

## Original Research Article

### “A STUDY ON ROLE OF UMBILICAL ARTERY DOPPLER IN FETUSES WITH INTRAUTERINE GROWTH RESTRICTION”

Dr. Rohan Krishna Kumar<sup>1</sup>, \*Dr. Vaishali Korde Nayak<sup>2</sup>, Dr. Sushma Sharma<sup>3</sup>, Dr. Santhosh Sabnis<sup>4</sup>

1. Consultant, Department of Obstetrics and Gynaecology, J K Women Hospital, Dombivli.
2. Professor & HEAD, Department of Obstetrics and Gynaecology, MIMER Medical College & BSTRH, Talegaon, Dabhade.
3. Professor, Department of Obstetrics and Gynaecology, MIMER Medical College & BSTRH, Talegaon, Dabhade.
4. Professor, Department of Radio diagnosis, MIMER Medical College & BSTRH, Talegaon, Dabhade.

\*Corresponding Author: Dr. Vaishali Korde Nayak, Professor & HEAD, Department of Obstetrics and Gynaecology, MIMER Medical College & BSTRH, Talegaon, Dabhade.

Email: [drvaishalinayak@gmail.com](mailto:drvaishalinayak@gmail.com)

## ABSTRACT

**Background:** Intrauterine Growth Restriction (IUGR) is a term used to describe the condition of a foetus whose size or growth is subnormal. "A foetus is growth restricted if its weight is less than tenth percentile of its gestational age". IUGR is associated with increased mortality and morbidity which possibly may extend into adult life as compared to foetuses and newborns presenting with characteristics of normal growth.

**AIM:** To evaluate the usefulness of umbilical artery Doppler indices as predictors in antepartum surveillance in clinically suspected cases of intra uterine growth restriction. **MATERIALS & METHODS** **Study Design:** Institutional prospective Observational study. **Study area:** The study was done in the Dept. of. in a Medical college. **Study Period:** 1 year. **Study population:** Women who presented to antenatal OPD/IPD with clinical symptoms and risk factors and laboratory data of IUGR meeting the mentioned inclusion criteria. **Sample size:** A total of 100 women were included in the study. **Sampling method:** Simple Random sampling method. **Ethical consideration:** Institutional Ethical committee permission was taken prior to the commencement of the study. **Study tools and Data collection procedure:** The study population comprised of 100 singleton pregnancies that were diagnosed as having a fetus with Intrauterine growth Restriction (IUGR) clinically and based on grey scale ultrasound findings. All the women were included in the study after their due consent. All the patients were then followed up with ultrasound measurements as well as fetal Doppler velocimetry parameters of various vessels till delivery. All guidelines prescribed by the Pre Natal Diagnostic Test (PNDT) act were strictly adhered to. **Statistical Analysis:** The data was collected, compiled and compared statistically by frequency distribution and percentage proportion. Quantitative data variables were expressed by using Descriptive statistics (Mean  $\pm$  SD). Qualitative data variables were

expressed by using frequency and Percentage (%). Statistical analysis was done by finding out the sensitivity and specificity, negative and positive predictive value.

**Results:** In our study 66 women had a raised umbilical PI out of which 44 (66.66%) had an adverse perinatal outcome, among which 36 were admitted to the NICU, 6 had a neonatal death (NND) and 2 were intrauterine deaths (IUD), whereas 22 (33.3%) had an uneventful outcome.

**CONCLUSION:** We conclude that study of umbilical artery by Doppler velocimetry in antenatal surveillance of pregnancies with Intrauterine Growth Restriction yields the best results with respect to monitoring, timing of delivery and predicting the adverse perinatal outcome.

**Key words:** Intrauterine Growth Restriction (IUGR), umbilical arteries, perinatal outcome.

## INTRODUCTION

Care given to a mother during her pregnancy and childbirth is an index of civilization. There is a sea of change in the antenatal and intranatal care since the inception of the concept of antenatal care by Bellantyne in 1901. While nutritional supplements, vaccinations and investigations as part of antenatal care have increased and improved for better maternal and foetal wellbeing, the last few weeks where delivery has to be weighed against lung maturity has remained the most dangerous aspect of obstetrics. Hence the necessity of monitoring of the foetus, in the antenatal and the intranatal period and hence an insight and research into the modern biomedical engineering and its application to foetal activity.

Simultaneous development in ultrasonography for other parameters of foetal wellbeing buttressed with foetal scalp blood sampling by Saling (1962) for diagnosis of foetal hypoxia and acidosis brought about a revolutionary change in the diagnosis of foetal distress. The already present velocimetry study by colour Doppler with its leap-frog advancements is heralding a new era in modern obstetrical care.

Intrauterine Growth Restriction (IUGR) is a term used to describe the condition of a foetus whose size or growth is subnormal. A foetus is growth restricted if its weight is less than tenth percentile of its gestational age. IUGR is associated with increased mortality and morbidity which possibly may extend into adult life as compared to foetuses and new-borns presenting with characteristics of normal growth. The recent UNICEF data suggests a 25-30% incidence in India.<sup>1</sup> Most common association is found with PIH, Primary placental insufficiency and in women with previous history of IUGR. The incidence also varies from region to region and varies in the same population as well.

Accurate antenatal diagnosis of IUGR by real time ultrasound can reduce the complications and improve the outcome. After introduction of ultrasound the small foetuses would be identified, however it could not be determined which of these foetuses were at increased risk due to utero placental insufficiency and therefore needed special surveillance. Small foetuses were monitored by Non Stress Test and Biophysical profile.

Apart from various other non-invasive tests like non stress test which provide information after clinical features set in, Doppler velocimetry studies give us vital information regarding foetus before such features begin to appear.

Pregnancies associated with specific risk factors have high likelihood of complicating into IUGR. Many such patients present in their 3<sup>rd</sup> trimester for antenatal examination. Such patients warrant a highly specific and sensitive test which can be non-invasively applied. Therefore the accurate knowledge of changes in uteroplacental and foetal circulation will surely help to predict perinatal outcome and help in deciding the time of appropriate intervention. It is here that role of Colour Doppler comes. Hence a study using colour Doppler ultrasonography was planned to evaluate foetal outcome in pregnancies complicated with intrauterine growth restriction.

**AIM:** To evaluate the usefulness of umbilical arteries Doppler indices as predictors in ante-partum surveillance in clinically suspected cases of intra uterine growth restriction.

### **MATERIALS & METHODS**

**Study Design:** Institutional prospective Observational study.

**Study area:** The study was done in the Dept. of. in a Medical college.

**Study Period:** 1 year.

**Study population:** Women who presented to antenatal OPD/IPD with clinical symptoms and risk factors and laboratory data of IUGR meeting the mentioned inclusion criteria.

**Sample size:** A total of 100 women were included in the study.

**Sampling method:** Simple Random sampling method.

#### **Inclusion Criteria:**

1. Singleton pregnancies with known LMP
2. Women with reliable dating of pregnancy by either first trimester ultrasound using CRL/BPD
3. The patient was a clinically diagnosed case of IUGR, based on the findings such as insufficient weight gain, static or no increase in the abdominal circumference, and decrease or no increase in the symphysis-fundal height and fetal biometry on USG.

#### **Exclusion Criteria:**

1. Multiple Pregnancies
2. Fetuses with congenital anomalies

**Ethical consideration:** Institutional Ethical committee permission was taken prior to the commencement of the study.

#### **Study tools and Data collection procedure:**

The study population comprised of 100 singleton pregnancies that were diagnosed as having a fetus with Intrauterine growth Restriction (IUGR) clinically and based on grey scale ultrasound findings. All the women were included in the study after their due consent. All the patients were then followed up with ultrasound measurements as well as fetal Doppler velocimetry parameters of various vessels till delivery. All guidelines prescribed by the Pre Natal Diagnostic Test (PNDT) act were strictly adhered to.

Considering the incidence of maximum perinatal morbidity in IUGR equal to 80% with an allowable error of 10% with 95% confidence limit and power of test equal to 90% the

estimated sample size was calculated as 100. Thus we included 100 consecutive Antenatal mothers who satisfied the inclusion criteria.

Complete and detailed evaluation was done of all the patients in the following manner

- a) Detailed clinical history
- b) Clinical parameters like weight gain, symphysio-fundal height, abdominal girth.
- c) NST, Fetal biometry & BPP.
- d) Doppler velocimetry waveforms for Umbilical artery (Umb A)
- e) **Instrument:**

All examinations were performed on the Toshiba Medical System NEMIO – XG (SSA-58A) Sr. No. – I7B1185568. PH/C.SP/RHVM/12/2012 with 3.5 MHz transducer.

For examination of the umbilical artery a suitable amniotic fluid pocket was chosen with loops of umbilical cord floating in it. Three sites of umbilical cord were chosen - insertion into the placenta; at insertion into the umbilicus and at midway. The values were noted down and the average of the values taken down.

#### **Pulsatility Index- (PI)**

PI= (Peak Systolic Velocity – End Diastolic Velocity) /Mean Velocity

PI=(S-D)/M

#### **Resistance Index- (RI)**

Also known as the Pourcelot's resistance index or resistive index.

RI = (Peak Systolic Velocity- End Diastolic Velocity)/ Peak Systolic Velocity.

RI = (S-D)/D

**Systolic Diastolic ratio:**The S/D ratio is calculated by dividing the peak systolic velocity by the end diastolic velocity. As the diastolic flow falls, S/D ratio increases. When there is no diastolic flow, the S/D ratio is infinity. In Obstetrics this ratio is also called as A/B ratio or AB ratio.

A standard proforma was compiled for each patient documenting the above mentioned parameters. The NST readings, need of induction, type of delivery, Apgar score at birth and five minutes, color of liquor, days of NICU stay and other complications mentioned below were recorded as per proforma.

#### **Statistical Analysis**

The data was collected, compiled and compared statistically by frequency distribution and percentage proportion. Quantitative data variables were expressed by using Descriptive

statistics (Mean  $\pm$  SD). Qualitative data variables were expressed by using frequency and Percentage (%). Statistical analysis was done by finding out the sensitivity and specificity, negative and positive predictive value.

**OBSERVATION& RESULTS:**

**Table 1: Maternal Age Distribution:**

Sr. No.	Age	Number	Percentage
1.	<20	17	17%
2.	21-25	51	51%
3.	26-30	27	27%
4.	>30	05	5%
	Total	100	100%

Table 1 shows the maternal age distribution, wherein maximum patients are seen in the age group between 21 years to 30 years i.e. 78 women. The mean age of the women in our study is 24.1 years. Youngest woman in our study being 18 years old and the oldest was 38 years old.

**Table 2: Maternal Characteristics**

Sr. No.	Variables	Number	%
1.	Parity		
	Primipara	51	51%
	Multipara	49	49%
2.	Delivery		
	Vaginal	43	43%
	Instrumental	12	12%
	Elective CS	14	14%
	Emergency CS	31	31%
3.	Indication Of CS		

	Fetal Distress	29	64.44%
	CPD	05	11.11%
	Breech	03	6%
	Protracted 1 <sup>st</sup> stage	06	13.33%
	Others	02	4%
4.	PIH		
	Yes	47	47%
	No	53	53%
5.	Induction		
	Induced	47	47%
	Spontaneous	39	39%
	Elective CS	14	14%

Out the 100 women delivered 43 % delivered vaginally, 12 % required instrumental delivery like forceps or ventouse, 14 % women underwent an elective Lower Segment Cesarean Section (LSCS) and 31 % women had to be taken for an emergency LSCS (Graph 2). Fetal distress was the most common indication (64.4%). Other indications of LSCS were CPD, Breech, protracted 1<sup>st</sup> stage of labor, transverse lie and abruption-placenta in 2 cases (Graph 3). Among the 100 women 47 % were induced for various maternal and fetal indications such as severe pre-eclampsia, abruption, eclampsia etc.

**Table 3: Perinatal Outcome**

Sr. No.	Variable	Number	%
1.	Mean Birth weight	1.94 kg	
2.	Mean Gestational Age	37.05 weeks	
3.	Uneventful Outcome	41	41%
4.	NICU Admission	49	49%
5.	Neonatal Death	08	08%
6.	Intrauterine Death	02	02%

Total	100	100%
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The mean birth weight in our study was 1.94 Kg and the mean gestational age at delivery being 37 weeks and 5 days. Out of the total 100 newborn, 41 % had an uneventful outcome and 59 % had an adverse perinatal outcome, as mentioned in materials and methods. 49 % neonates required NICU admission for various indications like Low Birth Weight, respiratory distress, brochopulmonary dysplasia, intraventricular hemorrhage, necrotizing enterocolitis, circulatory failure. A total of 8 neonatal deaths and 2 intrauterine deaths occurred in our study.

**Table 4: Gestational Age distribution with respect to Perinatal outcome.**

Gestational Age Distribution	No. of Pts	Adverse Perinatal Outcome		
		Neonatal Death	Intrauterine Death	NICU admission
28 to 32 weeks	03	02	01	00
32 to 34 weeks	05	02	00	03
>34 weeks	92	04	01	46
Total	100	59		

As seen by the above table 4, women were between 28 to 32 weeks at delivery and had the worst adverse outcome which included 2 NNDs' and 1 IUD. The 5 women in group between 32 to 34 weeks had 2 NNDs' and 92 women were above 34 weeks of gestation at delivery and had 46 NICU admissions, 4 NNDs' and 1 IUD.

**Table 5: Umbilical Artery Raised PI with perinatal outcome**

Sr.	Umb PI	Number	NICU	NND	IUD	ADVERSE	UNEVENTFUL
1.	Normal	34	13	02	0	15 (44.11%)	19 (55.8%)
2.	Raised	66	36	06	02	44 (66.66%)	22 (33.3%)
3.	Total	100				100	

The above table shows the number of women with raised umbilical artery PI. In our study 66 women had a raised umbilical PI out of which 44 (66.66%) had an adverse perinatal

outcome, among which 36 were admitted to the NICU, 6 had a neonatal death (NND) and 2 were intrauterine deaths (IUD), whereas 22 (33.3%) had an uneventful outcome.

When compared to the 34 women who had a normal umbilical artery PI, 15 (44.11%) had an adverse perinatal outcome, i.e. 13 NICU admissions, 2 NND's and 19 (55.8%) fetuses had an uneventful outcome.

**Table 6: Absent or Reversal of End Diastolic Flow with perinatal outcome.**

Sr. No.	Umbilical A. Flow	No. of Pts	Adverse Outcome			Uneventful Outcome
			NICU	NND	IUD	
1.	Normal flow	34	13	02	00	19
2.	Raised PI	61	33	05	01	22
3.	Absent	03	02	01	00	00
4.	Reversed	02	01	00	01	00
	Total	100	59			41

The above table shows the number of women with normal umbilical artery Doppler, raised umbilical artery PI and women with absent or reversal of end diastolic flow in umbilical artery and their respective perinatal outcome.

**Table 7: Table showing comparison of Doppler indices of umbilical artery with perinatal outcome**

Sr. No.	Vessel	TP	TN	FP	FN	Sensitivity%	Specificity%	PPV%	NPV%
1.	Umb. A. PI	44	19	22	15	81.48	46.34	75.00	55.88

Table no. 7 is a table of the sensitivities, specificities, positive predictive values (PPV) and negative predictive values (NPV) of umbilical artery studied by Doppler velocimetry in our study in relation to the perinatal outcome. As seen in the above table the umbilical artery has the maximum sensitivity of 81.48% with respect to the perinatal outcome.

## DISCUSSION

Fetal 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 fetuses grow or develop

equally. Intrauterine growth restriction does not imply a specific patho-physiology but merely a result of a series of events occurring along several possible pathways. Hence, accurate antenatal diagnosis must decide whether the fetus 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 (Feto-placental circulation) and middle cerebral artery (fetal-circulation).

Doppler helps to map the changes that can be observed in the arterial and venous compartments of the fetal and umbilical circulation. Colour Doppler imaging has enabled more detailed examination of the fetal circulation, thereby allowing a greater knowledge of the physiological and pathological changes in fetus during pregnancy. Doppler also helps us to investigate the fetal response to adverse conditions in utero. This information can only help in defining the small baby that is sick and also help in deciding when it is better to have such a fetus delivered.

The primary response observed with fetal Doppler is the 'brain-sparing' effect which has been demonstrated in both animal and human studies<sup>2</sup>. It has been possible to correlate the development of hypoxia and acidosis with changes in fetal haemodynamics that corresponds to the brain sparing effect, whereby the blood supply is preferentially diverted to the fetal heart, adrenal glands, and brain, at the expense of rest of the body.

In our study of hundred women with clinical IUGR we found that the maximum women were in the age group between 21 to 30 years i.e. 78 women. The incidence of PIH in our study was 47%. Baschat A had found an incidence of PIH of 33.33% in their study<sup>3</sup>. In 2013 Samir Kumar Hazra<sup>4</sup> found an incidence of 61% for LSCS in women with IUGR fetuses as compared to 45% in the present study.

In our study we found the Raised uterine artery RI had a sensitivity of 55.93%, specificity 60.97%, PPV 67.3% and NPV of 49.01% in comparison of that of Benson & Doublie<sup>5</sup>, 67% and Coleman<sup>6</sup> 83%. The discrepancy in values may be due to the different cut of levels of RI taken in these studies. Progressive growth of the placental villous tree, together with an increase in fetal cardiac output, increases both systolic and diastolic velocity in the umbilical artery. Therefore, PI values progressively falls as pregnancy advances. Diastolic velocities are typically present in normal pregnancies by 14-16 weeks of gestation.

In our study the sensitivity of umbilical artery PI was 81.48% in predicting the adverse perinatal outcome. Umbilical Artery is the main vessel for monitoring pregnancies with IUGR as it represents both fetoplacental and placental resistance.

Our results are similar to B.N Lakhkar<sup>7</sup>, Mishra<sup>8</sup>, and Khanduri Sachin<sup>9</sup>. It tells us that MCA PI alone has much less sensitivity as compared to the other vessels in predicting the adverse perinatal outcome.

In our study 59 fetuses had at least one adverse perinatal outcome. Remaining 41 fetuses had favorable outcome. There were 2 Intra uterine deaths and 8 had neonatal deaths

for various reasons like, Of the 2 IUD's one had reversal of diastolic flow at 30 weeks and the other IUD had only a raised PI in the Umbilical Artery and reactive NST. The mortality in cases of reversed and absent end diastolic flow was 50% and 33.3% respectively, indicating grave prognosis.

Of the 98 live births 59 neonates were admitted to NICU, 8 neonates had a neonatal death. 6 among the 8 neonatal deaths had various Doppler changes including AEDV and reversal of flow in ductus venosus. 2 out of the 8 NND's had normal Doppler velocimetry findings and yet had an adverse perinatal outcome. 1 among the 2 NNDs' with normal Doppler findings had meconium stained amniotic fluid which indicates fetal distress. This shows that Doppler cannot always accurately predict adverse perinatal outcome by picking up fetal compromise earlier. As seen in cases of late onset IUGR in which a substantial proportion of cases with normal umbilical artery Doppler waveforms may have true growth restriction and are at risk of adverse perinatal outcome.<sup>10,11</sup>

The umbilical artery PI has the maximum sensitivity closely matches that seen in studies by B.N.Lakhkar<sup>7</sup>, Mishra et al<sup>8</sup> and other authors. From our study we found that the umbilical artery was the most sensitive parameter to predict the perinatal outcome. As seen in many studies such as Yoon et al<sup>12</sup>, Baschat A<sup>3</sup> Doppler velocimetry changes predict fetal compromise earlier than NST or Biophysical profile<sup>13, 14, 15</sup>. Our study matches closely to that of B.N Lakhkar<sup>7</sup> and the study of umbilical artery was better in predicting perinatal outcome.

## **CONCLUSION:**

We conclude that study of umbilical artery by Doppler velocimetry in antenatal surveillance of pregnancies with Intrauterine Growth Restriction yields the best results with respect to monitoring, timing of delivery and predicting the adverse perinatal outcome.

## **REFERENCES:**

1. Devi PIC, Krishna Menon MK, Bhaskar Rao K. Postgraduate obstetrics and gynecology. Orient long man; 3rdEdn 1986: 219.
2. Peeters LLH, Sheldon RE, Jones MD, Makowski EL. Blood flow to fetal organs as a function of arterial oxygen content. *Am J Obstet Gynecol.* 1979;135:637-46.
3. Baschat AA, Gembruch U, Reiss I, Gortner L, Weiner CP, Harman CR. Relationship between arterial and venous Doppler and perinatal outcome in fetal growth restriction. *Ultrasound Obstet Gynecol.* 2000 Oct;16(5):407-13
4. Hazra SK, Dash KK, Chaudhuri A, Ghosh MK, Banerjee D, Guha S. A prospective study of doppler velocimetry in pregnancy-induced hypertension in a rural population of a developing country. *J Basic ClinReprodSci [serial online]* 2013;2:127-31.
5. Benson CB, Doubilet PM. Doppler criteria for intrauterine growth retardation: predictive values. *J Ultrasound Med.* 1988; 7: 655-659.
6. Coleman MA, McCowan LM, North RA. Mid-trimester uterine artery Doppler screening as a predictor of adverse pregnancy outcome in high-risk women. *Ultrasound ObstetGynecol* 2000 Jan; 15 (1): 4-6.

7. Lakhkar B N, Rajagopal K V, Gourisankar P T. Doppler prediction of adverse perinatal outcome in PIH and IUGR. *Indian J Radiol Imaging* 2006;16:109-16.
8. Divyangi Mishra, Pramod Sakhi and Abhinesh Sarat. Role of Obstetric Doppler examination in prediction of adverse perinatal outcome in Intrauterine growth retardation and pregnancy induced hypertension. *Sch. J. App. Med. Sci*,2013;1(6)1016-1020.
9. Sachin K, Umesh P, Shazia B, Samarjit B. Comparison of Diagnostic Efficacy Of Umbilical Artery and Middle Cerebral Artery Waveform with Colour Doppler Study for Detection of Intrauterine Growth Restriction. *JOGI*. 2013;63:249-235
10. McCowan LM, Harding JE, Stewart AW. Umbilical artery Doppler studies in small for gestational age babies reflect disease severity. *BJOG* 2000;107:916-25.
11. Figueras F, Eixarch E, Gratacos E, Gardosi J. Predictiveness of antenatal umbilical artery Doppler for adverse pregnancy outcome in small-for-gestational-age babies according to customised birthweight centiles: population based study. *BJOG* 2008;115:590-4
12. Yoon BH<sup>1</sup>, Romero R, Roh CR, Kim SH, Ager JW, Syn HC, Cotton D, Kim SW Relationship between the fetal biophysical profile score, umbilical artery Doppler velocimetry, and fetal blood acid-base status determined by cordocentesis. *Am J Obstet Gynecol*. 1993 Dec;169(6):1586-94.
13. Fleischer A, Schulman H, Farmakides G, et al. Umbilical artery velocity waveforms and intrauterine growth retardation. *Am J Obstet Gynecol*. 1985;151:502-5.
14. Arduini D, Rizzo G, Romanini C, et al. Fetal blood flow velocity waveforms as predictors of growth retardation. *Obstet Gynecol*. 1987;70:7-10.
15. Harrington K, Cambell S. Fetal size and growth. *Curr Opin Obstet Gynecol*. 1993;5:186-94.