

Evaluation of Cerebral - Umbilical Pulsatility Ratio using colour Doppler and its role in the Diagnosis of Intrauterine Growth Retardation and Prediction of Adverse Perinatal Outcome

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ABSTRACT

OBJECTIVE: The aim of our study was to evaluate the usefulness of the pulsatility index (PI) of the umbilical artery (UA) and that of the fetal middle cerebral artery (MCA), as well as the ratio of the MCA PI to the UA PI (C/U ratio), in the diagnosis of small-for-gestational-age (SGA) fetuses and in the prediction of adverse perinatal outcome.

MATERIALS AND METHODS: The study population comprised 80 pregnancies of 30-41 weeks gestation that had been diagnosed clinically as intrauterine growth retardation (IUGR) over a period of 1 year. The UA PI and the MCA PI as well as the C/U ratio were calculated.

RESULTS: Of the 80 pregnancies in the study, 22 showed abnormal UA PI. Among these, 21 (95%) were SGA and 18 (82%) had adverse perinatal outcome. Of the 10 of the 80 pregnancies that showed abnormal MCA PI, all were SGA and had adverse perinatal outcome. Similarly, of the 20 out of 80 pregnancies that showed abnormal C/U ratio (<1.08), all 20 (100%) were SGA and had adverse perinatal outcome.

CONCLUSION: The C/U ratio is a better predictor of SGA fetuses and adverse perinatal outcome than the MCA PI or the UA PI used alone,

KEYWORDS: Intrauterine growth retardation; middle cerebral artery pulsatility index; middle cerebral artery to umbilical artery pulsatility index ratio;

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I. INTRODUCTION:

Placental insufficiency, whether primary or secondary to maternal factors such as hypertension, poor nutrition, etc., is the most common cause of intrauterine growth retardation (IUGR), which is an important obstetric problem on account of the high associated perinatal mortality and morbidity. It is essential to recognize placental insufficiency early so that its hazards can be reduced, if not prevented.

Doppler USG enables a better understanding of the hemodynamic changes and has therefore become one of the most important clinical tools for fetomaternal surveillance in high-risk pregnancies. It can be credited with causing a significant decrease in perinatal mortality and morbidity.^[1] The purpose of our study was to evaluate the usefulness of the pulsatility index (PI) of the umbilical artery (UA) and that of the middle cerebral artery (MCA), as well as the ratio of the MCA PI to the UA PI (C/U ratio), in the diagnosis of small-for-gestational-age (SGA) fetuses and the prediction of adverse perinatal outcome.

II. MATERIALS AND METHODS:

This prospective study was carried out in Department of Radiodiagnosis ,GEMS & Hospital ,Srikakulam,Andhrapradesh during the period of June 2021 to June 2022 to establish the usefulness of Color Doppler evaluation of C/U pulsatility index ratio in diagnosis of IUGR and adverse perinatal outcome. For this purpose, a total number of 80 patients were enrolled in this study. The study population comprised pregnancies of 30-41 weeks' gestation that had been diagnosed clinically as IUGR and referred for USG colour doppler .The 80 patients were subjected to color Doppler examination (Philips), using 3.5 MHZ. After technically satisfactory Doppler waveform had been recorded, the Pulsatility index of the umbilical artery (UA) and the middle cerebral artery (MCA) was noted and the ratio of the MCA and UA (the C/U ratio) were calculated. The pregnancies were followed up and the perinatal outcome of each case were noted. Various intrapartum and neonatal indicators were used to assess the outcome, with an adverse outcome being defined as the presence of one or more of these indicator.

INCLUSION CRITERIA:

- Clinically diagnosed case of IUGR.
- LMP(Last menstrual period) of the patient well known.
- Gestational age of patient between 31 and 41 weeks.
- Singleton pregnancy
- Birth at the institution.

EXCLUSION CRITERIA:

- Cases in which a congenital anomaly is detected in the newborn,
- Cases of fetal anemia,

Diagnostic criteria:

C/U pulsatility index Ratio= MCA PI/ UA PI.

The cerebral umbilical P1 ratio remains constant in the last 10 weeks of the pregnancy therefore a single cutoff value of 1.08 considered normal.

Below that value, velocimetry was considered abnormal.

Normal C/U Pulsatility index ratio: > 1.08

Abnormal C/U Pulsatility index ratio: < 1.08

III. RESULT:

Distribution of age of the patients

All our patients ranged from 20 years to 38 years. Majority of the patients (58%) were in 26-30 years age group. The average age of the patients was 28.16 years. Least number of patients were seen in the age group of more than 30 years.

Of the 80 pregnancies in the study, 22 showed abnormal UA PI. Among these, 21 (95%) were SGA and 18 (82%) had adverse perinatal outcome. Ten of the 90 pregnancies showed abnormal MCA PI and all ten (100%) fetuses were SGA and all ten (100%) had adverse perinatal outcome. Perinatal death was noted in one pregnancy, which showed a normal MCA PI but an abnormal UA PI and C/U ratio. Twenty of the 80 pregnancies showed an abnormal C/U ratio (<1.08). Of these, 20 (100%) fetuses were SGA and all had an adverse perinatal outcome.

Table 1: Perinatal outcome of the study population according to the values of umbilical artery pulsatility index

Outcome of the study	Normal PI (n = 58) (%)	Abnormal PI (n =22) (%)
Adverse perinatal outcome	4 (7%)	18(82%)
Caesarian section for fetal distress	2(3%)	17(77%)
Apgar score <7 at 5 min	1(2%)	12(55%)
Stay in NICU 8 days	5(9%)	15(68%)
Still birth/perinatal death	-	1(5%)
Small-for-gestational age (birth weight less than 10th percentile for gestational age)	26(45%)	21(95%)

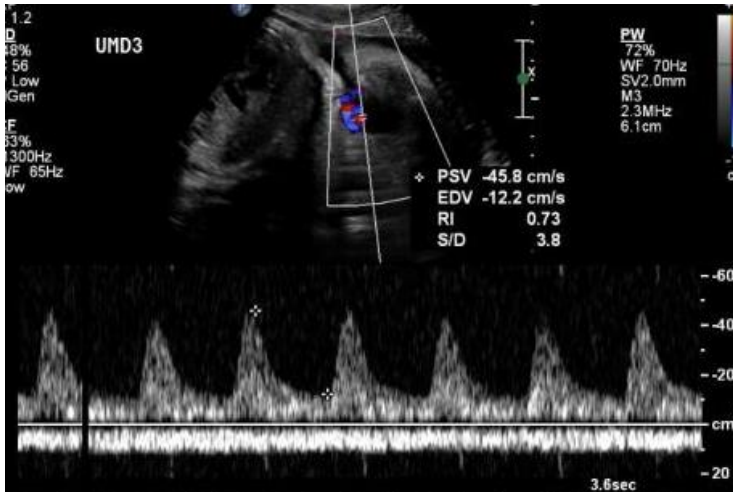
NICU - Neonatal intensive care unit; CS - Caesarian section

Table 2: Perinatal outcome of the study population according to the values of middle cerebral artery pulsatility index

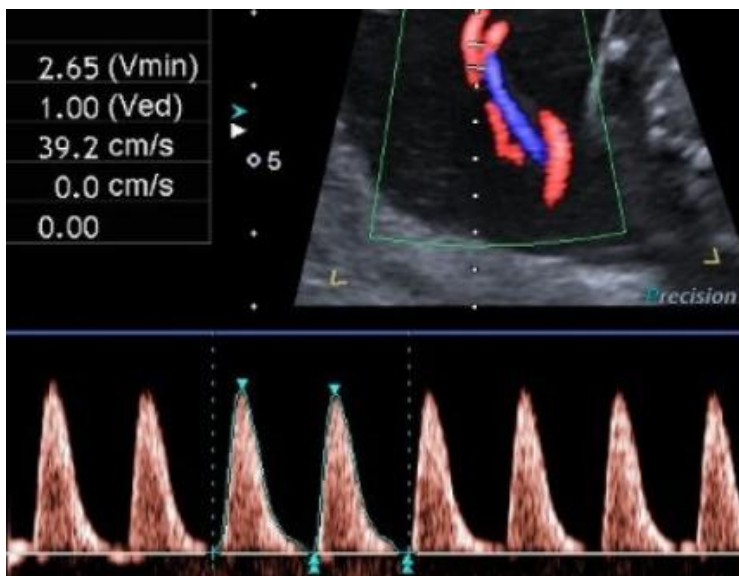
Outcome of the study	Normal PI (n = 70) (%)	Abnormal PI (n =10) (%)
Adverse perinatal outcome	22(31%)	10(100%)
Caesarian section for fetal distress	18(26%)	8(80%)
Apgar score <7 at 5 min	9(13%)	7(70%)
Stay in NICU 8 days	16(23%)	8(80%)
Still birth/perinatal death	1(1%)	1(10%)
Small-for-gestational age (birth weight less than 10th percentile for gestational age)	40(57%)	10(100%)

Table 3: Perinatal outcome of the study population according to the cerebral-umbilical ratio

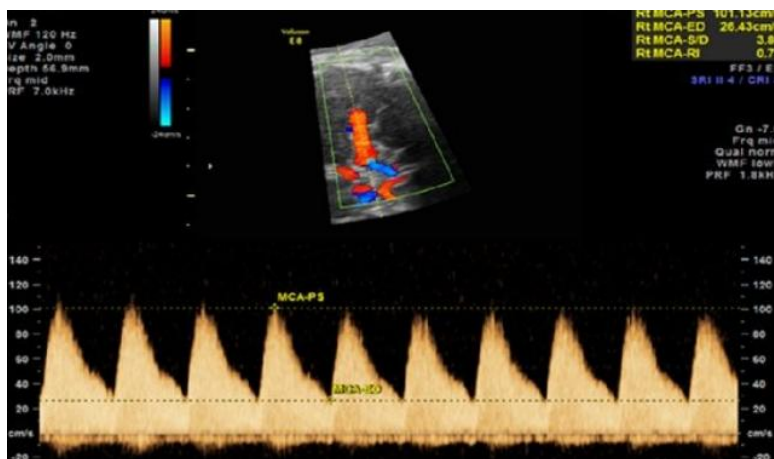
Outcome of the study	Normal PI ratio (>1.08) (n = 60) (%)	Abnormal PI ratio (<1.08) (n = 20) (%)
Adverse perinatal outcome	3(5%)	20(100%)
Caesarian section for fetal distress	1(2%)	18(90%)
Apgar score 7 at 5 min	1(2%)	8(40%)
Stay in NICU 8 days	2(4%)	14(70%)
Still birth/perinatal death	-	2(10%)
Small-for-gestational age (birth weight less than 10th percentile for gestational age)	22(37%)	20(100%)



Umbilical artery: elevated S/D ratio.



Abnormal umbilical artery waveform patterns showing markedly absent diastolic flow and increased pulsatility index



Increased middle cerebral artery end-diastolic velocities suggestive of brain sparing

IV. DISCUSSION:

IUGR is a pathological condition strongly related to the development and function of the uteroplacental and fetoplacental circulations. An adequate fetal circulation is necessary for normal fetal growth. To facilitate this, remarkable changes occur in the maternal, placental and fetal vasculatures.

Umbilical artery (UA) velocimetry correlates with hemodynamic changes in the fetoplacental circulation. With an increase in the number of tertiary stem villi and arterial channels, as the fetoplacental compartment develops, the impedance in the UA decreases. A diastolic component in the UA flow velocity waveform (FVW) appears during the early second trimester, i.e., at 15 weeks' gestation, and progressively increases with an increase in the gestational age. A mature UA FVW is usually achieved by 28- 30 weeks.[3] The normal UA waveform pattern shows low impedance and high diastolic flow with a low PI. During normal pregnancy, the MCA shows high resistance and low diastolic flow with an increase in the PI index .

Using the cut-off value, mentioned above we could divide the study population into two groups: Those with a normal ratio and those with an abnormal ratio.

In IUGR, umbilical blood flow is significantly reduced, mainly due to changes in the placental vascular resistance. Giles et al. [4] have found that a decrease in the number of resistance vessels in the tertiary stem villi in the placenta causes an increase in resistance, leading to decreased flow through the UA and an increase in the UA PI. This is described as umbilical placental insufficiency. Fleischer and Schulman[1] have found that in IUGR complicated by pregnancy-induced hypertension, there is inadequate trophoblastic invasion of the spiral arteries, leading to increased resistance in the spiral arteries and decreased blood flow in the placental vascular bed and in the UA, thereby resulting in an increase in the UA PI. This is described as uteroplacental insufficiency.

In pregnancies with chronic fetal hypoxia, the blood volume in the fetal circulation is redistributed in favor of vitally important organs, i.e., the heart, kidneys and brain. Vasodilatation of the MCA, with an increase in diastolic flow through it, results in a decrease in its PI. The resulting hyperperfusion is considered pathological . This 'brain-sparing effect' is associated with an abnormal C/U ratio (<1.08). However, if hypoxia persists, the diastolic flow returns to the normal level. Presumably, this reflects a terminal decompensation in the setting of acidemia or brain edema.[5]

Thus, in asymmetrical growth retardation, there is high UA PI and low MCA PI. As a result, the C/U ratio is lower than normal in growth-retarded fetuses. A significant association between the C/U ratio and the HC/AC ratio can be seen. The C/U ratio remains constant during the last 10 weeks of gestation and provides better diagnostic accuracy than either vessels' PI considered alone.[2]

In our study, we found that the C/U ratio was a better predictor of SGA newborns and adverse perinatal outcome than either the MCA PI or UA PI alone. Our results were more encouraging for the prediction of adverse perinatal outcome rather than diagnosing IUGR. We also observed perinatal death in one pregnancy, which had shown a change in the MCA PI from abnormal to normal. This suggests that normalization of the MCA PI during chronic hypoxia may not be an indicator of fetal well-being as, in severe fetal hypoxia, the brain-sparing effect breaks down due to acidemia or brain edema and the low MCA PI becomes normal. Therefore, MCA PI alone is not a reliable indicator. Doppler identifies fetal compromise earlier than NST. The lead time helps to plan delivery in preterm compromised pregnancies, resulting in better perinatal survival.[6]

V. CONCLUSION:

In this study Color Doppler findings of cerebral-umbilical vessels are almost identical as observed by other investigators compared with perinatal findings, so it can be concluded that color Doppler evaluation of MCA and UA PI ratio is an useful modality in diagnosis of IUGR and prediction of adverse perinatal outcome.

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