

A Hospital Based Diagnostic Value of MCA/UA Pulsatility Index Ratio for the Prediction of Adverse Perinatal Outcome in Patients with High-Risk Pregnancy: An Observational Study

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Abstract

Aim: The aim of the present study was to investigate the diagnostic value of MCA/UA pulsatility index ratio for the prediction of adverse perinatal outcome in patients with high-risk pregnancy.

Methods: The study group consisted of 200 women admitted to Department of Obstetrics & Gynaecology. All patients had undergone serial color Doppler ultrasound. The Umbilical Artery color Doppler waveforms were obtained from a free-floating portion of the umbilical cord during minimal fetal activity and the absence of fetal breathing. All measurements were performed in the semi-recumbent positions with the head and chest slightly elevated.

Results: 55% had vaginal delivery and remaining 45% had Caesarean delivery in the present study. 32% had pregnancy induced hypertension followed by PIH+IUGR (25%). Our results suggested that the MCA/UA PI Doppler ratio of less than 1 was a good predictive tool for neonatal outcome in preeclamptic and hypertensive pregnant women and could be used to identify fetuses at risk of morbidity and mortality. Fetuses with abnormal Doppler MCA/UA PI ratio in our study had a significantly lower birth weight, lower gestational age at delivery, a significantly higher incidence of perinatal deaths, higher incidence of admission to NICU and longer duration of treatment there, lower Apgar score at 5-minute.

Conclusion: Doppler study is a noninvasive method for assessing the hemodynamic function of the fetus and mother. There is a direct correlation between high-risk pregnancy with abnormal Doppler findings in the umbilical, middle cerebral artery, and CPR compared to non-high-risk pregnancies.

Keywords: Middle Cerebral Artery, Pre- Eclampsia, Umbilical Artery.

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Introduction

The primary objective of obstetric management is to identify pregnancies at risk of avoidable perinatal morbidity and death. [1] Pregnancy development is normal when nutrients and oxygen are provided in an adequate amount. The uterine and umbilical arteries are the primary conduits of blood to the fetus. The goal of obstetric care is to identify women who are at high risk of pregnancy-related illness or mortality. High risk pregnancies are a small segment of obstetric population that produces the majority of the maternal and fetal mortality and morbidity. In India, 20-30% pregnancies belong to high-risk category accounting for 80% of maternal and 75% of perinatal deaths. [2,3,4] Pregnancy needs a sufficient intake of food and oxygen. Both the uterine and umbilical arteries supply blood to the developing fetus throughout pregnancy. [5] Preeclampsia affects 5-10% of pregnancies and is a major cause of maternal and fetal morbidity and

mortality. [6,7] Abnormal placenta is a main preeclampsia characteristic. Its cause is a maternal spiral veins trophoblastic invasion failure, which conditions vascular resistances raise and uteroplacental perfusion decrease. Pregnancies with high blood pressure or a fetal-growth restriction have compromised umbilical and uterine blood flow. [8,9] Satomura demonstrated that the Doppler technique could evaluate blood flow. [10]

The goal of various ante partum Fetal surveillance techniques is to detect fetal distress so as to prevent fetal morbidity and mortality. The development of a good utero-placental circulation is essential for achievement of a normal outcome of fetus and mother. The largest advances have been made in the assessment of the fetus at risk of hypoxia and death secondary to placental insufficiency. There are numerous tests available for this purpose like NST, biophysical

profile, modified biophysical profile, doppler velocimetry. With advent of doppler ultrasound it is possible to determine the placental vascular insufficiency early and identify the fetal hemodynamic adaptation to decreased placental blood flow. It is possible to determine the presence of fetal hemodynamic decompensation that resulting in hypoxaemia and acidosis with the help of doppler. [11]

Nowadays, Doppler ultrasound velocimetry of uteroplacental umbilical and fetal vessels has become established method of antenatal monitoring, allowing the noninvasive assessment of fetal circulation. [12] Its indices provide important information on the hemodynamics of the vascular area under study. [13] Circulatory changes, reflected in certain fetal Doppler waveforms, predict adverse perinatal outcome. [14] Umbilical arteries are the common vessels assessed by Doppler ultrasound, but recent studies confirm the efficacy of middle cerebral artery (MCA) Doppler assessment and advocate it. [15]

The aim of the present study was to investigate the diagnostic value of MCA/UA pulsatility index ratio for the prediction of adverse perinatal outcome in patients with high-risk pregnancy.

Materials and Methods

The study group consisted of 200 women admitted to Department of Obstetrics & Gynaecology, IGIMS, Patna, Bihar, India for the period of one year. All patients had undergone serial color Doppler ultrasound. The Umbilical Artery color Doppler waveforms were obtained from a free-floating portion of the umbilical cord during minimal fetal activity and the absence of fetal breathing. All measurements were performed in the semi-recumbent positions with the head and chest slightly elevated. Doppler signals were recorded with a 3.5 MHz curved array duplex transducer. The UA pulsatility index were considered abnormal when the values were $>2SD$, the MCA pulsatility index was considered abnormal when the values were $<5th$ percentile. MCA/UA PI <1 was considered abnormal. [16] The reference values are according to Gramellini et al. [17] Major adverse perinatal outcome were stillbirth and neonatal death. Minor adverse perinatal outcome was cesarean delivery for fetal distress, admission to the neonatal intensive care unit, Apgar score below 7 at 5 minutes, IUGR fetuses. The gestational age of all women was confirmed, either by menstrual dates or by first trimester ultrasonography. Preeclampsia patients included thane who had a mild (systolic blood pressure >140 mmHg, diastolic >90 mmHg and proteinuria 300 mg/24 h or $= + 1$ dipstick) or severe preeclampsia (systolic blood pressure > 160 mmHg, diastolic > 100 mmHg and severe

proteinuria 2g/24 h or $+2$ dipstick). The diagnosis of gestational hypertension was made in women whose blood pressure reached 140/ 90 mmHg or greater for the first-time during pregnancy but in whom proteinuria was not developed. [18] Women with twin pregnancies, chromosomal abnormalities, gestational diabetes, were included in the study. Those included were followed by periodical Doppler flow measurements at least one time per week measurements until delivery. [19-24]

Inclusion Criteria

Patients in the age group of 18 to 35 years, with gestational age of 28 to 40 weeks were included. Pregnant women with gestational hypertension, IUGR, preeclampsia, preeclampsia plus IUGR were included. Only the ones who consented to the study were included.

Exclusion criteria

Patients with grand multiparity, multiple gestations, cardiovascular or renal disease, chronic hypertension, and fetus with congenital anomalies (already detected via scans) were excluded.

Methodology

For all pregnant women satisfying the inclusion criteria, after obtaining a clinical history, completing a clinical examination, and obtaining an ultrasound, the subjects were exposed to a Doppler examination. A Doppler waveform was collected for the umbilical, uterine, and middle cerebral arteries and several indices were determined. Pulsatility Index and Resistance -Index were measured. It was considered abnormal if the Doppler parameters for uterine, umbilical, and middle cerebral artery turned out to be less than the 5th percentile for gestational age. There was just one threshold for CPR=MCA PI/UA PI (1.0). CPR >1 was normal; CPR <1 was not. Investigations were carried out, including hematological, biochemistry, urine analysis, radiologic, non-stress tests, fundoscopy, and color Doppler. Other investigations were carried out as and when required. Fetal parameters such as gender, birth weight, time of birth, date of birth, admission to NICU, APGAR score at 5 min, need for positive pressure ventilation, and survival status (live born, stillborn, or perinatal deaths) were recorded.

Outcome Criteria

Pregnancy outcomes were predicted using Doppler findings from the umbilical, uterine, and middle cerebral arteries. "Adverse" pregnancies are defined as those in which any of the following conditions are present: An Apgar score of less than 7 at 5 minutes, an emergency C-section due to fetal distress, and a fetal death. When the foregoing difficulties were not present, the

pregnancy result was judged to be either uncomplicated or positive. To determine the outcome of each pregnancy, the records of the labor ward and the neonatal critical care unit were collected.

Statistical analysis

Data was analyzed using SPSS 24.0. The Chi-Square test was used to analyze categorical dependent and independent variables. 0.05 was statistically significant.

Results

Table 1: Table showing type of delivery

Type of delivery	No. of cases (%)
Vaginal	110 (55)
Caesarean	90 (45)

55% had vaginal delivery and remaining 45% had Caesarean delivery in the present study.

Table 2: Risk factors

Risk factors	No. of cases (%)
PIH	64 (32)
IUGR	34 (17)
PIH+IUGR	50 (25)
BOH	20 (10)
Twins	18 (9)
Post dated	14 (7)

32% had pregnancy induced hypertension followed by PIH+IUGR (25%).

Table 3: Table showing risk factors and doppler abnormal

Risk factors	Normaldoppler	Abnormal doppler (CPI <1)
PIH	44	20
IUGR	18	16
PIH+IUGR	30	20
BOH	13	7
Twins	15	3
Post dated	10	4

Doppler velocimetry studies of placental and fetal circulation can provide important information regarding fetal well-being, yielding an opportunity to improve fetal outcome. Our results suggested that the MCA/UA PI Doppler ratio of less than 1 was a good predictive tool for neonatal outcome in preeclamptic and hypertensive pregnant women and could be used to identify fetuses at risk of morbidity and mortality.

Table 4: Perinatal outcome

Perinatal outcome	No of cases (%)
Low birth weight	90 (45)
Poor Apgar Score	48 (24)
Hypoxic ischemic encephalopathy	14 (7)
Meconium aspiration	36 (18)
NICU admission	100 (50)
Neonatal deaths	4 (2)
Stillbirth	3 (1.5)

Fetuses with abnormal Doppler MCA/UA PI ratio in our study had a significantly lower birth weight, lower gestational age at delivery, 1 significantly higher incidence of perinatal deaths, higher incidence of admission to NICU and longer duration of treatment there, lower Apgar score at 5-minute.

Discussion

Doppler ultrasound velocimetry provides a non-invasive method of measuring changes in blood flow in the uteroplacental circulation and fetoplacental circulation, thus assessing fetal wellbeing. [25] Management protocols for women with PIH include frequent prenatal visits with

ultrasound and fetal heart monitoring. Ultrasound biometry helps to identify a heterogeneous group of small for gestational age fetuses. With the use of Doppler velocimetry, correct detection of compromised IUGR fetus is possible, which allows for timely intervention to improve perinatal outcome. [26] Evidence from randomized trials suggest that, if women with suspected intrauterine growth restriction and preeclampsia are offered Doppler studies of the umbilical artery, a clinically significant reduction in perinatal mortality may be expected. It has also been suggested that screening of low-risk women is not cost effective and also no significant improvement was observed in perinatal outcome. [27]

55% had vaginal delivery and remaining 45% had Caesarean delivery in the present study. 32% had pregnancy-induced hypertension followed by PIH+IUGR (25%). Our results suggested that the MCA/UA PI Doppler ratio of less than 1 was a good predictive tool for neonatal outcome in preeclamptic and hypertensive pregnant women and could be used to identify fetuses at risk of morbidity and mortality. Fetuses with abnormal Doppler MCA/UA PI ratio in our study had a significantly lower birth weight, lower gestational age at delivery, 1 significantly higher incidence of perinatal deaths, higher incidence of admission to NICU and longer duration of treatment there, lower Apgar score at 5-minute. Several investigators like Gramellini et al, [17] Berkowitz et al and Fairlie et al [28] have demonstrated the correlation between abnormal Doppler indices of fetal vessels and adverse perinatal outcome and fetal distress. Yoon BH et al demonstrated that an abnormal umbilical artery Doppler waveform is a strong and independent predictor of adverse perinatal outcome in patients with preeclampsia. [29]

Brar et al recognized that Doppler studies of the internal carotid artery or a ratio of cerebral to umbilical resistance could be used to identify pregnancies with a compromised post-date fetus. [30] The fetuses in our study with adverse outcome had a lower middle cerebral artery PI index, supporting the finding of Brar et al. According to Gramellini et al [17] and Arduini et al [31], assessment of MCA/UA PI index provide better information in predicting perinatal outcome when compared with umbilical or middle cerebral artery Doppler indices alone. In our study, we found high sensitivity of the MCA/UA PI ratio in predicting stillbirth (100%). Also, we found a high specificity and positive predicting value in need for treatment in neonatal intensive care unit.

Conclusion

Doppler study is a noninvasive method for assessing the hemodynamic function of the fetus and mother. There is a direct correlation between high-risk pregnancy with abnormal Doppler findings in the umbilical, middle cerebral artery, and CPR compared to non-high-risk pregnancies. Hence, pregnant women with hypertension and documented IUGR can benefit from Doppler velocimetry because changes in uterine, umbilical, and fetal middle cerebral artery circulation strongly correlate with postnatal prognosis. The routine use of Doppler scans for screening of fetal well-being during the third trimester in high-risk pregnancies of preeclampsia, and intrauterine growth restriction (IUGR) helps to decrease perinatal morbidity and mortality.

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