Original Article

Utility of Color Doppler Sonography in the Prediction of Outcome in Severe Pre-eclamptic Patients

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Abstract

Background: Pre-eclampsia causes placental insufficiency which is the most common cause of growth retardation, which is an important obstetric problem on account of the high association with perinatal morbidity and mortality. **Objective:** To assess fetal well-being by color Doppler ultrasonography in severe pre-eclamptic patients. **Methodology:** This prospective study was conducted in the department of Obstetrics & Gynecology of Dhaka Medical College Hospital between the periods of December 2023 to June 2024. Fifty diagnosed patients of pre-eclampsia were selected randomly for the study. Color Doppler sonography was done to them to see abnormal blood flow indices (pulsatility index, resistance index and systolic/diastolic velocity ratio) of uterine artery, umbilical artery and middle cerebral artery between 29-40 weeks of gestation. **Result:** In our study we found that, 70% of patients delivered at 34±3.7 weeks of gestational age had abnormal color Doppler indices (S/D PI, Rl) of uterine artery, umbilical artery, and middle cerebral artery, where most of them found abnormal blood flow. Out of 50 patients, 35 (70%) babies had an adverse perinatal outcome, and 15 (30%) had a normal outcome. **Conclusion:** The results of our study indicate that abnormal Doppler indices of the blood vessels in patients with pre-eclampsia will result in adverse clinical outcomes. Therefore, color Doppler ultrasonography can be done routinely in these patients to predict outcome.

Key words: Fetal wellbeing, color doppler, pre-eclampsia.

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Introduction

The main goal of prenatal testing is to identify fetus at risk for perinatal morbidity and mortality. The traditional methods for fetal surveillance like nonstress test, fetal heart monitoring, fetal biophysical profile are no more sufficient test because of their inability to detect early stage of fetal distress. It has long been recognized that impaired fetoplacental perfusion is associated with pre-eclampsia and subsequently intrauterine growth retardation (IUGR). Both the pregnancy-related complications make a significant contribution to perinatal mortality and morbidity [1]. Pre-eclamptic pregnancies demonstrate high impedance in the fetoplacental circulation and a reduction in the volume of flow, thought to result from failed trophoblastic invasion of spiral arteries in the early second trimester. Fetoplacental vascular resistance can be assessed by doppler ultrasound and therefore, impedance indices measured by doppler have been evaluated as an early screening test for high-risk pregnancies. Pre-eclampsia causes placental insufficiency which is the most common cause of growth retardation, which is an important

obstetric problem on account of the high association with perinatal morbidity and mortality.

Intrauterine growth retardation is defined as growth at the 10th or less percentile for weight of all fetuses at that gestational age [2]. IUGR is characterized by failure of the fetus to reach its normal growth potential. Intrauterine growth retardation is the 2nd leading cause of perinatal death [3]. IUGR is associated with significant morbidity, including increased rates of meconium aspiration, hypoglycemia, respiratory distress syndrome, intrapartum developmental delay and still birth. Intra uterine growth retardation is associated with an increased risk of perinatal mortality and morbidity and impaired neuro-development [4]. The correct detection of the compromised IUGR fetus to allow for timely intervention is a main objective of antenatal care.

Color Doppler is the most rigorous evaluation test among the non-invasive tests of fetal well-being. Doppler ultrasound allows a non-invasive assessment of fetal hemodynamics. Newborns affected by IUGR are at increased risk of HTN, CVD, and diabetes later in life. Uteroplacental circulation can be assessed using Doppler ultrasonography of the uterine artery. Placental insufficiency, whether primary or secondary to maternal factors such as hypertension, poor nutrition etc. is the most important cause of intrauterine growth retardation which is an important obstetric problem on account of the high association with perinatal mortality and morbidity. It is essential to recognize placental insufficiency early so that its hazards can be reduced [5]. Doppler measurements are taken from the maternal uterine artery, fetal middle cerebral artery and umbilical artery. Calculation of Systolic/Diastolic ratio (S/D), resistive index (RI), and pulsatility index (PI) is done. The indices are correlated with fetal outcome. Doppler indices are considered abnormal when S/D, PI, RI of each artery >2SD for the gestational age according to the standard reference value [6]. In normal pregnancy, all three indices show a gradual decline with increasing gestational age. But in pre-eclampsia, there is increased resistance in spiral arteries. This leads to increased impedance of blood flow in the uterine artery. This is reflected in higher values of S/D, PI, RI of the uterine artery.

The abnormal waveforms are characterized by a higher systole lower diastole and the persistence diastolic notch which helps in predicting PIH [7]. In normal pregnancy the mean of all indices shows a progressive decline with advancing age due to decrease in umbilical artery resistance. But in IUGR first there is decreased diastolic flow in the umbilical artery due to increase in the resistance that occurs in small arteries and arterioles of the tertiary villi. This raises the S/D ratio, Pl, RI of the umbilical artery. As the placental insufficiency worsens, the diastolic flow decreases, then may become absent and later reverse. Absent umbilical artery wave form is a strong and important predictor of adverse perinatal outcome [8]. Fetal middle cerebral artery (MCA) is a low resistance circulation throughout pregnancy. Normally the mean value of all indices showed decline with advancing gestational age due to decrease in impedance in MCA so as to meet the oxygen demands of the growing fetus. In IUGR in response to chronic hypoxia, there is redistribution of blood flow from nonessential organ to the brain and myocardium. This adaptation is known as brain sparing effect. Several observational studies have explored cerebral redistribution {abnormal MCA doppler indices and /or abnormal UA/MCA Doppler ratio} for the prediction of perinatal outcome in high-risk pregnancies [9, 10]. Doppler velocimetry has been proved to reliably predict any adverse fetal outcome in hypertensive pregnancies and aids in the appropriate timing of

delivery. It helps us to take timely action, plan the treatment and also counsel the patients in future pregnancies.

Materials & methods

This prospective study was carried out in the department of Obstetrics & Gynecology of Dhaka Medical College Hospital, Dhaka, Bangladesh between the periods of December 2023 to June 2024. We selected 50 patients randomly who were admitted due to severe pre-eclampsia. Doppler sonography was done to them between 29-40 weeks of gestation to evaluate uterine artery, middle cerebral artery and umbilical artery. Detail history and clinical examination was done. Prior to commencement of this study the respective authority approved the research protocol and informed consent was taken from the study subjects.

Doppler velocimetry indices include-

>Pulsatility index (PI)

>Resistance index (RI)

>Systolic/diastolic velocity ratio (S/D ratio)

Doppler indices were considered abnormal when S/D ratio, Pl and Rl of each artery > 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 appropriate standard statistical method.

Result

Among 50 patients 70% patients delivered at 34±3.7 weeks of gestational age having abnormal color doppler indices and 30% patients delivered at 38±1.6 weeks of gestational age whose color doppler indices were normal (Table-I). Among the patients, most of them found abnormal blood flow accordingly 70%, 68%, 62% in our study (Table-II). Among 50 Patients 33 (66%) had small for gestational age (SGA) baby and 17 (34%) had average gestational age (AGA) of baby (figure 1) and 70% had adverse perinatal outcome (figure 2).

Table I. Distribution of patients according to gestational age at delivery in weeks (n = 50).

Color Doppler indices findings	Frerquency n (%)	Gestational age at delivery (weeks) (Mean ± SD)
Abnormal	35 (70%)	34 ± 3.7
Normal	15 (30%)	38 ± 1.6

Table II. Distribution of respondents according to normal and abnormal blood flow indices (S/D, PI, RI) of uterine artery, umbilical artery, middle cerebral artery in doppler sonography (n=50).

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

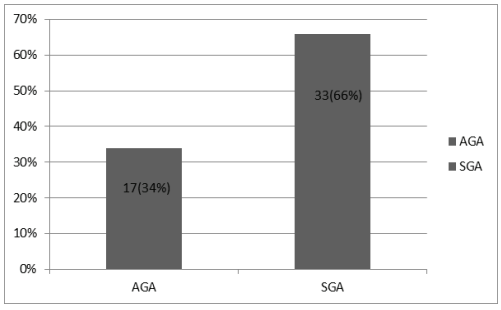


Figure 1: Bar chart shows prenatal outcome among the respondents (n=50).
AGA= Average Gestational Age of baby.
SGA= Small for Gestational Age baby.

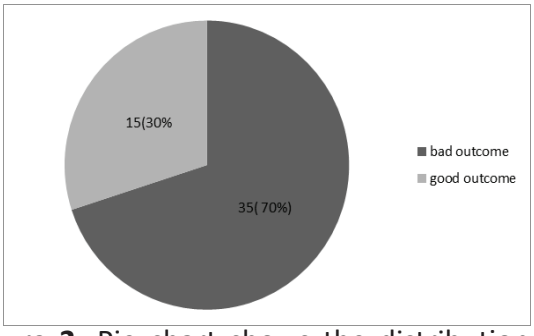


Figure 2: Pie chart shows the distribution of Adverse Perinatal Outcome (n=50).

Discussion

Two significant contributors to maternal and neonatal morbidity and mortality are pre-eclampsia and IUGR. Since traditional methods are not good enough to assess uteroplacental and fetoplacental circulation, blood flow studies by using color Doppler technology are used to assess fetal wellbeing in pre-eclampsia patients. Pre-eclampsia and intrauterine growth retardation (IUGR) are common complications of pregnancy which arc associated with a failure of normal placental invasion and development of the consequences of this placental dysfunction may include an altered resistance to blood flow in uterine circulation and carry a significantly increased risk of morbidity and mortality for both the mother and the fetus. This current study was carried out with an aim of establish the usefulness of color Doppler sonography of maternal uterine artery and fetal umbilical and middle cerebral artery, in evaluation of fetal out come in women with severe preeclampsia. Calculation of systolic diastolic ratio (S/D), resistive index (RI), and pulsatility index (PI) were done. The indices were correlated with fetal outcome.

Pre-eclampsia is a multisystem condition with an unknown etiology that manifests as hypertension that reaches 140/90 mmHg or higher and proteinuria after the 20th week of pregnancy in patients who were previously normotensive with no proteinuria. A non-invasive technique for assessing pathological hemodynamic alterations in uteroplacental circulation as well as subsequently changed fetal and fetoplacental circulation is the Doppler study [11].

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. MCA-PSV (peak systolic velocity) in the middle cerebral artery (MCA) rose as gestational stage grew, but PI dropped. These findings suggest that aberrant blood vessel Doppler indices in high-risk pregnant women would lead to unfavorable clinical outcomes [12]. In our study 70% patients delivered at 34±3.7 weeks of gestational age having abnormal color doppler indices and 30% patients delivered at 38±1.6 weeks of gestational age whose color doppler indices were normal. Fifty patients admitted in DMCH with severe pre-eclampsia were evaluated by color doppler to see the blood flow indices (S/D PI, Rl) of uterine artery, umbilical artery, and middle cerebral artery where most of them found abnormal blood flow accordingly 70%, 68%, 62% in our study. Another study also got similar findings that the most prevalent high-risk variables were preeclampsia and pregnancy-induced hypertension (PIH). In that study it was observed 58.33% abnormal umbilical artery (UA) flow patterns of the cases. Unfavorable results were substantially associated with abnormal UA and middle cerebral artery (MCA) Doppler indices [13]. In our study it was found that 33 (66%) patients had small for gestational age (SGA) baby and 17 (34%) had average gestational age (AGA) of baby. Out of 50 patients 35 (70%) baby had adverse perinatal outcome and 15 (30%) had normal outcome. UA (umbilical artery) Doppler is a placental function test that provides important diagnostic and prognostic information in preterm IUGR. Color Doppler effectively identifies those preterm IUGR fetuses that are at high risk for adverse outcome (particularly stillbirth) at least 1 week before delivery, independent of the UA waveform [14].

Conclusion & Recommendation

From the study it could be concluded that, color Doppler evaluation of maternal uterine artery, fetal middle cerebral and umbilical artery is a useful modality in diagnosis of IUGR and prediction of adverse perinatal outcome.

Further study with large number of sample size can be done in our country to establish the screening test standard for detection of IUGR which is strongly associated with perinatal mortality and morbidity.

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