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Comparative Study of Colour Doppler Versus Non Stress Test as a Predictor of Perinatal Outcome in PIH and IUGR

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Abstract
Hypertensive disorders of pregnancy (PIH) and intrauterine growth restriction (IUGR) are significant causes of perinatal morbidity and mortality. Predicting perinatal outcomes in these conditions is crucial for timely and effective intervention. This study aims to compare the predictive accuracy of Color Doppler and Non-Stress Test (NST) in assessing perinatal outcomes in pregnancies complicated by PIH and IUGR. A prospective observational study was conducted from April 1, 2019, to March 31, 2020, in the Department of Radiology at Darbhanga Medical College and Hospital, Darbhanga. A total of 100 pregnant women diagnosed with PIH and/or IUGR were enrolled. Participants underwent both Color Doppler and NST assessments. Perinatal outcomes were monitored and recorded, including Apgar scores, birth weight and neonatal intensive care unit (NICU) admissions. The predictive accuracy of each test was evaluated using statistical analysis. Out of the 100 participants, 60% had abnormal Color Doppler findings, while 45% had non-reactive NST results. The sensitivity, specificity, positive predictive value and negative predictive value for predicting adverse perinatal outcomes were 85%, 70%, 75% and 80% for Color Doppler, respectively, compared to 65%, 85%, 78% and 74% for NST. Neonates with abnormal Doppler findings had a significantly higher incidence of low Apgar scores (<7 at 5 minutes), low birth weight (<2500g) and NICU admissions. Color Doppler demonstrated superior sensitivity and negative predictive value in predicting adverse perinatal outcomes compared to NST in pregnancies complicated by PIH and IUGR. While NST had higher specificity, its lower sensitivity suggests that Color Doppler may be a more reliable tool for identifying at-risk pregnancies and guiding clinical management.

INTRODUCTION

Hypertensive disorders of pregnancy, particularly pregnancy-induced hypertension (PIH) and intrauterine growth restriction (IUGR) are significant contributors to perinatal morbidity and mortality worldwide. The timely prediction and management of adverse perinatal outcomes in these high-risk pregnancies are crucial for improving neonatal health and survival rates[1,2].

Color Doppler ultrasound and the Non-Stress Test (NST) are two commonly used non-invasive methods for fetal surveillance in high-risk pregnancies. Color Doppler ultrasound assesses the blood flow in the umbilical artery, middle cerebral artery and ductus venosus, providing valuable information about fetal hemodynamics and placental function[3]. Studies have shown that abnormal Doppler indices are associated with adverse perinatal outcomes, including low birth weight, low Apgar scores and increased neonatal intensive care unit (NICU) admissions[4,5].

The NST, on the other hand, monitors fetal heart rate patterns in response to fetal movements, indicating fetal well-being. A reactive NST is generally considered a reassuring sign, while a non-reactive NST suggests potential fetal compromise[6]. However, the predictive accuracy of NST for adverse perinatal outcomes remains a topic of debate, with some studies suggesting limited sensitivity in high-risk populations[7].

This study aims to compare the predictive accuracy of Color Doppler ultrasound and NST in assessing perinatal outcomes in pregnancies complicated by PIH and IUGR. By evaluating the sensitivity, specificity and predictive values of these tests, we seek to determine their relative effectiveness in clinical practice, thereby aiding in the early identification and management of at-risk pregnancies.

MATERIALS AND METHODS

Study Design: This prospective observational study was conducted in the Department of Radiology at Darbhanga Medical College and Hospital, Darbhanga, from April 1, 2019-March 31, 2020. The study aimed to compare the predictive accuracy of Color Doppler ultrasound and Non-Stress Test (NST) in assessing perinatal outcomes in pregnancies complicated by pregnancy-induced hypertension (PIH) and intrauterine growth restriction (IUGR).

Study Population: A total of 100 pregnant women diagnosed with PIH and/or IUGR were enrolled in the study. Inclusion criteria were singleton pregnancies, gestational age between 28 and 40 weeks and confirmed diagnosis of PIH or IUGR based on clinical and ultrasound criteria. Exclusion criteria included multiple pregnancies, congenital fetal anomalies and maternal conditions other than PIH that could affect fetal growth and outcomes.

Procedures:

Color Doppler Ultrasound: All participants underwent Color Doppler ultrasound using a standard protocol. Doppler assessments were performed on the umbilical artery, middle cerebral artery and ductus venosus. The indices measured included systolic/diastolic (S/D) ratio, pulsatility index (PI) and resistance index (RI). Abnormal Doppler findings were defined as elevated S/D ratio, PI, or RI in the umbilical artery, decreased PI or RI in the middle cerebral artery, or abnormal flow in the ductus venosus.

Non-Stress Test (NST): NSTs were conducted using standard electronic fetal monitoring equipment. Each NST session lasted for 20 minutes. A reactive NST was defined as the presence of at least two accelerations of 15 beats per minute above baseline, lasting for at least 15 seconds within a 20-minute period. Non-reactive NSTs were those that did not meet these criteria.

Data Collection: Demographic and clinical data were collected for all participants, including maternal age, parity, gestational age at diagnosis and previous obstetric history. Perinatal outcomes were recorded, including Apgar scores at 1 and 5 minutes, birth weight and the need for NICU admission.

Statistical Analysis: Data were analyzed using statistical software. The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of Color Doppler and NST were calculated to assess their predictive accuracy for adverse perinatal outcomes. Chi-square tests and t-tests were used to compare categorical and continuous variables, respectively. A $p<0.05$ was considered statistically significant.

RESULTS AND DISCUSSIONS

A total of 100 pregnant women diagnosed with PIH and/or IUGR were included in the study. The demographic and clinical characteristics of the study population are summarized in (Table 1).

Color Doppler and NST Findings: Out of the 100 participants, 60% had abnormal Color Doppler findings, while 45% had non-reactive NST results. The distribution of these findings is presented in (Table 2).

Perinatal Outcomes: The perinatal outcomes measured included Apgar scores at 1 and 5 minutes, birth weight and NICU admissions. The comparison of these outcomes between normal and abnormal test findings is detailed in Tables 3 and 4.

Table 1: Demographic and Clinical Characteristics of the Study Population

Characteristic	Value
Mean Maternal Age (years)	28.4 ± 4.2
Mean Gestational Age (weeks)	32.5 ± 3.1
Primigravida	45%
Multigravida	55%
Diagnosed with PIH	60%
Diagnosed with IUGR	40%

Table 2: Distribution of Color Doppler and NST Findings

Test	Normal Findings	Abnormal Findings
Color Doppler	40%	60%
NST	55%	45%

Table 3: Perinatal Outcomes Based on Color Doppler Findings

Outcome	Normal Doppler	Abnormal Doppler
Apgar Score <7 at 1 min	10%	35%
Apgar Score <7 at 5 min	5%	30%
Mean Birth Weight (grams)	2850 ± 400	2200 ± 500
NICU Admissions	15%	45%

Table 4: Perinatal Outcomes Based on NST Findings

Outcome	Reactive NST	Non-Reactive NST
Apgar Score <7 at 1 min	12%	28%
Apgar Score <7 at 5 min	8%	24%
Mean Birth Weight (grams)	2750 ± 450	2350 ± 550
NICU Admissions	20%	40%

Table 5: Predictive Accuracy of Color Doppler and NST

Test	Sensitivity	Specificity	PPV	NPV
Color Doppler	85%	70%	75%	80%
NST	65%	85%	78%	74%

Predictive Accuracy: The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of Color Doppler and NST in predicting adverse perinatal outcomes are summarized in Table 5.

Color Doppler demonstrated higher sensitivity (85%) and negative predictive value (80%) compared to NST, while NST showed higher specificity (85%) and positive predictive value (78%). Neonates with abnormal Doppler findings had a significantly higher incidence of low Apgar scores, lower birth weights, and increased NICU admissions compared to those with normal Doppler findings. Similarly, non-reactive NSTs were associated with poorer perinatal outcomes compared to reactive NSTs.

These results suggest that Color Doppler is a more sensitive predictor of adverse perinatal outcomes in pregnancies complicated by PIH and IUGR, while NST provides higher specificity.

The findings of this study demonstrate that Color Doppler ultrasound is a more sensitive predictor of adverse perinatal outcomes compared to the Non-Stress Test (NST) in pregnancies complicated by pregnancy-induced hypertension (PIH) and intrauterine growth restriction (IUGR). This is consistent with previous studies that have highlighted the utility of Doppler indices in high-risk pregnancies[1,2].

Sensitivity and Specificity: Color Doppler showed a sensitivity of 85% and a negative predictive value (NPV) of 80%, making it a reliable tool for identifying fetuses at risk of adverse outcomes. This is in line with studies by Baschat *et al.,* which reported that abnormal Doppler findings are strongly associated with fetal compromise and poor perinatal outcomes[3]. Conversely, the NST demonstrated a lower sensitivity (65%) but higher specificity (85%) and positive predictive value (PPV) (78%). This suggests that while NST is effective in confirming fetal well-being, it may not be as reliable in identifying all at-risk fetuses[4].

Perinatal Outcomes: Neonates with abnormal Doppler findings had significantly lower birth weights, lower Apgar scores and higher rates of NICU admissions compared to those with normal Doppler results. These outcomes reflect the hemodynamic changes and placental insufficiency often present in PIH and IUGR, which Doppler ultrasound can effectively detect[5]. The NST, while useful, did not correlate as strongly with these adverse outcomes, highlighting its limitations in high-risk populations.

Clinical Implications: The superior sensitivity of Color Doppler makes it a valuable tool in the management of PIH and IUGR, allowing for early intervention and potentially improving perinatal outcomes. The high specificity of NST, however, means it can still play a role in confirming fetal well-being, particularly in settings where Doppler ultrasound may not be readily available[6].

Limitations: This study has some limitations. The sample size of 100 participants, while adequate, may not capture the full variability seen in larger

populations. Additionally, the study was conducted in a single medical center, which may limit the generalizability of the findings. Future studies with larger, multi-center populations could provide more robust data.

CONCLUSION

In conclusion, Color Doppler ultrasound outperforms the NST in predicting adverse perinatal outcomes in pregnancies complicated by PIH and IUGR, owing to its higher sensitivity and NPV. These findings support the integration of Color Doppler into routine fetal surveillance protocols for high-risk pregnancies to ensure timely and effective clinical interventions.

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