# ISOLATED UMBILICAL ARTERY DOPPLER VELOCIMETRY IN INTRAUTERINE GROWTH RESTRICTED FOETUSES WITH CORRELATION OF FOETAL OUTCOME

*Bakka Sarada[1], Nagireddy Vasundhara[2]*

[1]Assistant Professor, Department of Radiodiagnosis, Government Medical College & Hospital, Ananthapuramu.
[2]Assistant Professor, Department of Radiodiagnosis, Government Medical College & Hospital, Ananthapuramu.

## ABSTRACT

### BACKGROUND
Intrauterine Growth Restriction (IUGR) is the condition of a foetus whose size or growth is subnormal and defined on the basis of foetal weight below 10th percentile for corresponding gestational age. The present study was an effort to determine the isolated umbilical artery Doppler velocimetry in such pregnancies.

The objective of the study is to determine the umbilical artery velocimetry in IUGR.

### MATERIALS AND METHODS
The descriptive study included 30 antenatal women attending the Department of Radiodiagnosis who were referred by Obstetric Department for Doppler evaluation. Umbilical artery Doppler velocimetry was done to assess the foetal outcome.

### RESULTS
Out of 30 cases Umbilical Artery (UmbA), Pulsatility Index (PI) was elevated in 18 foetuses (60%), absent diastolic flow in 5 and reversal of end diastolic flow in one foetus. Perinatal outcomes were 3 intrauterine deaths and 27 live births. Out of 27 neonates, 7 were admitted to Neonatal Intensive Care Unit (NICU) and 9 had low Apgar score (5 min. Apgar score of < 7) and 11 neonates were uneventful. 9 babies were delivered by emergency caesarean section. Out of 30 cases, 19 foetuses had at least one adverse perinatal outcome.

### CONCLUSION
Umbilical Artery Doppler velocimetry is a valuable modality in evaluating the perinatal outcome in pregnancy with IUGR.

### KEYWORDS
Intrauterine Growth Restriction, Umbilical Artery Doppler Velocimetry, Pulsatility Index, Absent End-Diastolic Flow, Reversal of End-Diastolic Flow.

## BACKGROUND
The intrauterine growth restriction (IUGR) is that "a foetus is growth restricted if its weight is less than the 10th percentile for its gestational age.[1] Before the advent of ultrasound evaluation, physicians were interested in the growth process of foetus, the prospective assessment of foetal growth during pregnancy has been limited to measuring the uterine size and guessing the foetal size by palpation, could only look at the infant at delivery and infer at what happened in utero and this led to increasing perinatal mortality and morbidity. But now, in the era of sophisticated modality of real time ultrasound, antenatal diagnosis of IUGR has become very easy, thus minimising the future catastrophe.

The incidence of IUGR varies from region to region and even in the same region, it varies in different subpopulations. In India, according to recent UNICEF surveys, the incidence

of IUGR is 25-30%.[2] In a population of women with hypertension or previous IUGR foetus, the incidence increases to 15-20% or higher. IUGR has multiple maternal causes including poor nutrition, hypertension, collagen vascular disease, renal disease and drug or alcohol abuse which cause placental insufficiency. Foetal infections such as cytomegalovirus, toxoplasmosis and chromosomal anomalies such as triploidy and trisomy 13 and 18 also result in IUGR.[3] Placental insufficiency in the absence of any maternal cause is called primary placental insufficiency and is the common cause of IUGR.

IUGR foetuses have 8- to 10-fold increase in perinatal mortality and 50-75% morbidity compared to appropriately sized foetuses.[4] With introduction of ultrasound, the small foetuses could be identified, however, it could not be determined which of these foetuses were at increased risk due to uteroplacental insufficiency and therefore need special surveillance.

Assessment of the umbilical artery Doppler velocimetry provides information on the blood perfusion of the foetoplacental unit. Normally there is very little impedance against blood flowing through the umbilical arteries. As the placenta matures and the pregnancy advances, more tertiary villi are formed, which directly leads to an increase in the end diastolic flow. Umbilical artery Doppler reflects downstream placental vascular resistance, strongly correlated with intrauterine growth restriction and the multisystem effects of

placental deficiency. Abnormalities in the umbilical artery waveforms are progressive with reduction, loss and finally reversal of the diastolic flow. Reversed flow is associated with high incidence of perinatal and overall mortality and severe IUGR compared to absent end-diastolic flow. Umbilical arterial (Umb A) Doppler velocimetry is the most valuable evaluated tests of foetal well-being.[5]

## Objective

To determine the umbilical artery flow velocimetry in intrauterine growth restricted foetuses.

## Study Design

A hospital-based descriptive study of 30 antenatal women with the diagnosis of intrauterine growth restriction above 28 weeks of gestational age carried out in the Department of Radiodiagnosis, Government General Hospital & Medical College, Ananthapuramu, Andhra Pradesh, India.

## MATERIALS AND METHODS

The descriptive study was conducted in the Department of Radiodiagnosis, Government General Hospital, Ananthapuramu from January 2015 to December 2015. The study population consisted of 30 women with singleton pregnancies with IUGR foetuses (birth weight less than 10th percentile of gestational age) who were referred from the inpatient ward as well as outpatient Department of Obstetrics and Gynaecology Department. These women underwent antenatal Doppler examination of umbilical artery between 28 and 40 weeks of gestation.

Doppler Ultrasound (US) evaluation was performed following a detailed clinical history and Umbilical Artery Doppler velocimetry waveforms were performed. Umbilical artery flow velocimetry, normal or abnormal, absent diastolic flow or reversal diastolic and Pulsatility Index (PI) normal or abnormal were recorded and Followup Doppler studies were performed, if clinically indicated to determine an absent, reversal diastolic flow or a worsening trend in the Doppler indices. However, only the results of the first Doppler ultrasound were used for analysis of perinatal outcome.

In our study, foetal outcome criteria: variables included 1) Birth Weight, 2) Perinatal death, 3) Emergency Caesarean section for foetal distress, 4) Low APGAR score (5 min. APGAR score less than 7), 5) Admission to NICU.

Pregnancy was considered to have "Adverse outcome" when any of the following complications were present i) Perinatal death, ii) 5 minute APGAR score of less than 7, iii) 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 UmbA Pulsatility index (PI) ratios of 1.5 to 1.0 are considered normal. The UmbA PI ratios were considered abnormal if the value was above the 95th percentile for the gestational age (>1.5). Of the various Doppler indices, PI has the smallest measurement error and narrower reference limits.

## Statistical Software

The data was expressed in number and percentage and for the analysis of the data, Microsoft Word and Excel have been used to calculate number, percentage and to generate tables.

## RESULTS

A hospital-based prospective observational study of 30 antenatal patients was done and Flow velocity waveforms of the umbilical artery were obtained from all the 30 cases and were analysed.

## Distribution of Age of the Patients

All our patients ranged from 19 years to 31 years. Majority of the patients (80%) were in 20-30 years age group (Table. 1). The average age of the patients was 24.5 years. Least number of patients was seen in the age group of more than 30 years.

| Age in Years | Number | Percentage |
|---|---|---|
| ≤ 20 | 4 | 13.3 |
| 21-25 | 15 | 50.0 |
| 26-30 | 9 | 30.0 |
| >30 | 2 | 6.7 |
| Total | 30 | 100.0 |
| Mean ± SD | 24.5 ± 2.07 | |
| Table 1. Distribution of Age of the Patients | | |

## Distribution of Gestational Age at Doppler Examination

In our study, group of 30 antenatal mothers, the gestational age at the time of Doppler examination ranged between 29 - 38 weeks.

| Gestational Age | Number | Percentage |
|---|---|---|
| 26-30 weeks | 4 | 13.3 |
| 31-35 weeks | 21 | 70.0 |
| 36-40 weeks | 5 | 16.7 |
| Total | 30 | 100.0 |
| Mean ±SD | 33.17±1.29 | |
| Table 2. Distribution of Gestational Age at Doppler Examination | | |

70% of the antenatal mothers examined were between 31-35 weeks of gestation, 13.3% between 26-30 weeks of gestation, and 16.7% with gestational age between 36-40 weeks (Table 2). None of the antenatal mothers were examined before 28 weeks of gestational age.

## Clinical Presentation and Indication for Doppler Study

In the study group of 30 antenatal mothers, the clinical presentation and the indications for the Doppler examination were shown below.

| Clinical Presentation | Number | Percentage |
|---|---|---|
| IUGR only | 8 | 26.67 |
| IUGR and pregnancy-induced hypertension (PIH) | 15 | 50.00 |
| IUGR with Anaemia | 5 | 16.67 |
| IUGR with bad obstetric history | 2 | 6.67 |
| Table 3. Clinical Presentation of the Antenatal Mothers | | |

50.00% of patients had pregnancy-induced hypertension which is the most common cause for IUGR in our series. Only IUGR as the indication for the Doppler study was seen in 26.67%. IUGR with anaemia complicating pregnancy was present in 16.67% of cases. Bad obstetric history was seen in 6.67% (Table 3).

## Analysis of Foetal Outcome

In our study, different foetal outcomes were analysed and depicted in Table 4. Out of 30 neonates, 11 foetuses were uneventful and adverse foetal outcome was observed in 19 foetuses. There were 27 live births and 3 intrauterine deaths. Nine babies were delivered by emergency caesarean section and 21 babies were by normal vaginal delivery. Seven neonates were admitted to NICU and 9 neonates had 5 min Apgar score of less than 7. There were 21 neonates with birth weight less than 2.5 kg and Mean birth weight at delivery was 2.18 ± 0.26 kg (2 SD). In 19 foetuses had at least one adverse perinatal outcome.

| Sl. No. | Foetal Outcomes | No. of Cases |
|---|---|---|
| 1. | **Mode of birth** | |
| | a) Live births | 27 |
| | b) Intra Uterine Deaths | 3 |
| 2. | **Mode of delivery** | |
| | a)Emergency caesarean section | 9 |
| | b) Vaginal delivery | 21 |
| 3. | **Birth weight** | |
| | a)  < 2.5 kg | 21 |
| | b)  > 2.5 kg | 9 |
| 4. | Admission to NICU | 7 |
| 5. | Low Apgar score | 9 |
| *Table 4. Foetal Outcome Analysis* | | |

## Analysis of Umbilical Artery Doppler Velocimetry
## Umbilical Artery Pulsatility Index

Umbilical artery PI was elevated in 18 patients (60%) and was normal in 12 (40%) patients.
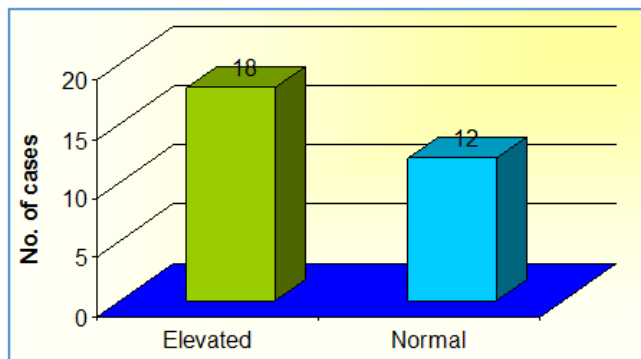


*Graph 1. Distribution of Umb A PI Values*

## Umbilical Artery End-diastolic flow Patterns

In our study, five foetuses (16.7%) showed absence and 1 foetus (3.33%) had reversal of end diastolic umbilical artery flow with the total of 6 foetuses (20.0%) having abnormal waveforms and positive diastolic flow seen in 24 foetuses (Table 5).

| Doppler Investigation Results | Number | Percentage |
|---|---|---|
| Absent | 5 | 16.7 |
| Reversal | 1 | 3.33 |
| Positive diastolic flow | 24 | 80.0 |
| **Total** | **30** | **100.0** |
| *Table 5. Analysis of Umbilical Artery Doppler Findings (End-diastolic Flow Patterns)* | | |

| Adverse Outcomes | No. of Cases | Umbilical Artery Doppler Findings | | |
|---|---|---|---|---|
| | | AEDF | REDF | PEDF |
| Intrauterine deaths | 3 | 2 | 1 | 0 |
| Admission to NICU | 7 | 3 | 0 | 4 |
| Low APGAR score | 9 | 0 | 0 | 9 |
| *Table 6. Adverse Foetal Outcome vs. Umbilical Artery Doppler Findings* | | | | |

AEDF: Absent End-diastolic flow; REDF: Reversal End-diastolic flow, PEDF: Positive End-diastolic flow.

Absence or reversal of the end-diastolic flow velocity was seen in 6 foetuses (20%) in our study. There were 3 intra uterine deaths in whom two cases had absent diastolic flow and one had reverse diastolic flow. The mortality in cases of reverse and absent end-diastolic flow was 100% and 40% respectively. Out of 7 NICU admissions 3 foetuses showed absent end-diastolic flow, 4 had positive end-diastolic flow and low Apgar score observed in 9 foetuses had positive diastolic flow.

| Doppler Investigation Results | Out Come of the Foetus | | | | | P value |
|---|---|---|---|---|---|---|
| | IUD | Admission to NICU | Low Apgar Score | Emergency Caesarean Section | Birth Weight <2.5 kg | |
| Reversal diastolic flow (3.33%) | 1 (33.33%) | - | - | - | 1 (4.76%) | 0.003 |
| Absent end-diastolic flow (16.67%) | 2 (66.67%) | 3 (42.86%) | - | 5 (55.56%) | 5 (23.81%) | 0.01 |
| Positive diastolic flow (80%) | - | 4 (57.14%) | 9 (100%) | 4 (44.44%) | 15 (71.43%) | 0.002 |
| **Total** | **3** | **7** | **9** | **9** | **21** | |
| *Table 7. Doppler Investigation Results- Association of Foetal Outcome* | | | | | | |

* Few foetuses were more than one outcomes.

The study results were statistically evaluated. The strength of association between Doppler investigation results

and foetal outcome was tested by Chi square test p value less than 0.05 significant.

## DISCUSSION

Foetal growth and development is a natural process for each and every human kind, which has aroused the interests of all clinicians for many years, since not all foetuses grow or develop equally. Intrauterine growth restriction does not imply a specific pathophysiology but merely a result of a series of events occurring along several possible pathways. Hence, accurate antenatal diagnosis must decide whether the foetus is constitutionally small for gestational age or small as a consequence of impaired placental perfusion. Doppler flow velocity analysis can be valuable in solving this problem, by examining uterine arteries (Uteroplacental circulation), umbilical arteries (Foetoplacental circulation) and middle cerebral artery (foetal-circulation).

Our study was done in 30 pregnant women, who were diagnosed as having foetuses with intrauterine growth restriction based on clinical suspicion and grey scale ultrasound examination, the maximum number of pregnant women were in the age group of 21-25 years (50%). This could be attributed probably for the increased pregnancy rate in these age groups. All patients underwent Doppler study in the third trimester of their pregnancy with 70% being investigated between 31 - 35 weeks of gestation. The earliest study was done at 29th week of gestation. Hence, most pregnancies were monitored between 31-35 weeks, when the foetus would have begun developing sufficient lung maturity to survive outside the uterus.

In our study, the identified causes for IUGR were pregnancy-induced hypertension (PIH) 50.00%, anaemia complicating pregnancy 16.67%, Bad obstetric history as a cause is seen in 6.67% and 26.67% had no detectable cause for IUGR. Similar observation has been reported in a study by Seyam Y S. et al.[6]

Changes in the umbilical artery include elevated indices as well as changes in the flow direction. Volume flow in the umbilical arteries increases with advancing gestation. Concomitantly, the high vascular impedance detected in first trimester impedance has been attributed to growth of the placental unit and increase in the number of the functioning vascular channels. Low vascular impedance allows a continuous forward blood flow in the umbilical artery flow velocity waveforms throughout the cardiac cycle.

A substantial increase in the vascular resistance of the foetoplacental unit leads to a decrease in end-diastolic flow velocity and its absence in the flow velocity waveform. Microvascular lesions in the placenta characterised by obliteration of the small muscular arteries in the tertiary stem villi causes an elevation in placental resistance to blood flow.

In the present study, the umbilical artery PI had a sensitivity of 84.2%. According to D Gramellini et al,[7] the sensitivity of PI in the Umbilical artery in predicting perinatal outcome was 64%. In present study as there are more number of PIH cases probably this could be attributed for difference in the studies.

The results of our study revealed that positive diastolic flow in 24 cases (80%), absent end-diastolic flow in 5 cases (16.7%) and reversal of the end-diastolic flow velocity was seen in one case (3.33%) (Table 5). The appearance of a reversed and diastolic flow velocity in the flow velocity waveform is the final step in the cascade of events that may lead to intrauterine foetal death.[8]

In our study, observed foetal outcomes were 27 live births and 3 intrauterine deaths. Neonates admitted into NICU were 7; out of 7, absent diastolic flow in 3 and reversal in 4 cases. Nine neonates had 5 min. Apgar score of less than 7, they had positive diastolic flow. Nine babies were delivered by emergency caesarean section. There were 3 intrauterine deaths in whom 2 cases had absent diastolic flow and 1 had reverse diastolic flow. The mortality in cases of reverse and absent end-diastolic flow was 100% and 40% respectively. Madazli et al[9] also studied the severely growth restricted foetuses with absent end-diastolic flow and found perinatal mortality of 40%. Perinatal mortality was highest in the reversal/absent end-diastolic flow foetuses which is considered ominous sign of placental compromise and is associated with high perinatal mortality rates.

Babies were delivered by emergency caesarean section were 9 and mean birth weight at delivery was 2.18 ± 0.26 kg (2SD). There were 21 neonates with birth weight less than 2.5 kg and 19 foetuses had at least one adverse perinatal outcome. Meta-analysis of randomised controlled trials suggests that inclusion of umbilical artery waveform analysis into management protocols for IUGR foetuses significantly decreased perinatal mortality.

The results of our study demonstrated the efficacy of umbilical artery in prediction of foetal outcome and Umbilical artery velocimetry should be done for all IUGR foetuses as a useful tool in reducing the scan time in hospitals with increased workload.

## Limitations

In this study, sample size was small because of short study period and sample taken from high risk cases referred by Obstetrics & Gynaecology Department.

## CONCLUSION

In the present study, we targeted only umbilical artery Doppler flow velocimetry in Growth restricted foetuses above 28 weeks of gestational age to reduce the scan time. We opine that Umbilical Artery Doppler velocimetry alone is an ideal screening tool to minimise scan time in the Department of Radiodiagnosis with increased workload than performing complete foetoplacental Doppler study of right and left Uterine Arteries, Middle Cerebral Artery and Umbilical arteries.

## Abbreviations

IUGR: Intrauterine Growth Restriction; UmbA: Umbilical Artery; PI: Pulsatility Index; US: ultrasound; AEDF: Absent End-diastolic flow and REDF: Reversal End-diastolic flow.

## REFERENCES

[1] Lugo G, Cassady G. Intrauterine growth retardation. Clinicopathological findings in 233 consecutive infants. Am J Obstest Gynecol 1971;109(4):615-22.

[2] Devi PIC, Menon KMK, Rao BK. Postgraduate obstetrics and gynecology. 3rd edn. Orient long man 1986:P 219.

[3] Seeds JW. Impaired fetal growth: definition and clinical diagnosis. Obstet Gynecol 1984;64(3):303-10.

[4]    Jain S, Puri M. Diagnosis of intrauterine growth retardation. A review Obstet and Gynec today 2001;11:670-3.

[5]    Kok JH, Ouden DAL, Verloove-Venhorick SP, et al. Outcome of very preterm small for gestational age infants: the first nine years of life. Br J Obstet and Genecol 1989;105(2):162-8.

[6]    Seyam YS, AI-Mahmeid MS, AI-Tamimi HK. Umbilical artery Doppler flow velocimetry in intrauterine growth restriction and its relation to perinatal outcome. Int J Gynaecol Obstet 2002;77(2):131-7.

[7]    Gramellini D, Folli MC, Raboni S, et al. Cerebral-umbilical Doppler ratio as a, predictor of adverse perinatal outcome. Obstet Gynecol 1992;79(3): 416-20.

[8]    Benson CB, Doubilet PM. Doppler criteria for intrauterine growth retardation: predictive values. J Ultrasound Med 1988;7(12):655-9.

[9]    Madazli R, Hernandez-Andrade E, Gudmundsson S, et al. Can the degree of retro grade diastolic flow in the abnormal umbilical artery flow velocity wave form predicting pregnancy out come? Ultrasound Obstet Gynecol 2002;19(3):229-34.