



## Prognostic Value of Doppler Velocimetry in Intrauterine Growth Restricted Fetuses

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### ABSTRACT

**Introduction:** *Intra uterine growth restriction (IUGR) is associated with increased perinatal mortality, morbidity and impaired neurodevelopment. Doppler velocimetry can assess the fetal hypoxia thereby deciding the timing of delivery and avoiding prematurity.*

**Objective:** *To predict the perinatal outcome in IUGR fetuses by Doppler velocimetry of umbilical artery, middle cerebral artery and descending thoracic aorta and deciding the management accordingly.*

**Material and methods:** *Twenty five IUGR fetuses were subjected for Doppler velocimetry of umbilical artery (UA), middle cerebral artery (MCA) and descending thoracic aorta (DTA). S/D ratio, PI and RI were calculated to predict the fetal hypoxia.*

**Observations:** *Umbilical artery S/D ratio was increased in 52% cases, whereas PI and RI were increased in 48% and 40% cases respectively. AEDV was found in 12% and REDV in 4% cases and were associated with 75% mortality. Positive predictive value of S/D ratio of MCA for fetal distress was 75% where as it was 85% for DTA.*

**Conclusion:** *Doppler parameters can detect the changes of fetal hypoxia, so the mortality and Morbidity can be reduced by timely intervention.*

**Keywords/Observations:** *IUGR-intrauterine growth restriction. AEDV-absent end diastolic volume. REDV-reversed end diastolic volume. S/D ratio-systolic to diastolic ratio. PI-pulsatility index. RI-resistive index*

### Introduction

Intrauterine growth restriction (IUGR) is a clinically significant problem. Perinatal mortality is 4-8 times higher in IUGR fetuses as compared to normal fetus. IUGR is defined as a condition where the weight of the fetus is below the 10<sup>th</sup> percentile for

gestational age or at least 2 standard deviations below the mean for age. Symmetric IUGR is due to early insult like chromosomal anomaly or infection in early pregnancy. These may be genetically or constitutionally small. Asymmetric IUGR is seen in placental insufficiency.

Doppler velocimetry is a non invasive technique for assessing IUGR fetuses with hypoxia. Fetal growth failure is associated with raised placental resistance. Systolic / Diastolic (S/D) ratio, pulsatility index (PI) and resistive index (RI) are angle independent indices, calculated to know the resistance to blood flow in the artery.

The sensitivity of raised S/D ratio of umbilical artery (UA) for abnormal perinatal outcome is 66.7% in IUGR as compared to 27.8% for fetuses without IUGR.<sup>[1]</sup> PI has better specificity than RI and S/D ratio. Reduced, absent and reversed end diastolic flow in umbilical artery is associated with poor perinatal outcome.

There is redistribution of fetal circulation with increased flow to vital organs like brain, heart and adrenals in hypoxemic fetuses. Increased PI in umbilical artery is associated with reduced PI in middle cerebral artery (MCA) which signifies brain sparing effect. Maximum reduction in PI of MCA is seen when partial pressure of oxygen is 2-4 standard deviation below the normal mean for gestational age. When the oxygen deficit increases, there is tendency for the PI in MCA to rise and this reflects development of brain oedema and high fetal mortality.<sup>[2]</sup>

### Material and Methods

Doppler velocimetry was done in 25 IUGR cases having at least 4 weeks disparity in fundal height and period of gestation at 28-40 weeks gestation. Fetuses with congenital anomaly and multiple pregnancy were excluded. Doppler was done in supine position on Toshiba Corevision Prodiagnostic ultrasound system SSA- 350A machine with 3-5 MHz convex probe. Normal biometry was done to know the period of gestation. Umbilical artery was selected midway between fetal and placental ends. Transverse images of fetal head at the sphenoid bone were taken. Colour flow imaging was done to display the circle of willis. MCA was sampled in sylvian fissure. Descending thoracic aorta was identified in the sagittal scan of the fetus. Arch of aorta was followed downwards

and DTA was sampled just above the level of thoracic diaphragm.

When 4-5 waveforms were seen on the screen, the image was frozen and measurement done with electronic calliper. S/D ratio, PI and RI were calculated by taking at least 3 readings for all the vessels sampled.

PI = maximum systolic velocity-end diastolic velocity/mean velocity

RI = maximum systolic velocity-end diastolic velocity/systolic velocity

S/D ratio = maximum systolic velocity/end diastolic velocity

Repeat examination was done at 1-3 weeks interval depending on the parameters. The cases were followed for perinatal outcome; still birth and death due to fetal hypoxia, APGAR score of < 7 after five minutes, admission in intensive care unit and caesarean section for fetal hypoxia.

### Observations

The mean age of pregnant mothers was 24.5years. 60% mothers were primigravida.

### Umbilical Artery Doppler Indices

S/D ratio of UA was normal in 48% cases. And raised in 13(52%) cases. PI value was normal in 13 (52%) cases and raised in 12 (48%) cases, normal RI was seen in 15 (60%) and raised in 10 (40%) cases.

Absent end diastolic flow was found in 3 (12%) cases. Reversed end diastolic flow was observed in 1 (4%) cases.

### Relationship of Doppler Parameters Of UA to Perinatal Outcome

Eleven (84.6%) of fetuses showing raised S/D ratio were delivered by caesarean section. Low APGAR was seen in 6 (46.1%) cases. Eight neonates were admitted to ICU and 3 perinatal deaths were reported in them.

LSCS was performed for 8 (66.7%) cases showing raised PI value. Low APGAR was seen in 4 (33.3%) neonates. 5 (41.6%) were admitted to ICU for fetal distress where as one neonate was admitted for jaundice. Perinatal deaths were reported in 3 (25%) cases

90% of the fetuses having raised RI were delivered operatively. 5(50%) in this group had low APGAR score, 6(60%) neonates were admitted to ICU with 2(20%) perinatal deaths.

All 3 fetuses having AEDV were delivered by LSCS and were admitted to ICU. The APGAR score at 5 minutes was < 7 in 2 neonates. One neonate died after 5 days. REDV was present in one fetus which resulted in still birth.

Table: Showing Relationship of Doppler Velocimetry of Umbilical Artery to Perinatal Outcome

Indices	Test Results		Perinatal Outcome						
			NVD (%)	Operative Delivery		Low Apgar (%)	ICU Admissions		Still Birth & Neonatal Death (%)
				For FD (%)	For Others		For FD (%)	For Others	
S/D	N (%)	12 (48%)	7 (58.3%)	3 (25%)	2 (16.7%)	2 (16.7%)	2 (16.7%)	2 (16.7%)	0
	Ab (%)	13 (52%)	2 (15.3%)	11 (84.6%)	0	6 (46.1%)	8 (61.5%)	0	3 (23%)
PI	N (%)	13 (52%)	5 (38.4%)	6 (46.1%)	2 (16.7%)	4 (30.7%)	5 (38.4%)	1 (7.7%)	0
	Ab (%)	12 (48%)	4 (33.3%)	8 (66.7%)	0	4 (33.3%)	5 (41.6%)	1 (8.3%)	3 (25%)
RI	N (%)	15 (60%)	8 (53%)	5 (33.3%)	2 (13.3)	3 (20%)	4 (26.7%)	2 (13.3%)	1 (6.7%)
	Ab (%)	10 (40%)	1 (10%)	9 (90%)	0	5 (50%)	6 (60%)	0	2 (10%)

N = normal, Ab = abnormal, NVD = normal vaginal delivery, FD = fetal distress, ICU = intensive care unit

**Middle Cerebral Artery Doppler Indices**

Normal S/D ratio was seen in 13 (52%) cases where as 12 (48%) showed decreased ratio. 8(32%) cases had normal PI and 17 (68%) had decreased PI. Normal RI was found in 17 (68%) and reduced RI in 8 (32%) cases.

**Relationship Of MCA Velocimetry To Perinatal Outcome**

In 9 out of 12 cases showing decreased S/D ratio were delivered by LSCS. Low APGAR at 5 minutes was seen in 6 (50%) cases and 3 (25%) perinatal deaths occurred in them.

Table Showing Relationship of Middle Cerebral Artery Velocimetry to Perinatal Outcome

Indices	Test Results		Mode Of Delivery			Perinatal Outcome			
			NVD (%)	Operative Delivery		Low Apgar (%)	ICU Admission		Still Birth & Neonatal Death (%)
				For FD (%)	For Others		For FD (%)	For Others	
S/D	N (%)	13 (52%)	6 (46.1%)	5 (38.5%)	2 (15.4%)	2 (15.4%)	2 (15.4%)	2 (15.4%)	0
	Ab (%)	12 (48%)	3 (25%)	9 (75%)	0	6 (50%)	8 (66.7%)	0	3 (25%)
PI	N (%)	8 (32%)	5 (62.5%)	3 (37.5%)	0	1 (12.5%)	1 (12.5%)	2 (25%)	0
	Ab (%)	17 (68%)	4 (23.5%)	11 (64.7%)	2 (11.7%)	7 (41.1%)	9 (52.9%)	0	3 (17.6)
RI	N (%)	17 (68%)	8 (47%)	7 (41.1%)	2 (11.7%)	3 (17.6%)	4 (23.5%)	2 (11.7%)	1 (5%)
	Ab (%)	8 (32%)	1 (12.5%)	7 (87.5%)	0	5 (62.5%)	6 (75%)	0	2 (25%)

N = normal, Ab = abnormal, NVD = normal vaginal delivery, FD = fetal distress, ICU = intensive care unit

**Descending Thoracic Aorta Doppler Indices**

8 (32%) cases showed raised S/D ratio. PI and RI were normal in 23 (92%) and increased in 2 (8%) fetuses.

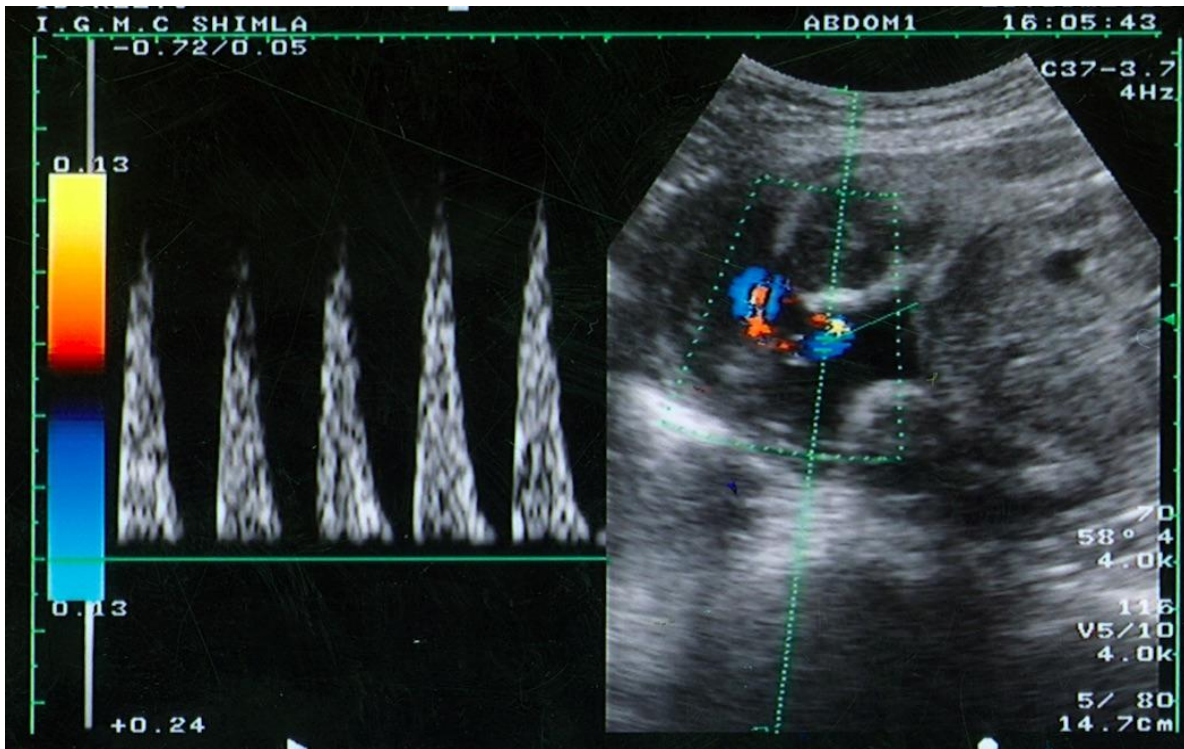
**Relationship of Descending Thoracic Aorta Velocimetry to Perinatal Outcome**

7 (87.5%) cases with raised ratio were born by LSCS. Low APGAR was seen in 3 (37.5%)

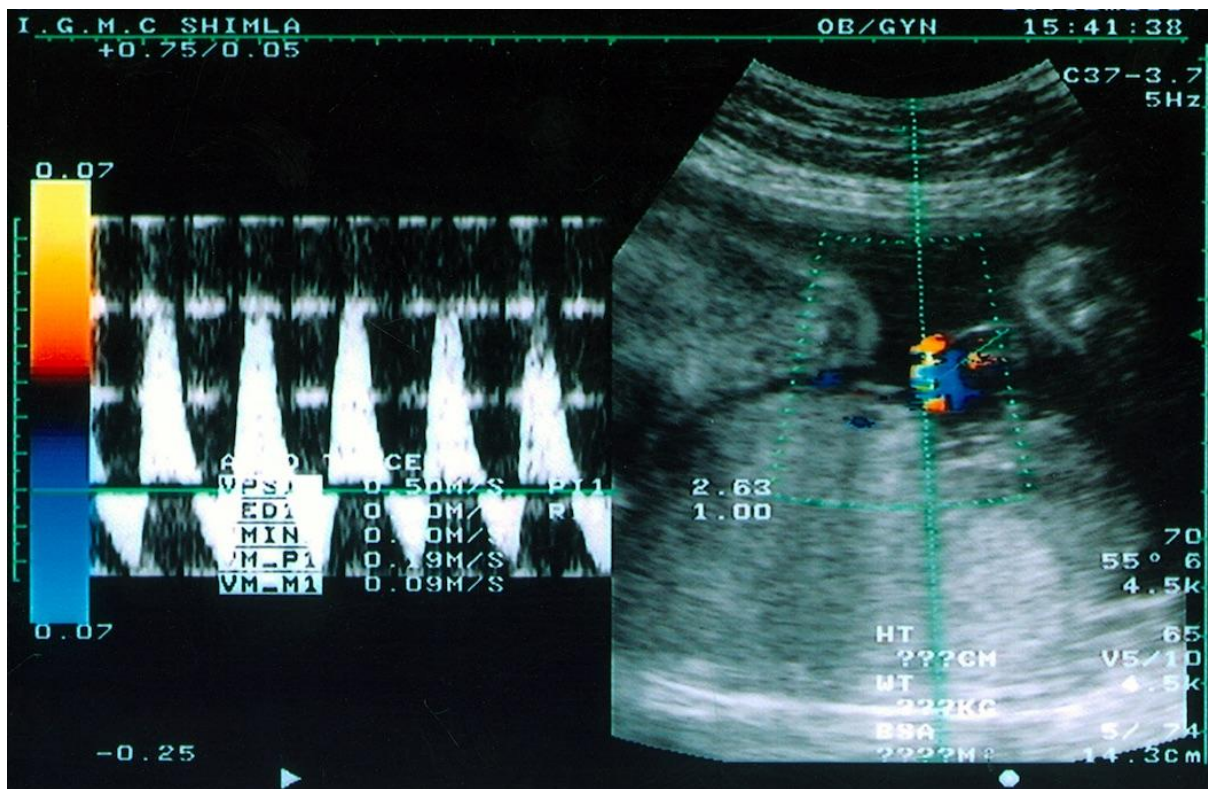
neonates. Four (50%) neonates were admitted to ICU and 2 (25%) were still born (fresh) 1 (12.5%) neonate died after 5 days.

2 cases with raised P I and RI were born by LSCS, 1 (50%) had low APGAR score and 1(50%) was

admitted to ICU, one was fresh still birth and another died after 5 days.



Case 1 – Umbilical artery showing absent end diastolic velocity (AEDV)



Case 2 - Reversed end diastolic velocity (REDV) in umbilical artery

## Discussion

IUGR affects 10% pregnancies and is associated with significant adverse perinatal outcome. Antenatal detection of fetus at risk remains a major challenge in obstetrics. Doppler velocimetry is used to evaluate hemodynamic adjustments arising in IUGR fetus. S/D ratio, PI and RI are the angle independent indices evaluated for knowing impedance to blood flow in the vessels.

S/D ratio of UA ranged from 3.2 at 28 weeks to 2.2 at 40 weeks. Trudinger BJ et al<sup>[3]</sup> stressed the importance of S/D ratio. S/D ratio was raised in 34 cases out of 53 IUGR fetuses. Good perinatal outcome was reported in cases having normal S/D ratio. Schulman H et al found higher rates of LSCS for fetuses having increases S/D ratio. 81.5% were admitted in ICU and 15.7 % perinatal deaths occurred amongst them.<sup>[4]</sup>

In our study raised S/D ratio of UA was found to be good predictor of adverse perinatal outcome. we found 13 (52%) cases with raised S/D ratio in UA, out of which 11 (84.6%) had operative delivery for fetal distress, 8 (61.5%) were admitted to ICU and there were 3 (23%) perinatal deaths. Sensitivity of raised S/d ratio was 78.5%, specificity 81.8%, negative predictive value 75% and positive predictive value was 84.6%. The sensitivity was higher in our study. Lakhar BN et al<sup>[5]</sup> reported specificity of 90-95% for raised PI. Our study also found raised PI of UA in 12 (48%) cases, out of which 8 (66.7%) were delivered by LSCS, low APGAR was seen in 4 (33.3%) cases and 5 (41.6%) were admitted to ICU. Perinatal deaths were reported in 3 (25%) cases.

Marked increase in impedance leads to absent or even reversed end diastolic flow in UA. Such flows predict grave prognosis. VHM et al<sup>[6]</sup>, Trudinger BJ et al reported that IUGR fetuses had higher risk of absent or reversed end diastolic flow. The overall mortality was 28%. ICU admissions were 96% for absent and 98% for reversed end diastolic flow. In our study 3 (12%) cases had AEDV, all of them were born by LSCS and admitted to ICU. One neonate died after 5 days. Reversed end diastolic

velocity was found in 1 (4%) case which resulted in fresh still birth.

In response to prolonged fetal hypoxia, circulatory adaptation occurs to provide constant oxygen supply to brain, heart and adrenals, resulting in brain sparing effect.

Woo JS et al<sup>[7]</sup> reported that S/D ratio in MCA declined from  $6.89 \pm 1.48$  at 25 weeks to  $4.23 \pm 0.67$  at term in normal pregnancies. In fetal hypoxia, when there is increased resistance to blood flow in UA, there is decrease in impedance to blood flow in MCA leading to decrease in S/D ratio, PI and RI. We found 12 (48%) cases with abnormal S/D ratio in MCA. LSCS was done for 9 (75%) cases and there were 3 (25%) perinatal deaths in this group. Positive predictive value of S/D ratio was 75%.

Chandran R Serra VS et al<sup>[8]</sup> reported that PI of MCA diminished significantly as gestation advances from 1.73 at 24 weeks to 1.38 at 39 weeks in normal pregnancies. Low PI in MCA was observed in 70.4% fetuses in complicated pregnancies. All hypoxic fetuses had low PI. Marri G et al<sup>[9]</sup> reported 3 (33.3%) deaths with abnormal PI values. In our study PI was abnormal in 17 (68%) fetuses. Perinatal deaths occurred in 3 (17.6%). 11 (64.7%) fetuses were delivered by LSCS and 9 (52.9%) fetuses were admitted to ICU.

Bahlman et al<sup>[10]</sup> found RI of 0.8 at 28 weeks and 0.62-0.69 at 37 weeks of POG. Kirkinin et al reported increase in perinatal fetal risk in cases having low RI. In our study 8 (32%) cases were found to have low RI in MCA. Low APGAR was seen in 5 (62.5%) neonates and there were 2 (25%) perinatal deaths. Weiner Z et al<sup>[11]</sup>, Forouzon et al<sup>[12]</sup>, Konje JC et al<sup>[13]</sup> reported that in very severe hypoxia there was increase in PI of MCA reflecting brain oedema which had grave perinatal outcome. No such case was detected in our study.

Jouppila P et al<sup>[14]</sup>, Soothill PW et al reported that there was total end diastolic block in fetuses having chronic hypoxia. In our study 8 (32%) fetuses were having raised S/D ratio in DTA, out of which 7 (87.5%) were born by LSCS, 3 (37.5%) neonates had low APGAR score, 4 (50%) cases were admitted to ICU and there were 3 (37.5%) perinatal

deaths. In 2 (8%) cases raised PI and RI was seen. Positive predictive value of S/D ratio was 87%. There were 2 cases with AEDV, one of which was still born and another was born by LSCS and admitted to ICU.

### Conclusion

Doppler velocimetry has higher predictive value for normal as well as abnormal perinatal outcome in IUGR fetuses. Early detection can improve the perinatal outcome and help the obstetrician to decide about the timing and mode of delivery so that premature delivery and related complications can be avoided.

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