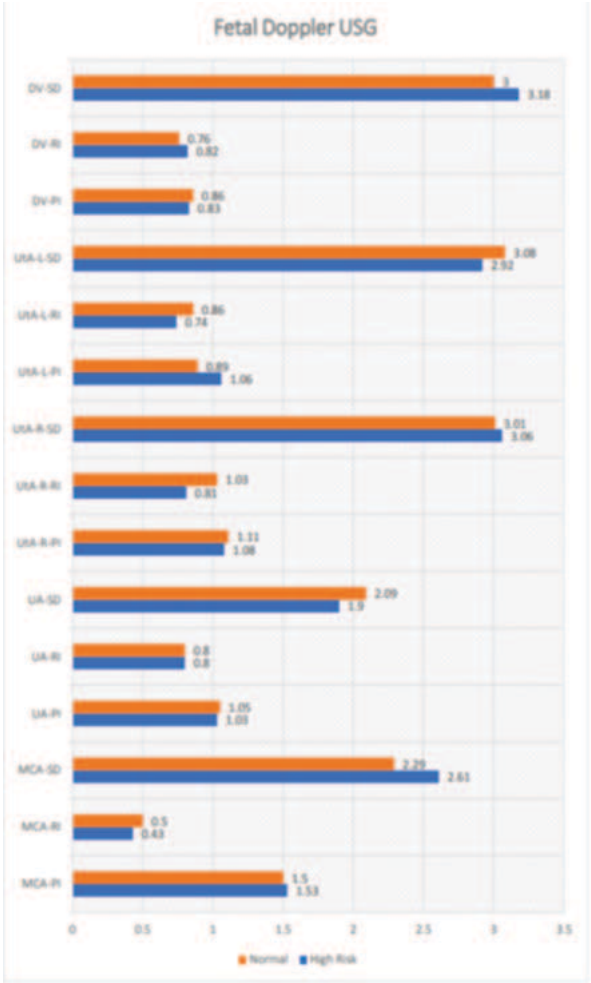


Fig. Fetal Doppler USG

Explanation: These Doppler findings are consistent with pathophysiological adaptations in high-risk pregnancies, where impaired placental function leads to fetal hypoxia, prompting compensatory changes in cerebral blood flow. The predictive value of

these indices highlights their importance as early markers for adverse outcomes.

DISCUSSION

The study conducted by the Obstetrics and Gynecology Department of KD Medical College assessed 50 high-risk pregnancies (HRP) and 50 normal pregnancies to evaluate adverse fetomaternal outcomes. Doppler ultrasonography was used to assess key vascular indices in both groups, and correlations were analyzed to predict adverse outcomes in HRP.

Profile of High-Risk Pregnancies

The mean age of HRP patients (27.34 ± 4.90 years) was comparable to the normal group (27.04 ± 4.63 years), with no significant differences in median age, gravidity, or gestational age. Most participants were under 30 years, consistent with findings by Chate et al. (2022) and Kulshreshtha et al. (2019), where high-risk pregnancies were predominantly in the 20–30 age range^{6,7}. Common high-risk factors included preeclampsia (42%), anemia (12%), GDM (12%), and IUGR (10%), in agreement with studies by Mahima Kale et al. (2023) and Shweta Khade et al. (2021)^{2,8}.

Fetomaternal Outcomes

Adverse maternal outcomes were significantly higher in HRP (88% vs. 22%), with preterm labor (62%), cesarean deliveries (34%), and maternal death (2%) being more frequent. Comparable patterns were observed in fetal outcomes, including NICU admissions (38% vs. 6%), low APGAR scores (54% vs. 8% at 1 minute), and stillbirths (8% vs. 0%). These findings are consistent with studies by Labib et al. (2023) and Kulshreshtha et al. (2019), which reported similar patterns in high-risk cohorts^{3,7}.

Doppler Indices

Key Doppler indices—MCA S/D ratio, umbilical artery S/D ratio, and right uterine artery resistive index—showed significant differences between HRP and normal pregnancies. Elevated MCA S/D ratios (2.61 vs. 2.29) and reduced uterine artery resistive indices (0.81 vs. 1.03) reflected compromised placental and fetal hemodynamics. These findings align with Labib et al. (2023) and Moawad et al. (2022), who emphasized the predictive utility of abnormal Doppler parameters in detecting adverse outcomes^{3,7}.

Comparative Analysis with Literature

The study corroborates prior findings that Doppler ultrasonography predicts adverse perinatal outcomes. For example:

- La Verde et al. (2023) and Neilson et al. (2000) reported reduced perinatal mortality with Doppler-guided monitoring^{4,9}.
- Moawad et al. (2022) highlighted cerebroplacental ratio (CPR) as the most sensitive marker of poor neonatal outcomes in late-onset preeclampsia⁷.
- Mahima Kale et al. (2023) found that abnormal UA PI was associated with IUGR and low birth weight, supporting similar observations in this study².

Clinical Implications

Routine integration of Doppler studies into antenatal care for HRP can guide timely interventions. Early identification of compromised fetal circulation enables clinicians to optimize delivery timing and improve neonatal outcomes. This study further emphasizes the need for multicenter trials to validate and refine Doppler protocols for high-risk pregnancies.

Limitations and Future Directions

The single-centre design and small sample size limit generalizability. Future research should focus on combining indices like CPR and exploring venous Doppler parameters for a more holistic assessment of fetal health. Multicentre trials with larger cohorts will strengthen evidence for routine Doppler use in HRP management.

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