

**ORIGINAL ARTICLE**<https://doi.org/10.3329/mediscope.v13i2.91969>**Diagnostic Value of Color Doppler Sonography and Its Correlation with Perinatal Outcome in Severe Pre-eclampsia Patients*****Ayesha Siddiqua¹, Anzuman Ara², Gayetri Rani³, Kaberi Guha⁴, Shirin Akter Jahan⁵, Hosne Ara⁶, Rawshan Ara⁷**

1. Assistant Professor (In situ), Department of Obstetrics and Gynaecology, Shaheed Suhrawardy Medical College Hospital, Dhaka, Bangladesh.

2. Assistant Professor (In situ), Jhikorgaccha Upazila Health Complex, Jhikorgaccha, Jashore, Bangladesh.

3. Assistant Professor (In situ), Department of Obstetrics and Gynaecology, NICRH, Dhaka, Bangladesh.

4. Assistant Professor, Department of Obstetrics and Gynaecology, Shaheed Suhrawardy Medical College Hospital, Dhaka, Bangladesh.

5. Assistant Professor (In situ), Department of Obstetrics and Gynaecology, Shaheed Suhrawardy Medical College Hospital, Dhaka, Bangladesh.

6. Assistant Professor (In situ), Department of Obstetrics and Gynaecology, Shaheed Suhrawardy Medical College Hospital, Dhaka, Bangladesh.

7. Associate Professor, Department of Reproductive Endocrinology & Infertility, Dhaka Medical College Hospital, Dhaka, Bangladesh.

***Corresponding author:** Dr Ayesha Siddiqua, Assistant Professor (In situ), Department of Obstetrics and Gynaecology, Shaheed Suhrawardy Medical College Hospital, Dhaka, Bangladesh. Email: drayesha39@gmail.com
<https://orcid.org/0009-0007-0797-0711>

How to cite: Siddiqua A, Ara A, Rani G, Guha K, Jahan SA, Ara H, Ara R. Diagnostic Value of Color Doppler Sonography and Its Correlation with Perinatal Outcome in Severe Pre-eclampsia Patients. Mediscope 2026; 13(2): 118-123.
<https://doi.org/10.3329/mediscope.v13i2.91969>

Submission: 08 October 2025

Acceptance: 19 May 2026

Publication: 30 July 2026



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Abstract

Background: One of the most frequent pregnancy problems that raises mother and fetal mortality and morbidity is preeclampsia. In patients with preeclampsia, Doppler ultrasonography can be a helpful tool to evaluate fetal outcome. This study aimed to ascertain the perinatal outcome based on Doppler alterations observed in the middle cerebral artery, uterine, and umbilical. **Objectives:** Assessment of the diagnostic value of color Doppler sonography and its correlation with perinatal outcome in severe pre-eclampsia patients. **Methods:** This prospective study was conducted in the Department of Obstetrics and Gynaecology, Dhaka Medical College Hospital (DMCH), Dhaka, from 22 December 2023 to 21 June 2024, a period of six months. where 50 patients were studied, aged between 16 and 35 years, selected by a convenient sampling method, whose color doppler sonography was done between 29 and 40 weeks of gestation. **Results:** In this study, 50 patients with severe pre-eclampsia who were admitted to DMCH were assessed using color Doppler to measure the blood flow indices (S/D PI, RI) of the middle cerebral artery, umbilical artery, and uterine artery. The majority of these patients had abnormal blood flow, with 70%, 68%, and 62% of them having adverse perinatal outcomes, and 15 (30%) of those patients had normal outcomes. The relationship was statistically examined, and the results showed a favorable association between the perinatal outcome and the color Doppler findings of the uterine, umbilical, and middle cerebral artery blood flow indices. **Conclusion:** Our study's findings suggest that pregnant individuals with pre-eclampsia who have aberrant blood vessel Doppler indices will have poor perinatal outcomes. As a result, Doppler ultrasonography can be used to monitor and treat the patients appropriately.

Keywords: Color Doppler sonography, Pre-eclampsia, Perinatal outcome.

Introduction

Prenatal testing's primary objective is to identify fetuses who are at risk for perinatal morbidity and mortality. Poor fetoplacental perfusion has long been known to be linked to pre-eclampsia and, later, intrauterine growth retardation (IUGR). Pregnancy-related problems contribute significantly to perinatal morbidity and mortality.¹

Doppler ultrasound has been used to quantify impedance indices as an early screening tool for high-risk pregnancies because it can detect fetal placental vascular resistance. The most prevalent cause of growth retardation, placental insufficiency, is brought on by pre-eclampsia. Growth retardation is a serious obstetric issue because of its strong correlation with perinatal morbidity and mortality. When the weight of all fetuses at that gestational age grows to the 10th or lower percentile, it is known as intrauterine growth retardation.²

The fetus's inability to develop to its full potential is a hallmark of IUGR. The second most common cause of perinatal mortality is intrauterine growth retardation.³ Severe morbidity, such as elevated rates of meconium aspiration, hypoglycemia, respiratory distress syndrome, intrapartum developmental delay, and stillbirth, is linked to IUGR. Increased perinatal mortality and morbidity, as well as impaired neurodevelopment, are linked to intrauterine growth retardation.⁴

One of the primary goals of prenatal treatment is to accurately identify the impaired IUGR fetus so that prompt intervention can take place. Of all the noninvasive tests for prenatal health, the color Doppler is the most exacting. Fetal hemodynamics can be evaluated noninvasively with Doppler ultrasonography. IUGR-affected newborns are more likely to develop diabetes, heart disease, and hypertension in the future. Doppler ultrasound of the uterine artery can be used to evaluate uteroplacental circulation. The most common cause of intrauterine growth retardation, which is a significant obstetric issue due to its strong correlation with perinatal mortality and morbidity, is placental insufficiency, whether it is primary or secondary to maternal conditions like hypertension, poor nutrition, etc. Early detection of placental insufficiency is crucial for minimizing its risks.⁵ The umbilical artery, fetal middle cerebral artery, and maternal uterine artery are used to get Doppler data. The pulsatility index (PI), resistance index (RI), and systolic/diastolic ratio (S/D) are calculated. There is a correlation between the indices and the fetal outcome. The usual reference value states that Doppler indices are abnormal if the S/D, PI, and RI of each artery are greater than 2SD for the gestational age.⁶ In hypertensive pregnancies,

Doppler velocimetry has been shown to accurately predict any unfavorable fetal outcome and help determine the best time to deliver. It assists us in planning treatments, acting promptly, and advising patients about future pregnancies.

Materials and methods

This prospective study was conducted in the Department of Obstetrics and Gynaecology, Dhaka Medical College Hospital (DMCH), Dhaka, from 22 December 2023 to 21 June 2024, during which 50 patients aged between 16 and 35 years were studied. The patients were selected by a convenient sampling method. The uterine artery, middle cerebral artery & umbilical artery Doppler sonography was done between 29-40 weeks of gestation. Then all the patients were evaluated by detailed history and clinical examination. Before the commencement of this study, the respective authority approved the research protocol. Proper permission was taken from the concerned department for this study. All the patients included in this study were informed about the nature of the risks and benefits of the study. These were explained to the patients in an easily understandable local language. Proper written consent was taken from the patients for the study. They were assured that all the information and records would be kept confidential.

This study included clinically diagnosed cases of severe pre-eclampsia in the 3rd trimester (29 to 40 weeks), who were referred to the Department of Radiology and Imaging of DMCH for color Doppler sonography. Patients having medical disorders other than pre-eclampsia and multiple pregnancies were excluded from this study.

Doppler velocimetry indices include:

1. >Pulsatility index (PI)
2. >resistance index (RI)
3. >Systolic/diastolic velocity ratio (S/D ratio)

In this study, we used:

1. Uterine artery Doppler to study uteroplacental circulation
2. Umbilical artery Doppler to study fetoplacental circulation
3. Middle cerebral artery Doppler to study fetal circulation

Doppler indices were considered abnormal when the S/D ratio, PI, and RI of each artery were > 2SD for the gestational age according to the standard reference

values.

Appropriate data were collected using a preformed data sheet. All the findings were analyzed by the appropriate statistical methods.

Operational definitions

1. Color Doppler ultrasonography: A color Doppler ultrasound is a non-invasive diagnostic imaging test that uses sound waves to create real-time images of blood flow.

2. Preeclampsia: Preeclampsia is a pregnancy-specific condition characterized by the sudden onset of high blood pressure and signs of organ damage, usually occurring after 20 weeks of gestation. The classic, historical triad used to identify preeclampsia consists of:

Hypertension: New-onset high blood pressure of ≥ 140 mmHg systolic or ≥ 90 mmHg diastolic on separate occasions.

Proteinuria: Excess protein in the urine, indicating kidney involvement.

Edema: Sudden or excessive swelling of the hands, face, or feet.

3. Perinatal outcome: Poor fetoplacental perfusion has long been known to be linked to pre-eclampsia and, later, intrauterine growth retardation (IUGR). Pregnancy-related problems contribute significantly to perinatal morbidity and mortality.¹ Severe morbidity, such as elevated rates of meconium aspiration, hypoglycemia, respiratory distress syndrome, intrapartum developmental delay, and stillbirth, is linked to IUGR. Increased perinatal mortality and morbidity, as well as impaired neurodevelopment, are linked to intrauterine growth retardation.⁴ Fetal hemodynamics can be evaluated noninvasively with Doppler ultrasonography. IUGR-affected newborns are more likely to develop diabetes, heart disease, and hypertension in the future.

Results

In order to predict the adverse perinatal outcome in high-risk pregnancies, a number of observational studies have investigated cerebral redistribution, abnormal MCA Doppler indices, and/or abnormal UA/MCA Doppler ratios.^{7,8} All three indicators gradually decrease with increasing gestational age in a typical pregnancy. In this study, we examined the diagnostic value of three indices of color Doppler

sonography in fetoplacental circulation for the early detection of pregnancy-induced hypertension and intrauterine growth retardation in early pregnancies to predict the perinatal outcome.

Table 01: Distribution of respondents according to normal and abnormal Blood Flow Indices (S/D, PI, RI) of the uterine artery, umbilical artery, and middle cerebral artery in Doppler sonography (n=50).

Blood flow indices (S/D ratio, PI, RI)	Normal flow	Abnormal flow	Total
Uterine artery	15(30%)	35(70%)	50(100%)
Umbilical artery	16(32%)	34(68%)	50(100%)
Middle cerebral artery	19(38%)	31(62%)	50(100%)

The blood flow indices (S/D PI, RI) of the uterine artery, umbilical artery, and middle cerebral artery were found to have abnormal blood flow in 70%, 68%, and 62% cases, respectively.

Table 02: Sensitivity, Specificity, Accuracy, Positive Predictive Value, and Negative Predictive Value of Blood Flow Indices for Diagnosis of SGA.

Validity test	Percentage (%)		
	Uterine artery	Middle cerebral artery	Umbilical artery
Specificity	97%	88%	95%
Sensitivity	100%	100%	99%
Accuracy	98%	92%	97%
Positive Predictive Value	100%	100%	100%
Negative Predictive Value	93%	79%	94%

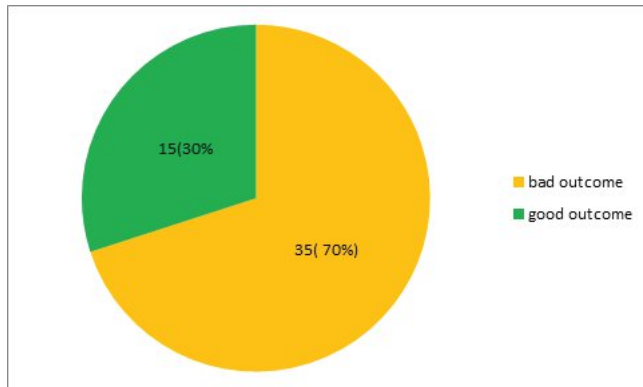


Figure 01: Distribution of cases according to adverse perinatal outcome (n=50).

Bad outcome=Adverse Perinatal Outcome present.
Good outcome=Adverse Perinatal Outcome absent.
Out of 50 patients, 35 (70%) babies had an adverse perinatal outcome, and 15 (30%) had a normal outcome (Figure 01).

Table 03: Association of uterine artery blood flow with adverse perinatal outcome.

Uterine Artery Blood Flow Indices	Adverse Perinatal Outcome		Total	Inferences
	Present	Absent		
Abnormal 35	35 (True Positive)	0 (False positive)	35	df =2, p< 0.05
Normal 15	0 (False Negative)	15 (True Negative)	15	
Total	35	15	50	

Data were analyzed using Fisher's exact test.

Table 03 shows that there was a positive association between abnormal color Doppler findings of uterine artery blood flow indices and adverse perinatal outcomes

Table 04: Association of umbilical artery blood flow with adverse perinatal outcome.

Umbilical Artery Blood Flow Indices	Adverse Perinatal Outcome		Total	Inferences
	Present	Absent		
Abnormal 34	34 (True Positive)	0 (False positive)	34	df =2, p< 0.05
Normal 16	1 (False Negative)	15 (True Negative)	16	
Total	35	15	50	

Data were analyzed using Fisher's exact test.

Table 04 reveals positive association between abnormal color Doppler findings of umbilical artery blood flow indices and adverse perinatal outcomes.

Table 05: Association of middle cerebral artery blood flow with adverse perinatal outcome.

Middle Cerebral Artery Blood Flow Indices	Adverse Perinatal Outcome		Total	Inferences
	Present	Absent		
Abnormal 31	31 (True Positive)	0 (False positive)	34	df =2, p< 0.05
Normal 19	4 (False Negative)	15 (True Negative)	19	
Total	35	15	50	

Data were analyzed using Fisher's exact test.

Table 05 reveals that there was a positive association between abnormal color Doppler findings of middle cerebral artery blood flow indices and adverse perinatal outcomes.

Discussion

In a healthy pregnancy, trophoblastic invasion converts high-resistance spiral arteries into low impedance utero-placental circulation, resulting in pre-eclampsia, a multi-system illness. In IUGR and pre-eclampsia, this utero-placental circulation is still unfinished. The purpose of this study is to link the fetal outcome in patients with pre-eclampsia with the Doppler findings.

Obstetricians have been dealing with preeclampsia and eclampsia, two potentially fatal pregnancy complications, for over a century. In the low-risk group, the systolic/diastolic ratio (SD), resistive index (RI), and pulsatility index (PI) all reduced with gestation length, while in the high-risk group, these values rose in the uterine and umbilical arteries.⁹

In this study, 50 patients with severe pre-eclampsia who were admitted to DMCH were assessed using color Doppler to measure the blood flow indices (S/D PI, RI) of the middle cerebral artery, umbilical artery, and uterine artery. The majority of these patients had abnormal blood flow, with 70%, 68%, and 62% of them having adverse perinatal outcomes, and 15 (30%) of those patients had normal outcomes.

According to a different study, pre-eclampsia causes a significant amount of maternal and neonatal morbidity and mortality and complicates 3-10% of pregnancies.¹⁰ A placental function test called the UA Doppler offers crucial diagnostic and prognostic data in cases of preterm IUGR. Regardless of the UA waveform, DV (Doppler velocimetry) successfully detects preterm IUGR pregnancies that are at high risk for a negative outcome, including stillbirth, at least one week before delivery.¹¹

Rahul Khatri conducted a study in 2021 and discovered that approximately 11 people had a faulty umbilical artery Doppler. The 11 infants were all admitted to the NICU for longer than 48 hours. Jaundice, convulsions, IUGR, and the need for ventilatory assistance were the primary problems observed in this group of babies. Despite the small study group, the results show that umbilical velocimetry has a decent specificity when it comes to neonatal morbidity. Regardless of the flow velocity waveforms in the umbilical artery, all patients with diastolic notching experienced adverse pregnancy outcomes. Furthermore, the incidence of fetal growth limitation rose when this pattern in the uterine artery was

linked to an increased flow impedance in the umbilical artery. Additionally, they discovered that eight individuals with severe IUGR had elevated middle cerebral artery pulsatility indices. Among these six patients, the umbilical artery flow velocity waveforms also showed a concurrently elevated resistance pattern. Abnormal cerebral artery velocimetry suggests that hypoxia has occurred, putting the fetus at risk for chronic hypoxia of placental origin. Indeed, he stated that 60% of fetuses were SGA and had a stormy perinatal fate when both umbilical and brain velocities were aberrant.¹²

Hypoxemia at steady state is linked to elevated umbilical artery Doppler indices when positive end-diastolic flow is present. Significant worsening of hypoxemia and acidemia is linked to absent end-diastolic flow in the umbilical artery. Yoon and Lee's 1994 study, which was published in the American Journal of Obstetrics and Gynecology, showed that women with anomalous umbilical artery waveforms had a higher risk of poor perinatal outcomes than those with normal waveforms.¹³ In fact, patients with an aberrant waveform had significantly greater odds of preterm delivery, fetal distress, caesarean sections, intensive care unit admissions, major newborn morbidity, and perinatal deaths.

An aberrant umbilical artery waveform was found in 65% of preeclampsia patients, according to Ducey et al. They proposed that patients with aberrant Doppler velocimetry have worse outcomes and that the degree of placental ischemia in preeclamptic patients is correlated with the severity of the condition.¹⁴ As a result, it may be concluded that in high-risk pregnant women with preeclampsia and suspected fetal growth restriction, umbilical artery doppler should be made available as the primary and best method of evaluating the fetoplacental circulation. In 2002, Vergani P et al. also discovered that a fourfold increase in the likelihood of a poor infant outcome is linked to aberrant Doppler waveforms at the uterine arteries.¹⁵

Conclusion

The results of our study indicate that abnormal Doppler indices of the blood vessels in pregnant patients with pre-eclampsia will result in adverse perinatal outcomes. Therefore, continuous monitoring & evaluation of color Doppler ultrasonography findings of blood flow indices are required for better management of those high-risk patients and to minimize the perinatal adverse outcome.

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