

# Is My Baby Safe? Predicting Perinatal Outcome on the Basis of Abnormality of Arterial Flow Patterns in 3<sup>rd</sup> Trimester - A One Year Prospective Study

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## ABSTRACT

### BACKGROUND

This study emphasizes on the importance of the arterial colour Doppler study in suspected intrauterine growth retardation (IUGR) pregnancy in third trimester to predict the perinatal outcome. The early prognosis prediction based on doppler indices and their ratios in suspected IUGR can play a great role in timely management of these pregnancies.

### METHODS

In our prospective study of 50 antenatal patients in their third trimester, the arterial doppler study was performed on suspicion of IUGR based on biometry, oligohydramnios and grade III placenta. Patients in their third trimester with suspected IUGR were evaluated with colour doppler study of foetal middle cerebral artery and umbilical artery and their indices and ratios were studied.

### RESULTS

The mean gestational age at the first Doppler US examination was 35.2 weeks+ 3.46 weeks (2SD). In our study, 24 fetuses had at least one abnormal outcome and remaining 26 fetuses had uneventful outcome. 60% of neonates (n=30) had birth weight of less than 2.5 Kg. There were 43 live births and 7 intra uterine deaths (IUD). 8 Neonates were admitted to NICU. 7 neonates had 5 min Apgar score of less than 7 and 12 babies were born by emergency caesarean section. Also, out of the 7 IUDs, 4 cases had reversal of diastolic flow and 3 had absent diastolic flow. The sensitivity of cerebroplacental ratio (MCA PI/UA PI Ratio) is 76.9% which is superior to that of UA PI (sensitivity 76.5%) or MCA PI (sensitivity 70.8%) alone in predicting the adverse outcome. Cerebroplacental Ratio and UA PI were almost equally specific (specificity= 91.7% and 87.9% respectively), but specificity of MCA PI was comparably low (69.2%). Also the diagnostic accuracy of cerebroplacental ratio (accuracy= 90%) was better than UA PI (accuracy= 88%) and MCA PI (accuracy= 66%) in predicting adverse outcomes.

### CONCLUSIONS

Cerebroplacental ratio (MCA/UA PI) was most sensitive and accurate in predicting the adverse perinatal outcome in suspected IUGR pregnancies while performing arterial doppler study in third trimester. Presence of absent or reversal of diastolic flow in umbilical artery is an ominous sign.

### KEYWORDS

Intrauterine Growth Retardation (IUGR), Colour Doppler Indices, Cerebro-Placental Ratio, Perinatal Outcome

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## BACKGROUND

Colour Doppler ultrasound is an important clinical tool for foetomaternal surveillance in intrauterine growth retardation (IUGR) where it has been used to assist the prediction of hypoxia, acidosis & death. The various flow velocity changes and Doppler indices are based on relationship between circulatory changes and the foetal condition.<sup>1</sup> Such surveillance seeks early detection of foetal compromise to allow timely interventions in an attempt to prevent perinatal and as well as long term damage. Changes in flow velocity wave form suggest organ sparing effect at various level of foetal compromise. This includes brain, adrenal and heart sparing.<sup>2,3</sup> This study has evaluated foetal Doppler parameters in III<sup>rd</sup> trimester and correlation has been made to predict the foetal outcome.

The aim of this study is to examine the relationship between the abnormality of arterial doppler study and the perinatal outcome in III<sup>rd</sup> trimester pregnancy.

## METHODS

This is a prospective study for a period of one year, included 50 patients. Patients were scanned using Sonoline G50 Siemens Doppler USG machine fitted with 3.5 MHz curvilinear transducer. During examinations Doppler spectral tracing and measurements were obtained from Umbilical artery (UA) and middle cerebral artery (MCA). Doppler US evaluation was performed following foetal biometry, status of amniotic fluid and placental maturity. Doppler indices include the systolic/diastolic ratio and the pulsatility index.

### Inclusion Criteria

1. Pregnancy in third trimester showing signs of IUGR based on ultrasound biometry, oligohydramnios and grade III placenta.
2. Results of the first Doppler ultrasound were used for prediction of perinatal outcome.

### Exclusion Criteria

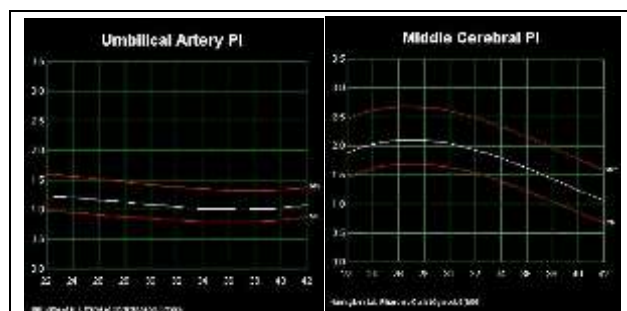
1. Pre-diagnosed foetoplacental insufficiency pregnancy under active treatment.
2. Pregnancy of first or second trimester with IUGR.

### Outcome Criteria

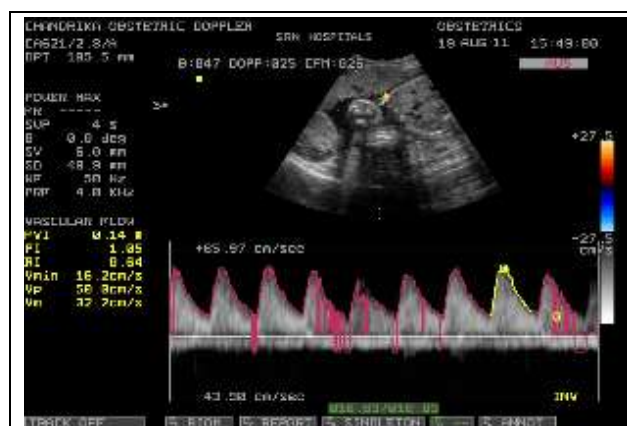
Outcome analysis was limited to perinatal period. One or more of the following complications were considered as "Adverse outcome" in the study.

1. Perinatal death.
2. Emergency Caesarean Section (CS) for foetal distress.
3. 5-minute Apgar score of less than 7.
4. Admission to NICU for complications of low birth weight.

The pregnancy was considered to be "Uneventful" if the above complications were absent.



**Figure 1. Distribution of Normal UAPI and MCA PI with Gestation (Normal Ranges for Gestational Age are Shown as 5<sup>th</sup>, 50<sup>th</sup>, and 95<sup>th</sup> Percentiles)**



**Figure 2. Normal Umbilical Artery Trace in a Patient with 33 Weeks Gestation**



**Figure 3. Normal Middle Cerebral Artery Trace in the Same Patient**



**Figure 4. Normal Umbilical Artery Trace in a Patient with 38 Weeks Gestation**

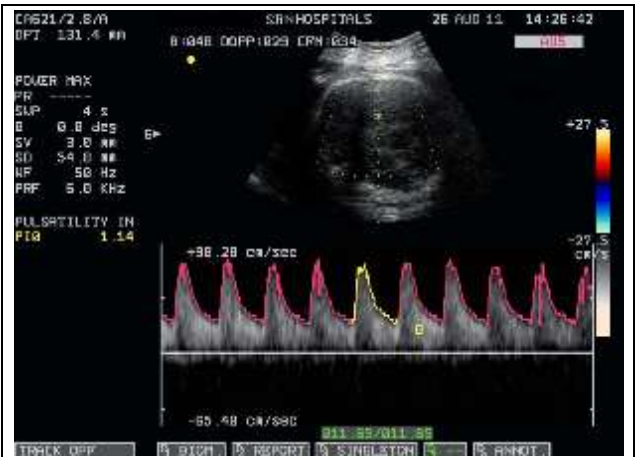


Figure 5. Normal Middle Cerebral Artery Trace in the Same Patient with 38 Weeks Gestation

The UA Pulsatility index were considered abnormal if the value was above the 95th percentile of previously published values for the respective gestational age.<sup>4,5</sup> The MCA pulsatility index were considered abnormal if the value was below the 5th percentile of previously published values for the respective gestational age.<sup>4,5</sup> The MCA/UA PI ratio (cerebro-placental ratio) of less than single cut off value of 1.08 was considered abnormal.<sup>6</sup> The sensitivity, specificity, positive predictive value, negative predictive Value and diagnostic accuracy were determined for all Doppler measurements.

RESULTS

In our prospective study of 50 patients, the mean gestational age at the first Doppler US examination was 35.2 weeks± 3.46 weeks (2SD). 48% (n=24) fetuses had at least one abnormal outcome, of those 8 had more than one abnormal outcome. Remaining 26 fetuses had uneventful outcome.

Pregnancy Outcome	No. of Cases	%
Adverse	24	48
Uneventful	26	52

Table 1. Pregnancy Outcome- Uneventful vs. Adverse

Mean birth weight at delivery was 2.43 Kg ± 0.26 Kg (2SD). 60% of neonates (n=30) had birth weight of less than 2.5 Kg. There were 7 intra uterine deaths (IUD) and 43 live births. Of the 43 live births, 12 babies were born by emergency caesarean section, 7 neonates had 5 min Apgar score of less than 7 and 8 Neonates were admitted to NICU.

Adverse Outcomes	No. of Cases
Intra Uterine Deaths (IUD)	7
Emergency CS	12
Low Apgar Score	7
Admission to NICU	8

Table 2. Adverse Outcomes

(Note: of the live births with adverse outcome 8 had more than one adverse outcomes)

The UA doppler spectral pattern showed 09 cases of absent end diastolic flow and 04 cases of reversal of the diastolic flow. In our study, out of the 7 IUDs, 3 had absent

diastolic flow and 4 had reversal of diastolic flow. In all cases with reversal of diastolic flow, IUD of the foetus occurred within one week of diagnosis.

Spectral Characteristics of UA	No. of Cases	IUD	Mortality
Absent EDF	09	03	33%
Reversed EDF	04	04	100%

Table 3. Spectral Characteristics Absent vs. Reversed EDF

Doppler Index	Sensitivity	Specificity	PPV	NPV	Diagnostic Accuracy
UA PI	76.5%	87.9%	76.5%	87.9%	88%
MCA PI	70.8%	69.2%	68.0%	72.0%	66%
Cerebroplacental ratio (MCA/UA PI ratio)	76.9%	91.7%	90.9%	78.6%	90%

Table 4. Performance Characteristics of Doppler Indices

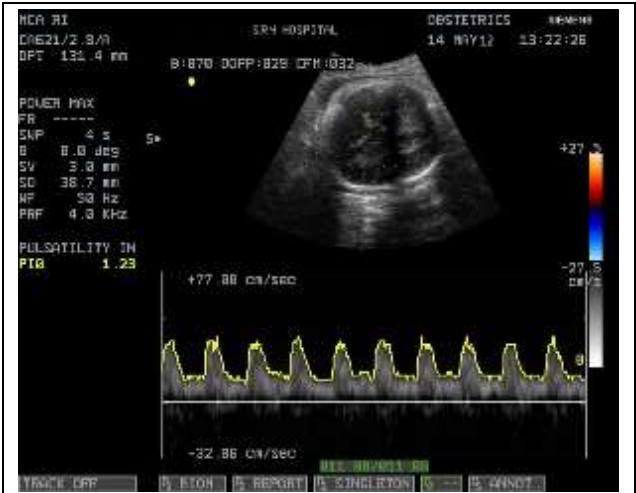


Figure 6. MCA Shows Reduced Pulsatility



Figure 7. MCA Showing Reduced Pulsatility in a Patient with 34 Weeks Gestation

The sensitivity of Cerebroplacental ratio (MCA/UA PI Ratio) was 76.9% and it was better than either UA PI (sensitivity 76.5%) or MCA PI (sensitivity 70.8%) alone in predicting any adverse outcome. Cerebroplacental Ratio and UA PI were more specific (specificity= 91.7% and 87.9% respectively) than that of MCA PI (specificity=69.2%). Cerebroplacental Ratio had highest Positive Predictive Value (PPV=90.9%), followed by UAPI (PPV=76.5%) and MCA PI



(PPV= 68.0%). Negative Predictive Value of Cerebroplacental Ratio was 78.6% while that of UA PI and MCA PI were 87.9% and 72.0% respectively. Also the diagnostic accuracy of Cerebroplacental ratio (accuracy= 90%) was better than that of UA PI (accuracy= 88%) and MCA PI (accuracy= 66%) in predicting adverse perinatal outcomes.



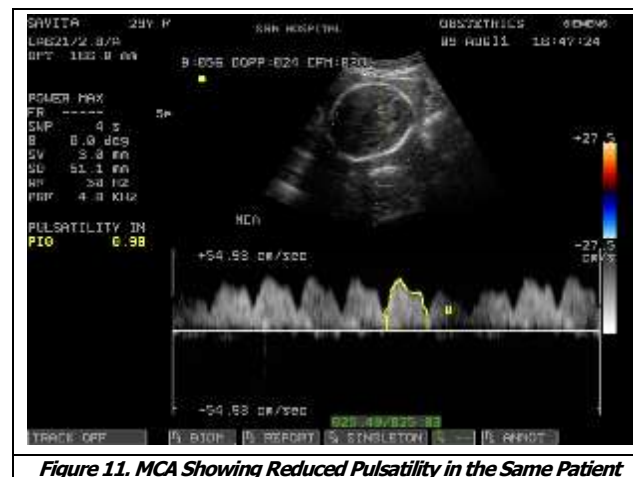
**Figure 8. First Doppler Examination Showing Absent End Diastolic Flow in UA**



**Figure 9. MCA Shows Reduced Pulsatility in the Same Patient**



**Figure 10. Umbilical Artery Shows Reversed End Diastolic Flow**



**Figure 11. MCA Showing Reduced Pulsatility in the Same Patient**

## DISCUSSION

Doppler flow velocity analysis is of great value to diagnose impaired placental perfusion in intrauterine growth retardation during the third trimester.<sup>7</sup> The haemodynamic adjustments of foetal growth retardation is directly related to the umbilical-placental and foetal cerebral vascular circulations.<sup>2</sup> In our study of 50 pregnancies with clinical suspicion of IUGR, the mean birth weight of neonates at delivery was 2.43 Kg  $\pm$  0.26 Kg (2SD) and 60% of neonates (n=30) had birth weight of less than 2.5 Kg. Many foetuses (48%, n=24) had at least one adverse outcome while some (n=8) had more than one adverse outcome. Remaining 26 foetuses had favourable outcome. There were 7 intra uterine deaths and 43 live births. Reversal of the diastolic blood flow in spectral pattern of UA is highly sensitive indicator of perinatal mortality.<sup>8</sup> 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 caesarean section. By using the first Doppler US results for analysis, the MCA/UA pulsatility index (PI) ratio had a higher sensitivity and positive predictive value for adverse perinatal outcome than did the MCA PI and the UA PI.

Our findings agree with the results of the studies that have shown MCA/UA PI Doppler ratio to be more useful than UA PI or MCA PI in predicting adverse outcome.<sup>9</sup> In the literature, the criteria for cerebral redistribution vary, including an MCA PI below the 5th percentile<sup>9</sup> or below 2 SD,<sup>10</sup> UA/MCA PI ratio greater than 0.7287, UA/MCA PI ratio above the 95th percentile,<sup>9</sup> UA/MCA resistance index ratio above 1.01, MCA/UA resistance index ratio below 1.0<sup>2</sup> and MCA/UA PI Ratio of less than 1.08.<sup>6</sup> We studied the Doppler index of umbilical artery only after 30th week because it is difficult to define normal or abnormal umbilical flow velocity before 30th week, with the exception of absent end diastolic flow velocity after 20th week. This was in agreement with the studies of Schulman<sup>11</sup> and Gramellini<sup>6</sup> et al.

According to Wladimiroff et al,<sup>12</sup> it is possible to use a single cut off value for cerebroplacental ratio after 30th week because the cerebral-umbilical Doppler ratio does not vary significantly between 30th and 40th weeks. In a study of 120 small-for-gestational age foetuses, Arduini and Rizzo<sup>9</sup> et al

had evaluated the characteristics of the pulsatility index of the UA, MCA and Renal artery (RA) to predict adverse perinatal outcome. By using the first Doppler US result for analysis, the authors found that the UA/MCA pulsatility index ratio was the best when compared with MCA, UA, and RA pulsatility indices (sensitivity, 89% vs 68%, 66%, and 43%; specificity, 94% vs 91%, 88%, and 91%). Gramellini D, Folli MC, et al<sup>6</sup> concluded that the cerebral-umbilical Doppler ratio was a better predictor of adverse perinatal outcome in small for gestational age newborns than either the middle cerebral artery or umbilical artery alone. Fong KW et al<sup>13</sup> studied two hundred ninety-three small-for-gestational age fetuses with Doppler US of the UA, MCA and RA. They concluded that the MCA pulsatility index (PI) on comparison 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.

	Sensitivity	Specificity	PPV	NPV
Arduini, Rizzo <sup>9</sup> (1992)	89%	94%	---	---
Gramellini et al <sup>6</sup> (1992)	68%	98.4%	94.4%	88.8%
Fong KW et al <sup>13</sup> (1999)	51.3%	80.6%	48.1%	82.2%
Present study*	76.9%	91.7%	90.9%	78.6%

**Table 5. MCA/UA PI Ratio in Predicting Adverse Perinatal Outcome**

	Sensitivity	Specificity	PPV	NPV
Arduini, Rizzo <sup>9</sup> (1992)	66%	88%		
Gramellini et al <sup>6</sup> (1992)	64%	90.7%	72.7%	86.7%
Fong KW et al <sup>13</sup> (1999)	44.7%	86.6%	54%	81.7%
Present study*	76.5%	87.9%	76.5%	87.9%

**Table 6. UA PI in Predicting Adverse Perinatal Outcome**

	Sensitivity	Specificity	PPV	NPV
Arduini, Rizzo <sup>9</sup> (1992)	68%	91%		
Gramellini et al <sup>6</sup> (1992)	24%	100%	100%	77.7%
Fong KW et al <sup>13</sup> (1999)	72.4%	58.1%	37.7%	85.7%
Present study*	70.8%	69.2%	68.0%	72.0%

**Table 7. MCA PI in Predicting Adverse Perinatal Outcome**

	MCA/UA PI Ratio	UA PI	MCA PI
Gramellini et al <sup>6</sup>	90%	83.3%	78.8%
Present Study	90%	88%	66%

**Table 8. Comparison of Diagnostic Accuracies**

We chose incidences of perinatal death, emergency section for foetal distress, NICU admission for complication of low birth weight and low Apgar score as outcome variables in concurrence with other similar previous studies. However the choice of "Low 5 min Apgar score" could be debated as only about 15% of newborns affected by cerebral palsy have low Apgar scores.<sup>14</sup> Comparison between different studies would be more meaningful if uniform or standardized criteria were used. The following table compares the results of the present study with other studies.

Our study confirms with that of Gramellini et al<sup>6</sup> that best results are obtained when we used MCA/UA PI Ratio, rather than PIs of middle cerebral artery and Umbilical artery separately.

## CONCLUSIONS

Foetal Doppler indices, in particular ratios that include measurements obtained from the umbilical and cerebral circulation, help in the recognition of the compromised growth retarded fetus. In suspected IUGR, cerebroplacental ratio (MCA/UA PI) is a better predictor of adverse perinatal outcome than an abnormal MCA PI or UA PI. Presence of absent/reversal of diastolic flow in umbilical artery is an ominous sign. "Is my baby safe?" can be best answered by studying the MCA and UA arterial flow patterns and doppler indices in 3<sup>rd</sup> trimester.

## REFERENCES

- [1] Low JA. The current status of maternal and foetal blood flow velocimetry. Am J Obstet Gynecol 1991;164(4):1049-1063.
- [2] Roza SJ, Steegers EA, Verborg BO, et al. What is spared by foetal brain-sparing? foetal circulatory redistribution and behavioral problems in the general population. Am J Epidemiol 2008;168(10):1145-1152.
- [3] van den Wijngaard JA, Groenenberg IA, Wladimiroff JW, et al. Cerebral Doppler ultrasound of the human fetus. Br J Obstet Gynaecol 1989;96(7):845-849.
- [4] Harrington K, Carpenter RG, Nguyen M, et al. Changes observed in Doppler studies of the foetal circulation in pregnancies complicated by pre-eclampsia or the delivery of a small-for-gestational age baby. I. Cross-sectional analysis. Ultrasound Obstet Gynecol 1995;6(1):19-28.
- [5] Hoffman C, Galan HL. Assessing the 'at-risk' fetus: Doppler ultrasound. Curr Opin Obstet Gynecol 2009;21(2):161-166.
- [6] Gramellini D, Folli MC, Raboni S, et al. Cerebral-umbilical Doppler ratio as a predictor of adverse perinatal outcome. Obstet Gynecol 1992;79(3):416-420.
- [7] Suhag A, Berghella V. Intrauterine growth restriction (IUGR): etiology and diagnosis. Curr Obstet Gynecol Rep 2013;2(2):102-111.
- [8] Cosmi E, Ambrosini G, D'Antona D, et al. Doppler, cardiotocography, and biophysical profile changes in growth-restricted fetuses. Obstet Gynecol 2005;106(6):1240-1245.
- [9] Arduini D, Rizzo G. Prediction of foetal outcome in small for gestational age fetus: comparison of Doppler measurements obtained from different foetal vessels. J Perinat Med 1992;20(1):29-38.
- [10] Burns PN. The physics of Doppler. In Chervenak FA, Isaacson GC, Campbell S, eds. Ultrasound in obstetrics and gynecology. Boston, Little, Brown and Co 1993: p. 33.
- [11] Schulman H. Doppler velocimetry of the umbilical and uteroplacental circulation: a critical review. Echocardiography 1990;7(5):583-587.

- [12] Wladimiroff JW, vd Wijngaard JA, Degani S, et al. Cerebral umbilical arterial blood flow velocity waveforms in normal and growth-retarded pregnancies. *Obstet Gynecol* 1987;69(5):705-709.
- [13] Fong KW, Ohlsson A, Hannah ME, et al. Prediction of perinatal outcome in fetuses suspected to have intrauterine growth restriction: Doppler us study of foetal cerebral, renal, and umbilical arteries. *Radiology* 1999;213(3):681-689.
- [14] Freeman JM, Nelson KB. Intrapartum asphyxia and cerebral palsy. *Pediatrics* 1988;82(2):240-249.