

Comparison of Diagnostic Efficacy of Umbilical Artery and Middle Cerebral Artery Waveform with Color Doppler Study for Detection of Intrauterine Growth Restriction Fetuses

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ABSTRACT

Introduction: Intrauterine growth restriction (IUGR) is associated with an increased risk of perinatal mortality, morbidity, and impaired neurodevelopment. This prospective study was performed to determine the degree of neonatal morbidity in fetuses suspected of having intrauterine growth restriction (IUGR) by doppler ultra sound.

Material and Methods: Present study included a total number of 50 cases. Doppler US evaluation was performed following a detailed clinical history, US biometry, and assessment of amniotic fluid and placental maturity. Follow up Doppler studies were performed if clinically indicated to determine a favourable or a worsening trend in the Doppler indices. However only the results of the first Doppler ultrasound were used for analysis of perinatal outcome.

Results: Among 50 pregnancies with clinical suspicion of IUGR Mean birth weight at delivery was 2.43kg +/- 0.26 kg (2SD). 60% of neonates (n=30) had birth weight of less than 2.5 kg. 48% (n=24) fetuses had at least one adverse outcome; some of them (n=8) had more than one adverse outcome. Remaining 26 fetuses had favorable outcome. 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. MCA/UA pulsatility index ratio had a higher Sensitivity, Positive predictive value for adverse perinatal outcome than did the MCA pulsatility index and the UA PI. It was found that MCA PI had low specificity in predicting adverse outcome. There were 7 IUDs in whom 4 cases had reversal of diastolic flow and 3 had absent diastolic flow. In all cases with reversal of diastolic flow IUD occurred within one week of diagnosis. And all the 4 cases were less than 32 weeks. In our study Mortality in case of Reversed end diastolic flow was 100% and 33% in absent diastolic flow indicating grave prognosis.

Conclusions: In fetuses with suspected IUGR, abnormal MCA/UA S/D ratios are strongly associated with low gestational age at delivery, low birth weight, and low UA pH. Abnormal MCA/UA S/D ratios are also significantly associated with shorter interval to delivery and the need for emergent delivery.

Key words: Umbilical Artery, Middle Cerebral Artery Waveform, Color Doppler, Intrauterine Growth

INTRODUCTION

Intrauterine growth restriction (IUGR) is associated with an increased risk of perinatal mortality, morbidity, and impaired neurodevelopment. Ultrasonographic (US) biometry helps to identify a heterogeneous group of small-for-gestational age fetuses that include fetuses with IUGR, fetuses with small constitution, and fetuses with appropriate growth (misdiagnosed as small). Umbilical arterial (UA) Doppler velocimetry is the most thoroughly assessed test amongst noninvasive trial of fetal health.¹ A meta-investigation of randomized controlled trials of UA Doppler velocimetry in high-chance pregnancies (for

the most part pregnancies with related hypertension and suspected IUGR) showed that its utilization was related with a pattern to the reduction of perinatal mortality, in spite of the fact that there was no impact on the rate of neonatal morbidity.^{1,2} Consequences of a few examinations recommend that the MCAPI/UAPI Doppler proportion is more precise in the anticipation of antagonistic perinatal result than UA Doppler only US.²⁻⁴ Our investigation was an attempt at building up the part of UA and MCA Doppler ultrasound in foreseeing unfavorable perinatal outcome in clinically presumed IUGR pregnancies, and to decide the part of Doppler velocimetry in clinical administration

of such pregnancies.

Study Design

The present study was planned for evaluation of the usefulness of umbilical artery and middle cerebral artery Doppler indices as indicators of antagonistic perinatal outcome in clinically presumed IUGR Pregnancies and to build up the Role of Doppler Ultrasound in the Management of IUGR pregnancy.

Women referred for antenatal Doppler were included in the study if the following

Inclusion criteria were met:

- a. Singleton pregnancy.
- b. 31 to 40 weeks of gestational age of fetus
- c. clinically presumed intrauterine development impediment. (Estimated fetal weight <10th percentile for gestation)

'The gestational age depended on ultrasound biometry performed before the twentieth gestational week, when the LMP is unverifiable or not known and did not perform early ultrasound before 13 weeks'.

Exclusion criteria for the study included any pregnancy with

- a) History of congenital anomalies
- b) History of several gestations
- c) Intrauterine death on first Doppler examination.

The investigation was led for a time of 2 years. A sum total of 50 cases meeting the consideration criteria were incorporated in the study. A written informed was obtained from the patients and a form was filled according to PCPNDT(Pre-conception and Prenatal diagnostic techniques) act preceding examination. an explained clinical history was obtained and followed by Doppler US assessment was performed. US biometry and evaluation of amniotic liquid and placental development was done. Follow up Doppler thinks about were performed if clinically demonstrated to decide an ideal or a declining pattern in the Doppler records. However just the consequences of the primary Doppler ultrasound were utilized for investigation of perinatal outcome.

However only the results of the first Doppler ultrasound were used for analysis of perinatal outcome..

Doppler US Technique

ESOATE MY LAB 40 MACHINE with the transducer recurrence of 3.5–5.0 MHZ was utilized. The patients were permitted to rest for 10 to 15mins out of a semi-supine position preceding beginning the ultrasound examination. Fetal biometry was performed initially. The waveforms were acquired amid fetal inactiveness and apnea. Umbilical corridor Doppler stream speed waveforms were gotten from a free circle of string, and estimations taken when a reasonable waveform was procured without fetal breathing or body movement. The Pulsatility list (PI) was measured, and the nearness or nonappearance of end-

diastolic frequencies was noted. The PI was utilized as it keeps on reflecting changes in resistance with dynamic nonattendance of end-diastolic frequencies or invert stream, and the qualities are ordinarily appropriated in the third trimester.⁵ For MCA Doppler US, a transverse picture of the fetal head was gotten at the level of the sphenoid bones. Shading stream imaging was utilized to show the circle of Willis. The MCA in the close field was insonated around 1 cm distal to its root from the inner carotid corridor.

Doppler US results were analyzed for prediction of perinatal outcome. Outcome variables included,

1. Birth Weight.
2. Perinatal death
3. Emergency CS for fetal distress
4. Low Apgar score (5 min Apgar score less than 7)
5. Admission to NICU for complications of Low Birth Weight.

Pregnancy was considered to have "Adverse outcome" when any of the following complications were present

1. Perinatal death
2. Emergency CS for fetal distress
3. 5 minute Apgar score of less than 7
4. Admission to NICU for complications of low birth weight.

Pregnancy outcome was considered to be Uneventful or Favourable when the above complications were absent. The outcome for each pregnancy was obtained by examining the labor ward records and neonatal intensive care unit records wherever appropriate. The UA and MCA Pulsatility index ratios were considered abnormal if the value was above the 95th percentile and below the 5th percentile of the values published for gestational age previously respectively.⁷ In the investigation, we utilized a solitary cutoff value (1.08), above which velocimetry was viewed as ordinary and beneath which it was viewed as abnormal. The affectability, specificity, positive prescient value, negative prescient Value and diagnostic precision was resolved for all Doppler estimations.

RESULTS

We obtained satisfactory wave forms from all 50 cases of pregnancies. Follow up of 7 cases was done using repeat Doppler.

56% (n=28) of the mothers had Pregnancy Induced Hypertension, 22% (n=11) had anemia, one patient had Diagnosed Diabetes Mellitus at first Doppler examination. (Table 1) 22% (n=11) had normal liquor and 78% (n=39) had Oligohydramnios at first Doppler examination. Other results are self descriptive in Tables 2-4.

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. And all the 4 cases were less than 32 weeks. Cerebroplacental ratio (MCA/UA PI Ratio) was most

sensitive (sensitivity 95.8%). It was more sensitive than either UA PI (sensitivity 91%) or MCA PI (sensitivity 87.5%) alone in predicting any adverse out come. Cerebroplacental Ratio and UA PI were equally specific (Specificity=84.6%) and MCA PI had comparably low specificity (specificity=46%). Cerebroplacental Ratio had highest Positive Predictive Value (PPV=85%) followed by UAPI (PPV=84%) and MCA PI (PPV=60%).Negative Predictive Value(NPV) of Cerebroplacental Ratio was 95% when compared to 91% for UA PI and 80% for MCA (Table 5).

Maternal complications	Number	Percentage
PIH	28	56%
Anaemia	11	22%
DM	1	2%

Table-1: Maternal Complications

Pregnancy outcome	Number of cases	Percentage
Adverse	24	48%
Uneventful	26	52%

Table-3: Table showing Pregnancy Outcome Uneventful Vs Adverse

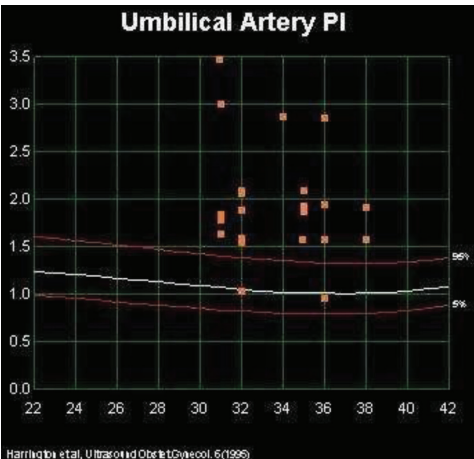


Figure-1: Distribution of UA PI Values with gestation for pregnancies with adverse outcome.

Diagnostic accuracy of Cerebroplacental ratio (Accuracy=90%) was better than UA PI (Accuracy=88%) and MCA PI (Accuracy=66%) in predicting adverse outcomes (Figures 1-4).

DISCUSSION

The goal of study was to determine the role of colour doppler of MCA and UA in rural pregnant women with clinical suspicion of IUGR and its role in management. The prospective study included about 50 pregnancies with

Placental maturity	Number of cases	Percentage
Grade II	12	24%
Grade III	38	76%

Table-2: Table showing Distribution Characteristics of Placental Maturity

Adverse outcomes	Number of cases
Intra uterine deaths	7
Emergency CS	12
Low APGAR score	7
Admission in to NICU	8

Table-4: Table showing Adverse Outcomes

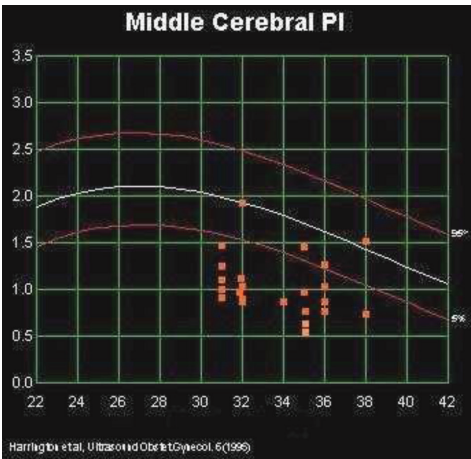


Figure-2: Distribution of MCA PI Values with gestation for pregnancies with adverse outcome.

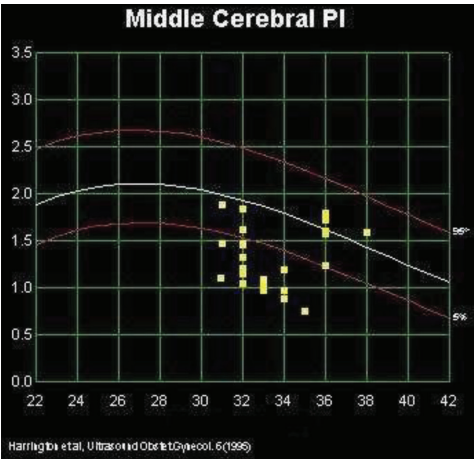


Figure-3: Distribution of MCA PI Values with gestation for pregnancies with favourable outcome

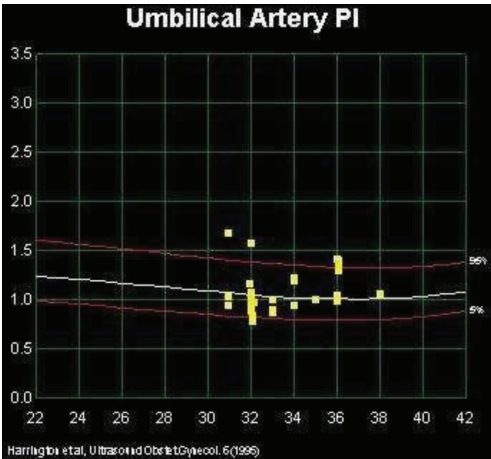


Figure-4: Distribution of UA PI Values for pregnancies with favourable outcome.

clinical suspicion of IUGR. The study was conducted in ACSR Govt medical school and general hospital facility for a time of One year. The examination for the most part included rural pregnant ladies. The investigation was directed in pregnancies of 31 to 40 weeks gestational age. Mean birth weight at conveyance was 2.43kg +/- 0.26 kg (2SD). 60% of neonates (n=30) had birth weight of under 2.5 kg. 48% (n=24) fetus had no less than one unfriendly result; a few (n=8) had more than one unfriendly result. Remaining 26 fetuses had positive result. There were 7 intra uterine deaths and 43 live births. Of the 43 livebirths, 8 Neonates were admitted to NICU. 7 neonates had 5 min Apgar score of under 7 and 12 babies were born by emergency caesarian section. The present study has 24 primigravidas (48%). Of them 14 had pregnancy induced hypertension(58%) and 6 had anaemia (25%). 7 had adverse outcome. Out of total cases of pregnancy induced hypertension primi had more incidence(50%) in the present study. Anaemia in primigravida (54%),out of all cases of anaemia. This indicates primi has more incidence of pregnancy induced hypertension and anaemiaClinical history had also an impotant role in predicting outcome..

Doppler index	PPV	NPV
UA	84%	91%
MCA	60%	80%
MCA/UA	85%	95%

Table-5: Table showing Predictive Values of Doppler Indices

As 50% of patients with abnormal clinical findings had an adverse outcome and deaths. But compared to this doppler indices of umbilical and middle cerebral artery played an important role in outcome (Table 6).

Cerebroplacental ratio (MCA/UA PI Ratio) was most sensitive (sensitivity 95.8%). It was more sensitive than either UA PI (sensitivity 91%) or MCA PI (sensitivity 87.5%) alone in predicting any adverse out come. Cerebroplacental Ratio and UA PI were equally specific (Specificity=84.6%) and MCA PI had comparably low specificity (specificity=46%) (table-7).

Cerebroplacental Ratio had highest Positive Predictive Value (PPV=85%) followed by UAPI (PPV=84%) and MCA PI (PPV=60%). Negative Predictive Value of Cerebroplacental Ratio was 95% when compared to 91% for UA PI and 80% for MCA. Diagnostic accuracy of Cerebroplacental ratio (Accuracy=90%) was better than UA PI (Accuracy=88%) and MCA PI (Accuracy=66%) in predicting adverse outcomes. Arduini and Rizzo² studied the test characteristics of the pulsatility index from the UA, MCA, and RA to predict adverse perinatal outcome in 120 small-for-gestational age fetuses. In 46.7% (56 of 120) of fetuses, there was at least one of the adverse effects. By using the first Doppler US result for analysis, the authors found that the UA/MCA pulsatility index ratio was the best test when compared with MCA, UA, and RA pulsatility indices (sensitivity, 89% vs 68%, 66%, and 43%; specificity, 94% vs 91%, 88%, and 91%). In comparison

	Sensitivity	Specificity	PPV	NPV
Arduini, Rizzo ² (1992)	89%	94%	-	-
Gramellini et al ³ (1992)	68%	98.4%	94.4%	88.8%
Fong KW et al ⁷ (1999)	51.3%	80.6%	48.1%	82.5%
Present study*	95.8%	84.6%	85%	95%

Table-6: MCA/UA PI Ratio in Predicting Adverse Perinatal Outcome.

		Sensitivity	Specificity	PPV	NPV
Arduini and Rizzo ²	(1992)	66%	88%	-	-
Gramellini et al ³	(1992)	64%	90.7%	72.7%	86.7%
Fong KW et al ⁷	(1999)	44.7%	86.6%	54%	81.7%
Present study*		91%	84.6%	84%	91%

Table-7: UA PI in predicting Adverse Perinatal outcome

	Sensitivity	Specificity	PPV	NPV
Arduini and Rizzo ¹⁰ (1992)	68%	91%	-	-
Gramellini et al ¹¹ (1992)	24%	100%	100%	77.3%
Fong KW et al ²⁷ (1999)	72.4%	58.1%	37.7%	85.7%
Present study*	87.5%	46%	60%	80%

Table-8: MCA PI in predicting adverse perinatal outcome

	Present Study	Gramellini et al
MCA/UA PI Ratio	90%	90%
UA PI	88%	83.3%
MCA PI	66%	78.8%

Table-9: Comparison of Diagnostic accuracies

to Arduini and Rizzo¹⁰ sensitivity and specificity of cerebroplacental ratio well correlated with present study in predicting adverse outcome. The sensitivity and specificity of UA PI and MCA PI not correlated with present study (Table 8).

Gramellini D, Folli MC, et al³ concluded that the cerebral-umbilical Doppler ratio provided a better predictor of small for gestational age newborns and adverse perinatal outcome than either the middle cerebral artery or umbilical artery alone. In fact, in predicting those newborns that were small for gestational age, the cerebral-umbilical ratio had a 70% diagnostic accuracy compared with 54.4% for the middle cerebral artery and 65.5% for the umbilical artery. The results were more encouraging for prediction of adverse perinatal outcome; diagnostic accuracy for the cerebral-umbilical ratio was 90%, compared with 78.8% for the middle cerebral artery and 83.3% for the umbilical artery.

Our study confirms with those of Gramellini et al¹¹ that best results are obtained when we used MCA/UA PI Ratio, rather than PIs of middle cerebral artery and Umbilical artery separately (Table 9). Fong KW et al⁴ studied 293 small-for-gestational age fetuses with Doppler US of the UA, MCA, and RA. They concluded that The MCA pulsatility index (PI), compared with the UA PI and RA PI, was more sensitive (72.4% vs 44.7% and 8.3%) but less specific (58.1% vs 86.6% and 92.6%) in predicting adverse outcome.

Results of present study confirm with those of Fong et al⁷ that MCA PI had low specificity in predicting adverse perinatal outcome. There are several possible explanations for the low Specificity of the MCA pulsatility index for adverse perinatal outcome. The present study has not included the doppler of renal artery as that in Fong KW et al.

Chan et al⁸ studied 71 high-risk fetuses with weekly UA and MCA Doppler US examinations until delivery. In 15.5% (11 of 71) of fetuses, there was perinatal mortality or major morbidity. By using the last Doppler US result for analysis, the UA/MCA resistance index ratio, compared with the UA systolic-to-diastolic ratio, was more sensitive (75% vs 64%) but less specific (60% vs 74%).

Results of present study confirm with those of Chan et al⁸ that UA Doppler US was a better predictor for each of the individual adverse outcomes when separate analyses were performed. sensitivity, specificity, PPV, NPV of UA PI in predicting adverse perinatal outcome was 91%, 84.6%, 84%, 91% respectively in present study.

When compared to pulsatility index of umbilical artery and middle cerebral artery resistive index has less sensitivity and less diagnostic accuracy. Systolic diastolic ratio has equal specificity but less sensitivity when compared to pulsatility index. Individual peak systolic velocity and diastolic velocity has least diagnostic accuracy. Presence

or absence of diastolic flow well correlated with fetal mortality. When compared to all indices cerebroplacental ratio had highest sensitivity, specificity, predictive values and diagnostic accuracy.

Among several published nomograms for MCA Doppler⁹⁻¹³ the cutoff values for an irregular MCA pulsatility record are comparable up to around 30 weeks gestational age yet vary following 32 weeks. The nomograms we utilized for investigation are from the distributed crosssectional study by Harrington K et al.⁶ The present study revealed that doppler study in pregnant women with IUGR played an important role in management and predicting outcome.

Along with doppler indices mainly pulsatility index and cerebroplacental ratio, a valuable method for foretelling the result of pregnancy is to measure end diastolic flow of umbilical artery. The mortality rate of cases with reversed end diastolic flow has high mortality rate (100%). The cases with absent diastolic flow has 33% mortality rate.

There were 7 IUDs in whom 4 cases had reversal of diastolic flow and 3 had absent diastolic flow. In all cases with reversal of diastolic flow, IUD occurred within one week of conclusion. And all the 4 cases were under 32 weeks. The recommendations for future examination is to incorporate pregnant ladies in second trimester and to distinguish early IUGR by fetal and maternal doppler and its initial administration to diminish the occurrence of unfavorable perinatal result.

CONCLUSION

The Fetal Doppler indices, specifically proportions that take account of estimations from the circulation of umbilical and cerebral area, help in the detection of the compromised growth retarded fetus. In presumed IUGR, cerebroplacental Ratio (MCA/UA PI) is a better predictor of adverse perinatal outcome than an abnormal MCA PI or UAPI.

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