

## ORIGINAL ARTICLE

### ROLE OF DOPPLER STUDY IN THE EVALUATION OF INTRAUTERINE GROWTH RETARDATION

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**ABSTRACT: BACKGROUND AND OBJECTIVE:** Intrauterine growth retardation (IUGR) is a fetal growth disorder defined on the basis of a fetal weight below 10<sup>th</sup> percentile for the corresponding gestational age. Our study was an effort at establishing the role of Umbilical artery (UA) and Middle cerebral artery (MCA) Doppler indices in predicting the adverse perinatal outcome in clinically suspected IUGR pregnancies, and to determine the role of Doppler velocimetry in clinical management of such pregnancies. Elevation of the umbilical artery systolic/diastolic ratio or of the pulsatility index (PI); absent or reversed end-diastolic flow in the umbilical artery and decreased systolic/diastolic ratio or pulsatility index in the fetal internal carotid and middle cerebral arteries are the predictors of abnormal perinatal outcome. Our study was to evaluate the role of ratio of pulsatility index (PI) which is called as Cerebroplacental Ratio i.e. MCAPI/UAPI Doppler ratio as the most accurate predictor of adverse perinatal outcome among women with clinical suspicion of IUGR attending our (SVRR Govt.) hospital. **METHODOLOGY:** 50 Antenatal women attending the antenatal O.P.D who were clinically suspected as having growth retardation based on clinical history of previous child with growth retardation, signs of pallor ( anaemia ) and high documented Blood pressures –s/o PIH, reduced abdominal height for gestational age,were evaluated using screening ultrasound.Doppler velocity wave forms were obtained from umbilical artery and fetal middle cerebral artery from all the 50 cases. 16 cases were followed up with repeat Doppler.Pulsatility index ratio of middle cerebral artery and umbilical artery, also called as Cerebroplacental ratio was evaluated in each case. Abnormal ratio is defined as Cerebroplacental ratio <1.08 was considered as a cut off value. Ratio was calculated and correlated clinically with the perinatal outcomes – in the form of IUD's, low APGAR scores and admission into ICU. **RESULTS:** Out of the total 50 antenatal cases, 62% (n = 31) neonates had birth weight <2.5 kg. There were 7 intra uterine deaths and 43 live births. Of the 43 live births 8 Neonates were admitted to NICU. 7 neonates had 5 min Apgar score of less than 7 and 12 babies were born by emergency caesarian section. Of the 7 IUD's 4 cases had reversal of diastolic flow and 3 cases had absent diastolic flow in umbilical artery. In all cases with reversal of diastolic flow, IUD of the fetus occurred within one week of diagnosis. **INTERPRETATION AND CONCLUSION:** Based on our study and on reviewing the literature, we can conclude that Doppler ultrasound is a valuable modality in evaluating growth retardation. Cerebroplacental ratio is the most specific parameter in predicting the perinatal outcome when compared to UA PI or the MCA PI alone. Absent or reversed diastolic flow in umbilical artery is an ominous finding associated with adverse perinatal outcome and mortality. Thus the umbilical artery and middle cerebral artery Doppler studies help in the prediction of adverse perinatal outcome and management of clinically suspected IUGR.

**KEYWORDS:** Pulsatilityindex, Cerebroplacentalratio, IUGR.

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**INTRODUCTION:** Intrauterine growth retardation (IUGR) is a common complication of pregnancy associated with an increased risk of perinatal mortality, morbidity, and impaired neurodevelopment. Before the advent of ultrasound, assessment of fetal growth during pregnancy was limited to measuring the uterine size, assessing the fetal size by palpation and looking at the infant after delivery. Now, in the present era of Doppler sonography, diagnosis of intrauterine growth restriction has become easier and thus decreasing the perinatal mortality and morbidity rate. The incidence of IUGR in a population where the mothers are generally healthy and well-nourished is estimated to be about 3-5%. In a population of women with hypertension or previous growth restricted fetus however the incidence increases to 15-20% or higher. The incidence of IUGR varies from region to region and even in the same region, it varies in different sub populations. In India, according to recent UNICEF surveys, the incidence of IUGR is 25-30%.

Doppler ultrasound allows a noninvasive assessment of fetal hemodynamics.

The growing availability of Doppler equipment in the mid to late 1980s led to an outpouring of studies examining the use of this technique in pregnant women.

The rationale for suspecting that Doppler imaging may be a useful diagnostic technique for IUGR is based on a chain of reasoning:

1. some cases of growth retardation are due to abnormalities of placental circulation;
2. these placental abnormalities may lead to increased resistance to blood flow in the placenta;
3. increased resistance leads to decreased velocity in the feeding arteries, especially during diastole, and this in turn leads to decreased volume of blood flow through the placenta;
4. Disproportionate slowing of diastolic relative to systolic flow leads to elevation of a number of Doppler indices, including the systolic/diastolic ratio and the pulsatility index.

As Doppler ultrasound provides a unique, non-invasive and safe method of studying blood flow characteristics in both the Fetoplacental and uteroplacental circulations, it is being used in Clinical evaluation of high risk pregnancies.

Umbilical arterial (UA) Doppler velocimetry is the most evaluated test among noninvasive tests of fetal well-being. A low end-diastolic velocity in umbilical artery as a consequence of high flow resistance in capillaries of terminal villi.

In response to prolonged fetal hypoxic stress, circulatory adaptation occurs, resulting in redistribution of the cardiac output to provide a constant supply of oxygen to brain and other essential organs (i.e heart and adrenal glands). This compensatory adjustment on which brain sparing effect is based, is associated with a rise in diastolic velocities in Doppler cerebral artery waveforms. This rise is considered a manifestation of cerebral vasodilatation, causing a decrease in Doppler indices such as pulsatility index. In majority of severely growth retarded fetuses, sequential deterioration of arterial and venous Doppler precedes biophysical score deterioration. At least one third of fetuses show early signs of circulatory deregulation one week before biophysical profile deterioration, and in most cases, Doppler deterioration precedes biophysical profile deterioration by 1 day. This indicates the significance of Doppler study in these patients for early detection of fetal compromise.

At cordocentesis, a significant correlation has been observed between hypoxemia in fetuses with IUGR.

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Our study was an effort to establish the role of Doppler indices, especially the MCAPI/UAPI Doppler ratio as the most accurate predictor of adverse perinatal outcome among women with clinical suspicion of IUGR attending our hospital and an abnormal MCA pulsatility index.

## AIMS AND OBJECTIVES:

1. To establish the role of umbilical artery and middle cerebral artery Doppler indices in diagnosing IUGR.
2. To evaluate the usefulness of umbilical artery and middle cerebral artery as predictors of adverse perinatal outcome in clinically suspected IUGR Pregnancies.
3. To establish the Role of Doppler Ultrasound in the Management of IUGR pregnancy.

## METHODOLOGY:

**Present study:** Hospital based cross-sectional observational study conducted in the department of Radio diagnosis, S.V.R.R G.G Hospital Tirupati. This study was proved by the Ethical Committee of our institution.

**Source of Data:** Data for the study was collected from pregnant women clinically suspected to have IUGR, referred to the department of radio diagnosis, S.V.R.R.G.G Hospital attached to S.V Medical College.

**Size of the Data:** The study included 50 singleton pregnancies.

**Inclusion Criteria:** (a) Singleton pregnancy. (b) Fetal gestational age of 30 to 40 weeks with clinically suspected intrauterine growth retardation.

Exclusion criteria for the study included any pregnancy with a) Documented major congenital abnormality b) Multiple gestations.

**Method of Collection of Data:** Doppler US evaluation was performed following a detailed clinical history, US biometry, and assessment of amniotic fluid and placental maturity. Repeat Doppler studies were performed if clinically indicated to determine a favorable or a worsening trend in the Doppler indices. The results of the first Doppler ultrasound were used for analysis of perinatal outcome.

**Doppler US Technique:** The patients were evaluated on ESOATE MY LAB 50 color Doppler ultrasound scanner with a curvilinear transducer, having a variable frequency of 3.5–5.0 MHz. The Doppler wall filter was set at 50–100 Hz.

Patients' consent was taken in the prescribed form as per PNDT Act.

**PHYSICS OF DOPPLER ULTRASONOGRAPHY:** The Doppler Effect is defined as a change in the perceived frequency of sound emitted by a moving source. This effect was first described by Christian Doppler in 1843.

When the frequency of the emitted and received sound, and its insonation angle are known, the Doppler shift can be calculated (that is the difference between the emitted and the

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reflecting frequency), as it is correlated to the velocity of the relative movement between the target and transducer. This relation is defined by the formula.

$$F_D = F_r - F_o = \frac{2f_o V}{C} \cos \theta$$

Where  $F_D$  is the Doppler shift,  $F_o$  is the frequency of the transmitted ultrasound,  $F_r$  is the received frequency.  $V$  is the velocity of the relative movement,  $\theta$  is the angle of insonation and  $C$  is the velocity of sound with in the tissue.<sup>37</sup> Continuous Wave Doppler Ultrasonography: - The sound beam is continuously emitted from one transducer and received by a second.

Color flow imaging (CFI): In this technique color is assigned to show direction. Customarily flow towards the Doppler transducer is displayed in red, and flow away from it is shown in blue. The structures that do not move are presented in basic gray scale image. The color saturation is related to the magnitude of the frequency shift.

Color Doppler energy (CDE) detects the energy of Doppler signals generated from moving blood. The information obtained is different from that of conventional CDI. The most distinctive feature of CDE is that it is independent of direction of flow.

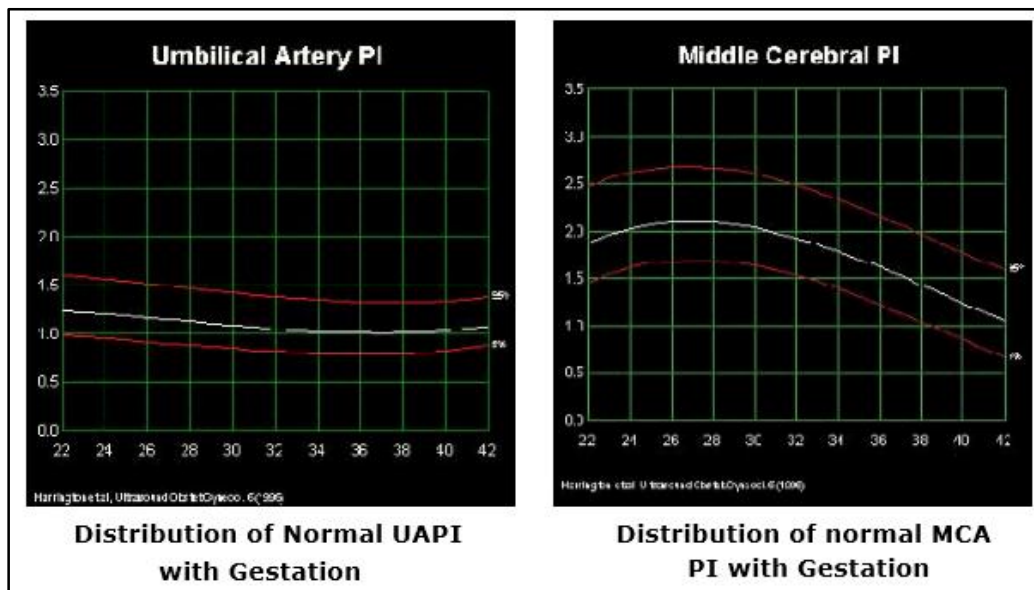
**Doppler Velocimetry: Semi Quantitative Assessment:** Here the relationship between the systolic and diastolic components of the wave form is evaluated, and the angle dependence, which is important in quantitative measurements become less important. Different indices have been proposed to define the properties of the Doppler spectrum the most common in obstetric application being the pulsatility index, the resistance index and the Systolic/Diastolic(S/D) ratio.

$$PI = \frac{S - D}{A} \quad RI = \frac{S - D}{S} \quad S/D \text{ ratio}$$

Where  $S$  is the maximum peak systolic frequency,  $D$  is the end diastolic frequency and  $A$  is the mean Doppler shift frequency during a cardiac cycle.

**PULSATILITY INDICES FOR GESTATIONAL AGE:** The normal range is shown in 5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup> percentiles.

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The UA Pulsatility index ratios were considered abnormal if the value was above the 95th percentile for gestational age.

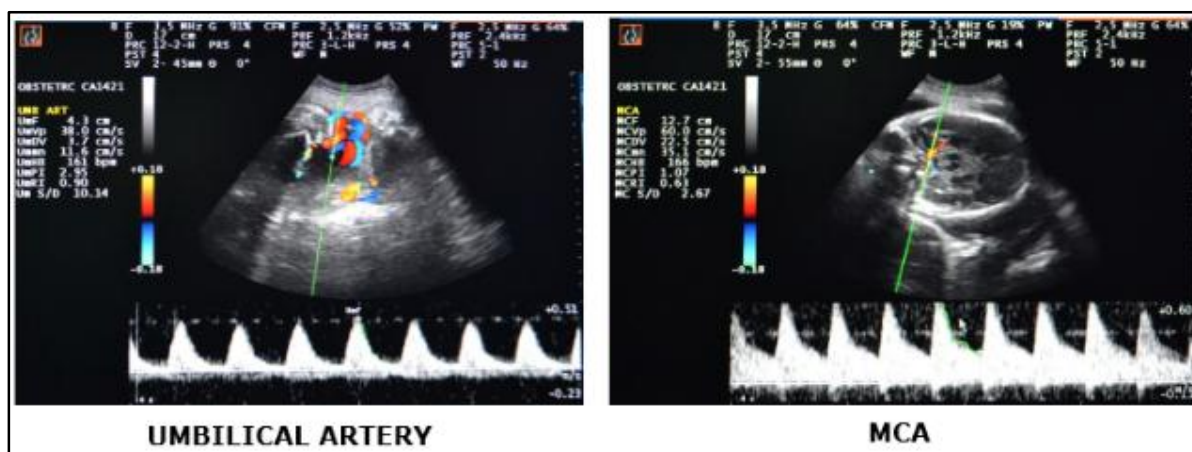
The MCA pulsatility index was considered abnormal if the value was below the 5th percentile for gestational age.

The MCA/UA PI ratio (cerebro-placental ratio) is usually constant during the last 10 weeks of gestation. It is possible to use a single cut off value after 30th week because cerebral-umbilical Doppler ratio does not vary significantly between 30th and 40th weeks.

Therefore, in our study a single cutoff value (1.08) was used, above which velocimetry was considered normal and below which it was considered abnormal.

The sensitivity, specificity, positive predictive value, negative predictive Value and diagnostic accuracy were determined for all Doppler measurements.

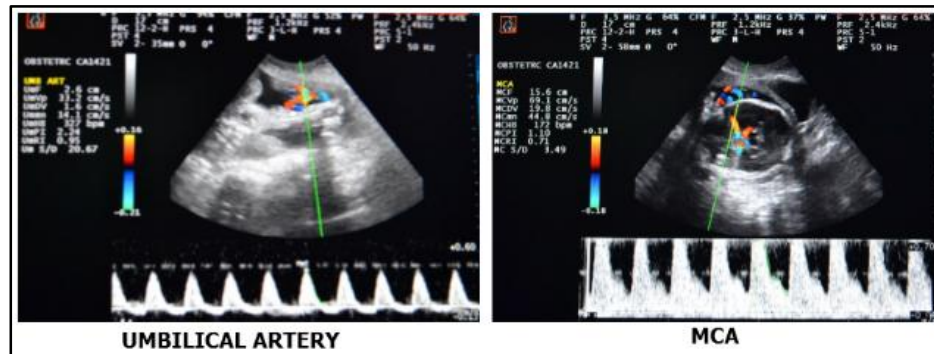
## CASES: Case 1: G3P2L1D1 with severe PIH with suspected IUGR.



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**UMBILICAL ARTERY MCA:** Decreased diastolic flow noted in Umbilical artery (increased PI value 2.9).MCA Doppler shows (decreased PI value 1.0). Cerebroplacental Ratio: 0.34 (abnormal). The child postnatally had low APGAR -4 and was admitted to ICU.

## Case 2: 22yr old G2P1L1 with severe PIH.



Reversal of diastolic flow within umbilical artery showing (high PI value 2.2). Similarly MCA shows decreased PI value 1.1. Cerebroplacental ratio: 0.5 (abnormal). There was IUD of the fetus within 48 hours as the patient refused admission.

## OBSERVATION AND RESULTS:

GESTATIONAL AGE	NUMBER	PERCENTAGE
30-32	21	42%
33-35	12	24%
36-40	17	34%
<b>TOTAL</b>	<b>50</b>	<b>100%</b>
MEAN+/-2SD	33.66+/-2.46	
Gestational age distribution in the study group		

PARITY	NO. OF CASES	PERCENTAGE
Primigravida	32	54%
Multigravida	18	36%
Parity distribution among the study group		

**Maternal complications of the study group:** 60% (n=30) of the mothers had Pregnancy Induced Hypertension, 20 % (n=10) had anemia, 8 % (n=4) patients had diagnosed chronic kidney disease, 12 % (n=6) had PIH associated with anemia at first Doppler examination.

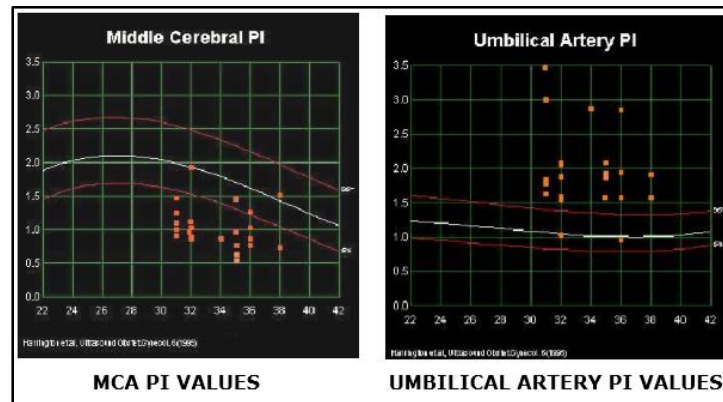
**Amniotic Fluid Distribution in the Study Group:** 30% (n=15) had normal liquor and 70% (n=35) had Oligohydramnios at first Doppler examination.



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**Distribution Characteristics of Placental Maturity:** 72% of cases (n=36) had Grade III Placental maturity at the time of first Doppler Examination and 28 % (n=14) had Grade II; Placental maturity.

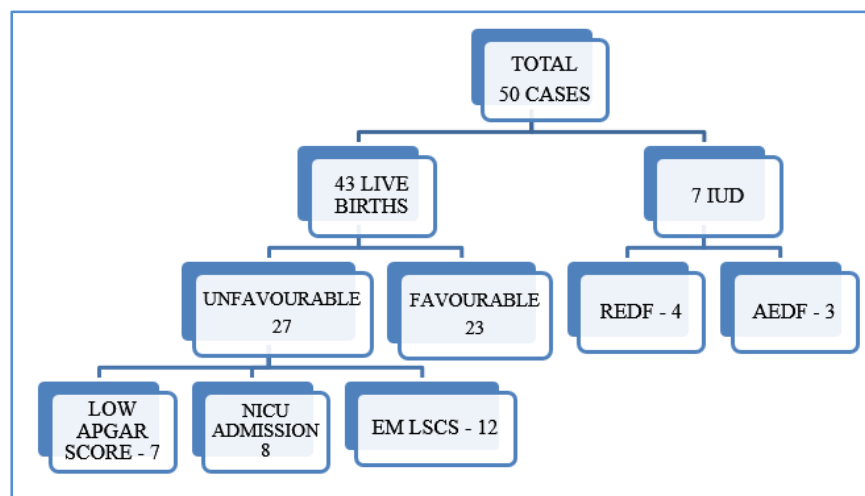
## Distribution of PI Values among the study group:



Patients with abnormal PI values in Umbilical artery (value above 95<sup>th</sup> percentile and low PI value in MCA (less than 5<sup>th</sup> percentile) had a subnormal clinical outcome.

ADVERSE OUTCOME	NO. OF CASES	PERCENTAGE
Intrauterine deaths	7	20%
Emergency CS	12	34.28%
Low Apgar score	8	22.85%
Admission to NICU	8	22.85%
Adverse Fetal Outcomes		

Of the 7 IUDs 4 cases had reversal of diastolic flow and 3 had absent diastolic flow. In all cases with reversal of diastolic flow, IUD of the fetus occurred within one week of diagnosis – S/o 100% mortality and all the 4 cases were less than 32 weeks.



TP- true positives; TN –true negatives; FP-false positives; FN-false negatives.

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Doppler index	TP	TN	FP	FN	Sensitivity	Specificity	Diagnostic Accuracy
UA PI	26	4	7	13	86.6%	80 %	78%
MCA PI	20	5	13	11	76%	78%	52%
MCAPI/UAPI RATIO	27	8	4	16	90%	88%	86%

Performance Characteristics of Doppler Indices

Doppler index	Diagnostic accuracy
UA PI	78%
MCA PI	62%
MCA/UA PI Ratio (Cerebroplacental Ratio)	86%

Table showing Diagnostic accuracies of Doppler Indices

**DISCUSSION:** Doppler velocimetry is a noninvasive technique that evaluates the abnormal fetal hemodynamics that take place in response to changes in placental resistance. A Doppler index that reflects these changes can be useful in identifying the fetuses with increased placental and decreased cerebral resistance.

We chose incidences of perinatal death, emergency section for fetal distress, NICU admission for complication of low birth weight and low Apgar score as outcome variables in concurrence with previous studies done.

Cerebro-placental ratio has a high sensitivity, specificity and diagnostic accuracy in predicting adverse perinatal outcome.

Our results in evaluating the usefulness of umbilical and middle cerebral artery Doppler in predicting the adverse perinatal outcome in IUGR indicate that both abnormal umbilical Doppler indices and cerebro-placental ratio are strong predictors of adverse outcome in IUGR. MCA PI is not a reliable indicator when used alone. The combination of umbilical and middle cerebral Doppler indices may increase the utility of Doppler ultrasound in clinically suspected IUGR.

## CONCLUSION:

1. Doppler Ultrasound is a valuable initial modality for the evaluation of patients. With suspected intrauterine growth retardation.
2. Doppler evaluation of umbilical and middle cerebral arteries has an important role in the early diagnosis of clinically suspected growth retardation.
3. Abnormal Cerebroplacental ratio, in particular is a strong predictor of adverse perinatal outcome in IUGR.
4. Umbilical artery Doppler is more useful than middle cerebral artery in Prediction of outcome in IUGR when considered individually.



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5. Umbilical artery Doppler is more useful than middle cerebral artery in prediction of outcome in IUGR when considered individually.
6. Absent and reversed diastolic flow in umbilical artery in IUGR is an ominous finding associated with increased mortality and morbidity.

Fetal Doppler study plays a significant role in the management of growth restricted fetuses by early identification of compromised fetuses and thus determine the line of management.

Thus fetal Doppler study should be an integral part in evaluation of a suspected IUGR pregnancy, diagnosing and predicting the adverse outcome

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