

# Diagnosis of Intrauterine Growth Retardation with Color Doppler Evaluation of Cerebral-Umbilical Pulsatility Ratio and Prediction of Adverse Perinatal Outcome

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## ABSTRACT

**Introduction:** Growth restriction in fetus is one of the major factors for the complications including NEC, respiratory problems, coronary disease, obesity, hypertension et. Early diagnosis of IUGR fetus can be done using Doppler study of umbilical artery, uterine artery and MCA. Assessment of CPR is a useful indicator in predicting the outcome of the fetus and helps in the management.

**Objectives:** To evaluate the pulsatility index (PI) of the umbilical artery (UA) and 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.

**METHODS:** The descriptive cross sectional study was conducted over a period of 10 months. All the females who were having clinical suspicion of IUGR were referred to radiology department for fetal biometry and obstetric Doppler between gestational age 30-41 weeks were included in the study. Doppler parameters like PI, RI and CPR was calculated and analyzed to make a diagnosis.

**Results:** Of the 50 pregnancies in the study, 24 showed abnormal UA PI. Among these, 21 were SGA and 19 had adverse perinatal outcome. 6 pregnancies showed abnormal MCA PI, all were SGA and had adverse perinatal outcome. 20 pregnancies showed abnormal C/U ratio, all 20 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. The UA PI can be used to identify IUGR per se. The MCA PI alone is not a reliable indicator for predicting fetal distress.

**Key words:** IUGR (Intra Uterine Growth Retardation), Colour doppler, RI, PI, C/U Ratio

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## INTRODUCTION

Small for gestational age (SGA) are those small foetuses with no maternal pathology and with normal UA and middle cerebral artery (MCA) Doppler ultrasound results. In contrast, growth-restricted fetuses are small fetuses with a recognizable maternal pathology or an abnormal UA or MCA Doppler ultrasound [1,2].

Small babies are more likely to suffer antenatal and intrapartum stillbirth<sup>1</sup>. Of those who survives, early neonatal adaptation is hampered and complications like necrotizing enterocolitis, respiratory distress, neurodevelopmental handicap and neonatal death are more common among small for gestational age (SGA) infants.<sup>2</sup> SGA babies also have more chances of Coronary artery disease, obesity, hypertension, type 2 diabetes, the metabolic syndrome and premature death in adulthood [3,4]. In comparison to SGA (birth weight less than the 10th centile) the American College of Obstetricians and Gynecologists (ACOG) describes intra-uterine growth restriction (IUGR) as “a fetus that fails to reach its potential growth” [5]. This highlights the importance of recognizing that some fetuses are small but not growth restricted. Apart from the biometry, Doppler plays an important role in the diagnosis of SGA and IUGR which

helps in the appropriate management of the patients and favorable outcome. The purpose of my 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. 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.

**AIMS AND OBJECTIVES**

To evaluate the pulsatility index (PI) of the umbilical artery (UA) and 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 descriptive cross sectional study was undertaken at Radiodiagnosis department of tertiary care hospital for duration of ten months. All the females who were having clinical suspicion of IUGR were referred to radiology department for fetal biometry and obstetric Doppler between gestational age 30-41 weeks were included in the study. The study was conducted with informed consent in compliance with all the regulatory authorities .The ethics committee provided ethical clearance for the study. They were studied using standard USG machine at our department.

**RESULTS AND INTERPRETATION**

Of the 50 pregnancies in the study, 24 showed abnormal UA PI, 20 showed abnormal C/U PI and 6 showed abnormal MCA PI (depicted via bar diagram in Figure 1 and; a pie chart in Figure 2. Among these, 21 were SGA and 19 had adverse perinatal outcome (Figure 3). 20

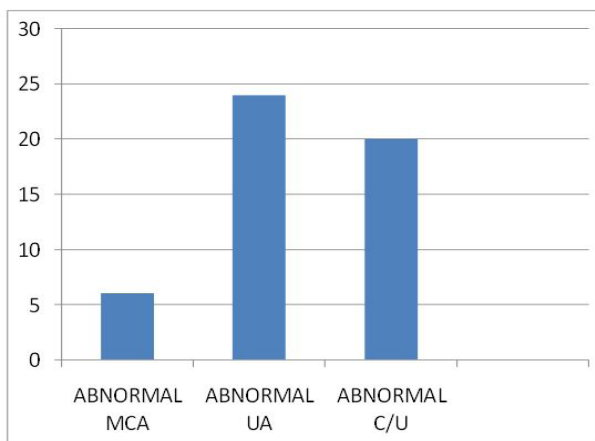


Figure 1: Shows number of patients with abnormal MCA, abnormal UA and abnormal C/U ratio (cerebral-umbilical pulsatility ratio).

in the fetoplacental circulation. 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

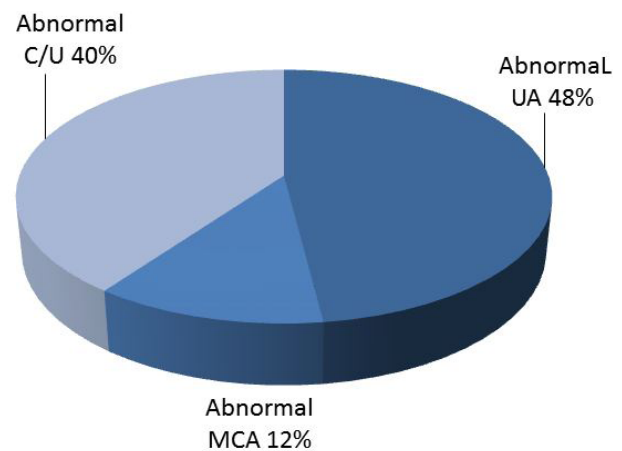


Figure 2: Showing abnormal UA, abnormal MCA and abnormal C/U (cerebral-umbilical pulsatility ratio).



Figure 3: In 24 patients with abnormal UA PI, 21 were having SGA, out of which 19 had adverse outcome. 3 cases having no SGA had normal outcome.



Figure 4: Out of 20 patients having abnormal MCA/UA PI ratio (cerebral-umbilical pulsatility ratio), all were SGA with adverse perinatal outcome.



Figure 5: In 6 patients having abnormal MCA PI all were having SGA with adverse perinatal outcome.

pregnancies showed abnormal C/U ratio, all 20 were SGA and had adverse perinatal outcome (Figure 4). 6 pregnancies showed abnormal MCA PI, all were SGA and had adverse perinatal outcome (Figure 5).

**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.

**Umbilical artery**

UA velocimetry correlates with hemodynamic changes

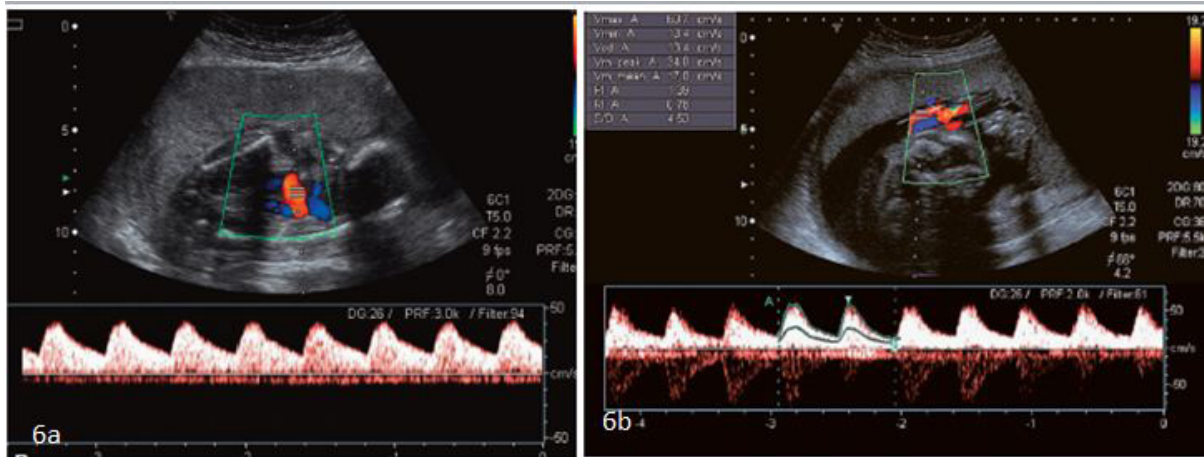


Figure 6A: Normal umbilical artery waveform shows low impedance, high diastolic flow and decreased pulsatility index. B: Umbilical artery waveform at 26 weeks of gestation. PI is 1.39 just above the mean for this gestational age.

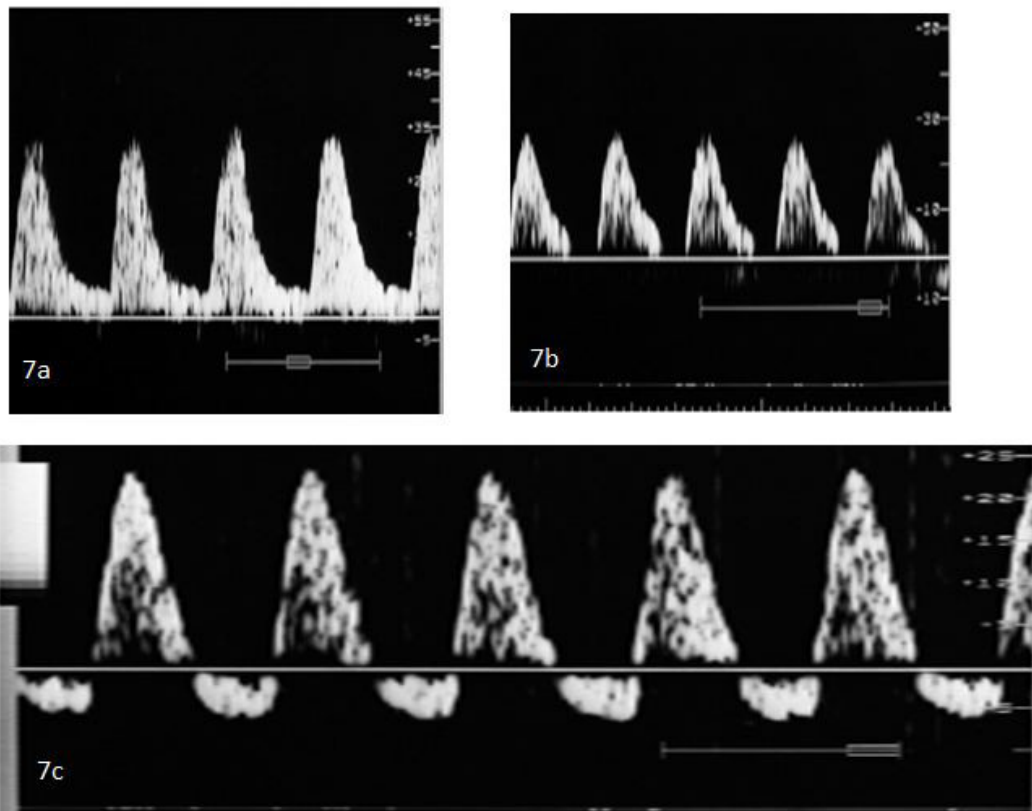


Figure 7a: In IUGR there is reduction in end diastolic flow and increased PI in umbilical artery. b: Severe IUGR with absent end diastolic flow in umbilical artery. c: Reversed diastolic flow in umbilical artery as severity of iugr further increases.

gestational age.

A mature UA Flow velocity waveform is usually achieved by 28- 30 weeks (Figure 6 and Figure 7).

The normal UA waveform pattern shows low impedance and high diastolic flow with a low PI.

Maulik et al. [6] in a study of umbilical artery Doppler velocimetry in normal pregnancy observed that the umbilical artery flow velocity waveform has a rapid upstroke during systole and gradually declines during

diastole maintaining continuous forward flow. Since blood flow during diastole is largely passive and corresponds to the number of tertiary main stem villi available to absorb the circulating blood volume, a decrease in peripheral resistance results in increase in end diastolic flow velocity.

Trudinger et al. observed that indices before 20 weeks of gestation are of less value due to low or absent end-diastolic velocity. Although variations have been reported, there is decrease in mean value of all the

indices in the latter half of pregnancy [4-6].

**Middle cerebral artery**

During normal pregnancy, the MCA shows high resistance and low diastolic flow with an increase in the PI index (Figure 8 and Figure 9).

In a study by Chander et al. [7], normal pregnancy MCA shows high resistance and low diastolic flow pattern with continuous forward flow throughout the cardiac cycle. PI of MCA decreases in all normal pregnancies over the last trimester of pregnancy as reported by Khurana et al. [8]. Chauhan et al. [9] studied that in IUGR, there is increase in the PI secondary to decrease, absence or reversal of diastolic flow. These changes of these waveforms are due to indicate increased placental resistance. The ARED is associated with adverse course of pregnancy and higher incidence of perinatal complications, compared with reduced end-diastolic flow IUGR fetuses [9].

**Umbilical/middle cerebral artery ratio**

C/U ratio was calculated and it was found that it remained constant in the last 10 weeks of pregnancy. We, therefore, used a single cut-off value of 1.08 for all cases of 30–41 weeks of gestation. Above this value, Doppler velocimetry was considered normal and, below it, abnormal [8,9].

**Cerebroumbilical ratio- <1.08 is abnormal [7-9]**

In IUGR, umbilical blood flow is significantly reduced, mainly due to changes in the placental vascular resistance. A decrease in the number of resistance vessels 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 [7-9].

Bano et al. [10] reported that Cerebro-umbilical ratio is a better predictor of SGA fetuses than MCA PI alone in predicting adverse perinatal outcome. Inadequate

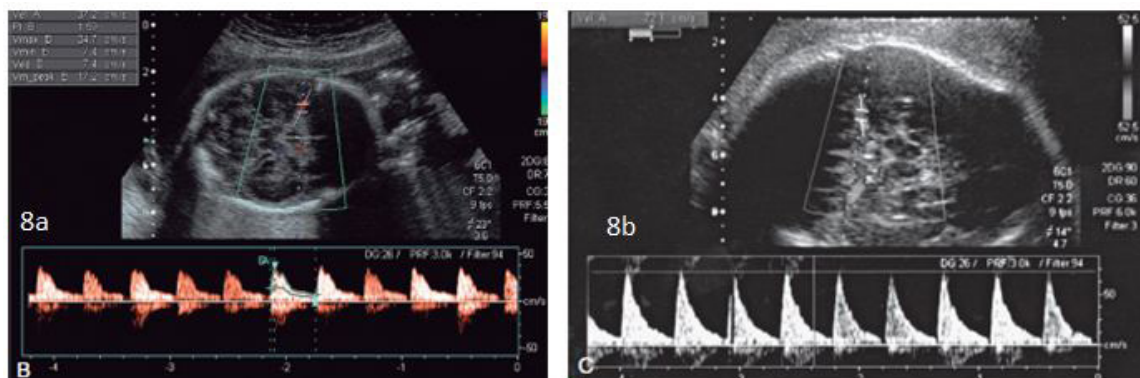


Figure 8a: Spectral flow within normal MCA shows high resistance, low diastolic flow and increased pulsatility index PI IS 1.6 and peak velocity of 37 cm/sec. b: Increased MCA PSV to 72 cm/sec in IUGR.



Figure 9: There is marked increase in diastolic flow in MCA as evidence of cerebral redistribution in IUGR.



trophoblastic invasion of the spiral arteries in case of pregnancy induced hypertension, 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.

Abnormal UA waveform patterns include decrease in diastolic flow, absence of diastolic flow and reversal of diastolic flow. All these patterns were associated with increased UA PI. Patients with absent end-diastolic volume (AEDV) and reverse end-diastolic volume (REDV) have the gravest outcome.

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 hyper perfusion is considered pathological. This 'brain-sparing effect' is associated with an abnormal C/U ratio (<1.08).

Thus, in asymmetrical growth retardation, there is a high UA PI and low MCA PI. As a result, the C/U ratio is lower than normal in growth-retarded fetuses [9,10].

Baschat et al. [11] reported that if there is continued and progressive fetal hypoxia, brain sparing effect phenomena is seen with vasodilatation of fetal intracranial vessels. The Doppler waveform depicts this as increase in diastolic blood flow with decreased Pulsatility index (PI) suggesting a compromised fetus. An MCA PI > 2SD below the gestational age mean is considered as evidence of brain sparing. Martinez et al. [12] reported that in mild fetal hypoxia when the resistance of the umbilical artery is increased, no change may be demonstrated in the flow pattern of MCA due to adaptation in fetal circulation in maintaining the afterload of left ventricle. The C/U ratio remains constant during the last 10 weeks of gestation and provides better diagnostic accuracy than either vessels' PI considered alone. 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.

### CONCLUSION

From our study, we draw inference that the C/U ratio (cerebral-umbilical pulsatility ratio) is a better predictor of SGA fetuses and adverse perinatal outcome than the MCA PI or the UA PI used alone. The UA PI (umbilical

artery pulsatility index) can be used to identify IUGR independently. The MCA PI (middle cerebral artery pulsatility index) alone is not a reliable indicator for predicting fetal distress.

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