

## Radiology in IUGR: A Study

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### Abstract

**Introduction:** Every newborn has the right to be born undamaged mentally and physically. The fulfillment of this goal plays a pivotal role in materno-fetal medicine, whose sole objective is that every pregnancy should culminate into a healthy baby and a healthy mother.

### Aims and Objectives

- to evaluate the role of colour doppler in assessment of intrauterine fetal growth
- to assess in intrauterine growth retardation
  1. uteroplacental circulation which are maternal uterine arteries
  2. fetal circulation which includes middle cerebral arteries
- to evaluate the diagnostic accuracy of uterine artery and middle cerebral artery doppler indices as predictors of perinatal outcome in clinically suspected IUGR pregnancies
- to determine the role in its management

**Material and Method:** This study was approved by the Ethical Committee of our institution. Data for the study was collected from patients attending the department of Radiodiagnosis, referred by Department of Obstetric and Gynecology at our college

**Summary & Conclusion:** The umbilical-placental and cerebral vascular beds are directly involved in the haemodynamic adjustments of fetal growth restriction. A Doppler index that reflects both of these areas can be useful for identifying fetuses with increased placental and/or decreased cerebral resistance.

Assessment of both the uteroplacental circulation and the fetoplacental circulations together is more sensitive to predict to perinatal outcome, than assessment of each alone.

In suspected IUGR, uterine artery PI proved to be a better predictor in early weeks of pregnancy than uterine artery RI and diastolic notch and umbilical artery and middle cerebral artery.

Best results are obtained when we use MCA PI, which is more sensitive in detecting IUGR in later weeks of gestation from 31-36 weeks rather than umbilical artery and uterine artery And the diagnostic accuracy of the middle cerebral artery is maximum between 31-36 weeks.

**Keywords:** IUGR, Doppler.

### 1. INTRODUCTION

Every new born has the right to be born undamaged mentally and physically. The fulfillment of this goal plays a pivotal role in materno- fetal medicine, whose sole objective is that every pregnancy should culminate into a healthy baby and a healthy mother. The growth of human fetus, a complex process resulting in an increase in size over time has been the

subject of extensive study. Before the advent of ultrasound evaluation physicians are interested in the growth process of fetus, the prospective assessment of fetal growth during pregnancy has been limited to measuring the uterine size and guessing the fetal size by palpation and could only look at the infant at delivery and infer at what happened in utero This lead to increasing perinatal mortality and morbidity.

The very objective of obstetrics was getting defeated. But now, in the era of sophisticated modality of real time ultrasound, antenatal diagnosis of intrauterine growth restriction has become very easy, thus minimizing the future catastrophe.

Intrauterine growth restriction (IUGR) is a term used to describe the condition of a fetus whose size or growth is subnormal. The most common definition of intrauterine growth restriction is that "a fetus is growth restricted if its weight is less than the tenth percentile for its gestational age". IUGR is classified into two types symmetric or asymmetric. Symmetric IUGR is result of early complication in pregnancy and asymmetric IUGR is result of result later in pregnancy. Asymmetric IUGR which is the focus of current study account for 70% of cases.

The incidence of IUGR in a population where the mothers are generally healthy and well nourished is estimated to be about 3-5%. In a population of women with hypertension or previous growth restricted fetus however the incidence increases to 15-20% or higher<sup>2</sup>. The incidence of IUGR varies from region to region and even in the same region, it varies in different sub populations. In India, according to recent UNICEF surveys, the incidence of IUGR is 25-30%<sup>3</sup>. IUGR has many causes, maternal causes include hypertension, collagen vascular disease, renal disease, poor nutrition and drug or alcohol abuse which causes placental insufficiency. Fetal infections such as cytomegalovirus, toxoplasmosis and chromosomal anomalies such as triploidy and trisomies 13 and 18 also result in IUGR<sup>4</sup>. Placental insufficiency in the absence of any maternal cause is called primary placental insufficiency and is common cause of IUGR. Growth retarded fetuses have eight to ten fold increase in perinatal mortality and 50-75% morbidity compared to appropriately sized fetuses<sup>5</sup>. Those fetuses who have suffered from IUGR were prone to develop still birth, Intrapartum fetal acidosis, Perinatal asphyxia, Meconium aspiration syndrome, Hypoglycemia, Hypocalcemia, Hypothermia and Hypoxic ischemic encephalopathy etc.

Accurate antenatal diagnosis of IUGR by real time ultrasound can reduce the complications and improve the outcome. After the introduction of ultrasound the small fetuses could 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

fetuses were therefore monitored by non stress test of fetal heart rate and the biophysical profile.

With the introduction of Doppler Ultrasound examination it became possible to assess the uteroplacental blood flow, fetoplacental blood flow and to assess the fetal blood circulation. The uteroplacental and fetoplacental circulation give information on the placental resistance whereas evaluating the fetal circulation using Doppler ultrasound could non-invasively assess the fetal response to hypoxia. This is become possible to identify those small fetuses that were at increased risk of perinatal morbidity and mortality due to impaired uteroplacental and fetoplacental circulations. Umbilical arterial (Umb A) Doppler velocimetry is the most rigorously evaluated tests of fetal well-being<sup>6</sup>. Doppler ultrasound studies of the human fetal circulation have shown that in fetuses with IUGR there is a significant reduction of middle cerebral arterial (MCA) pulsatility index when compared with those in normal fetuses<sup>7</sup>. At Cordocentesis, a significant correlation has been observed between hypoxemia in foetuses with IUGR and an abnormal MCA pulsatility index<sup>8</sup>. Recently published meta-analysis has proved that systemic application of Doppler sonography has resulted in 50% reduction of perinatal mortality among high risk pregnancies.

This dissertation titled "Colour Doppler Evaluation of Uterine Artery and middle cerebral artery in intrauterine foetal growth assessment and its Prognostic Significance" focuses on establishing the role of Umbilical artery and Middle cerebral artery Doppler ultrasound in predicting adverse perinatal outcomes in clinically suspected IUGR pregnancies and to determine the role of Doppler velocimetry in clinical management of such pregnancy

## 2. AIMS AND OBJECTIVES

- to evaluate the role of colour doppler in assessment of intrauterine fetal growth
- to assess in intrauterine growth retardation
  1. *uteroplacental circulation which are maternal uterine arteries*
  2. *fetal circulation which includes middle cerebral arteries*
- to evaluate the diagnostic accuracy of uterine artery and middle cerebral artery doppler indices as predictors of perinatal outcome in clinically suspected IUGR pregnancies

➤ to determine the role in its management

### 3. MATERIAL AND METHOD

This study was approved by the Ethical Committee of our institution. Data for the study was collected from patients attending the department of Radiodiagnosis, referred by Department of Obstetric and Gynecology at our college

**Study Design:** Prospective study

**Study Period:** September 2013 to September 2014

**Work Plane:** Department of Radio diagnosis G.R. Medical College & Jayarogya Hospital, Gwalior.

#### Inclusion Criteria

- i. All singleton antenatal women (at 24 weeks)
- ii. Females with pregnancy confirmed by first trimester ultrasound by CRL OR BPD or with known LMP

#### Exclusion Criteria

- i. All antenatal women less than 24 weeks
- ii. All subjects with history of fetuses with congenital anomalies, multiple pregnancies rupture of membranes, active labour

**Study Group:** All antenatal women at 24 weeks fulfilling inclusion criteria in department of radiodiagnosis, G.R. Medical College Gwalior For colour Doppler evaluation of intrauterine growth assesment and management

#### Methodology

1. Colour Doppler Aloka Machine Ssd4000
2. Aloka Japan Model Prosound Alpha 6

Doppler US evaluation was performed following a detailed clinical history and US biometry. Subject will be considered cases if fetus is diagnosed with intrauterine growth restriction based on grey scale ultrasound and subsequent Doppler ultrasound will be performed Follow up doppler at 30 weeks and at term will be done if clinically indicated to determine a favourable or worsening trend in Doppler Indices. However, only the results of the patients last Doppler ultrasound examination were used for analysis of perinatal outcome

#### Outcome Criteria

Doppler results were analyzed for prediction of perinatal outcome.

#### Perinatal Outcome Variables Included

1. Birth Weight
2. Perinatal death
3. Emergency Caesarean section 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

- I. Perinatal death
- II. Emergency CS for fetal distress
- III. 5 minute APGAR score of less than 7
- IV. Admission to NICU for complications of low birth weight.

Pregnancy outcome was considered to be “normal” when the above complications were absent.

The uterine artery RI  $> 0.7$  and uterine artery PI value  $> 1.4$  and presence of diastolic notch were considered abnormal.

The UmA Pulsatility index ratios were considered abnormal if the value was above the 95th percentile for the gestational age (UMA PI value  $> 1.45$ ). UMA S/D ratio  $> 3$  were considered abnormal.

UMA diastolic flow velocity patterns were seen which showed normal forward diastolic flow velocity pattern and abnormal reduced, absent and reversed diastolic flow velocity pattern. The MCA pulsatility index was considered abnormal if the value was below the 5th percentile for the gestational age reference value PI  $< 1.45$  and S/D ratio  $< 3$ , according to reference values of D Gramellini et al.<sup>72</sup>

Of the various Doppler indices, pulsatility index has the smallest measurement error and narrower reference limits. The MCA/Umb A PI ratio (cerebroumbilical ratio) is usually constant during the last 10 weeks of gestation. It is possible to use a single cut off value after 30th week because cerebralumbilical Doppler ratio does not vary significantly between 30th and 40th weeks as reported by Wladimiroff et al 73who observed a significant differences in cerebroumbilical ratio only between weeks 26-

38. After 26<sup>th</sup> week, the statistical comparison showed no significant differences between the intervals considered.

The MCA PI/ Umb A PI ratio was calculated. In our study a single cutoff value of 1.08 for MCA/Umb A PI ratio (cerebral-umbilical ratio) was used, above which velocimetry was considered normal and below which it was considered abnormal, according to reference values of D Gramellini et al.

**Statistical Methods**

The diagnostic statistics were used to find the diagnostic value of Umb A PI, MCA PI in relation to perinatal outcome.

The sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy were determined for all Doppler measurements using formulas

Statistical software:

Microsoft Word and Excel have been used to generate graphs, tables etc.

SPSS 20 was used for statistical analysis.

**4. RESULTS**

Prospective study of 90 antenatal patients was done after considering the inclusion and exclusion criteria.

Out of these 90 patients 44 patients were considered for subsequent follow up out of which 23 patients were again followed up. Total ultrasound examination done were 156 in span of thesis study in 90 patients out of which 36 examination were between 26-30 weeks and 120 examination between 31-36 weeks, accordingly Flow velocity waveforms of the uterine, umbilical, middle cerebral artery & ductus venosus were obtained from all 156 total examination in 90 patients and analyzed.

**Distribution of Age of the Patients**

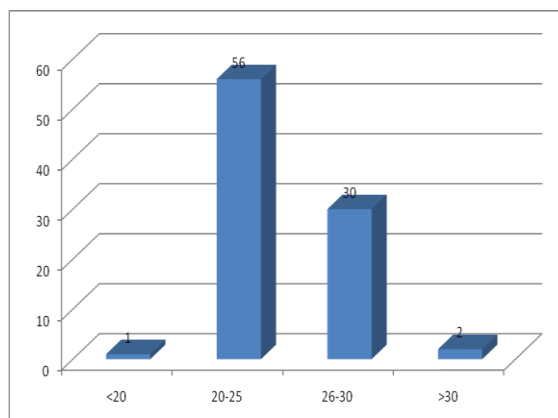
**Table1.** Distribution of age of patients

Age In Years	Number
<20	1
20-25	56
26-30	30
>30	2
<b>Total</b>	<b>90</b>

All our patients ranged from 18 years to 35 years. Majority of the patients 56 were in 20-25 years age group. 30 were between 25-30 years

and 2 patients were > 30 years and only 1 patient was < 18 years.

**Graph1.** Showing the distribution of age of patients



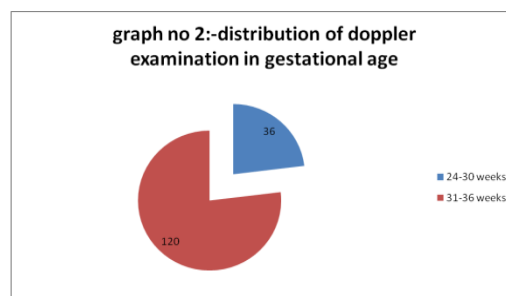
**Distribution of Doppler Examinations Done in Gestational Age**

In our study, total 156 examinations were done in 90 patients range between 24-36 weeks

**Table2.** Distribution of Doppler Examinations done in Gestational Age between 24-36 Weeks

24-30 weeks	36
31-36 weeks	120
total	156

36 examinations were done between 24-30 weeks and 120 examination done between 31-36 weeks in total 150 examinations done in 90 patients.



**Distribution of Clinical Presentation in 90 Antenatal Patients**

In study group of 90 antenatal patients, data for clinical presentation shown below

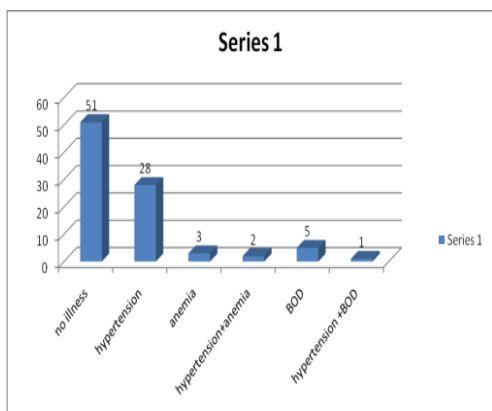
**Table3.** Clinical Presentation in 90 Antenatal Patients

No illness	51
Hypertension	28
Anemia	3
Hypertension+ anemia	2
Bod	5
Hypertension+bod	1
<b>TOTAL</b>	<b>90</b>

Out of 90 patients indicated for Doppler ultrasound 28 had pregnancy induced

hypertension 3 patients had anemia only, 2 patients had both pregnancy induced hypertension and anaemia, 5 patients had bad obstretic history and 1 patient had both pregnancy induced hypertension and bad obstretic history, rest 51 indicated for Doppler ultrasound had no illness

**Graph3.** Distribution of Clinical Presentation in 90 Patients



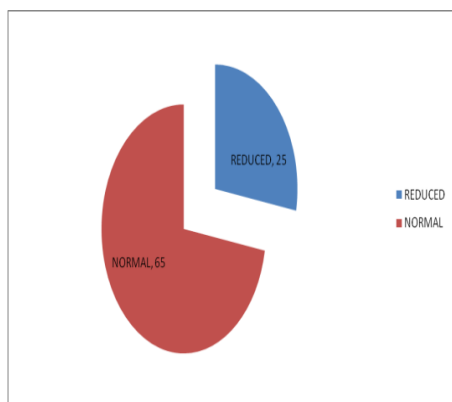
**Distribution of Amniotic Fluid Volume**

**Table4.** Showing the Distribution of Amniotic Fluid Volume in 90 Patients

Amniotic Fluid Volume	Number
Normal	65
Reduced	25
<b>Total</b>	<b>90</b>

Among 90 patients examined, 25 patients had reduced amniotic fluid volume and 65 had adequate amniotic fluid volume

**Graph4.** Showing the Distribution of Amniotic Fluid Volume in 90 Patients



Data Was Analyzed Taking 156 Examination in Consideration done in 90 Patients in Study Time.

(A) In between 24-30 Weeks 36 Examinations were done

**1. Uterine Artery Doppler Studies**

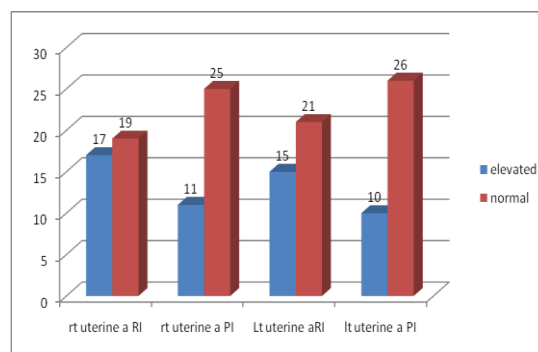
a. Changes In Ri and Pi Value Changes

**Table5.** Changes in Right and Left Uterine Artery RI and PI Value

	Right Uterine A RI	Right Uterine A PI	Left Uterine A RI	Right Uterine PI
Elevated	17	11	15	10
Normal	19	25	21	26
<b>TOTAL</b>	<b>36</b>	<b>36</b>	<b>36</b>	<b>36</b>

Among 36 examinations done between age 24-30 weeks elevated RI and PI in right uterine artery is 17 and 11 and left uterine artery is 15 and 10 respectively and rest showed normal RI and PI values

**Graph5.** Showing the Changes in Right and Left Uterine Artery Ri and Pi



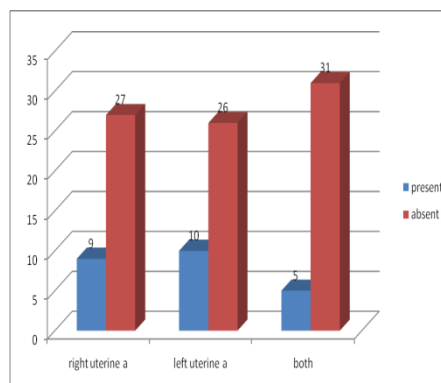
**Distribution of Persistant Diastolic Notch in Uterine Arteries**

**Table6.** Showing Distribution of Diastolic Notch in Uterine Arteries

Diastolic Notch	Right Uterine A	Left Uterine A	Both
Present	9	10	05
Absent	27	26	31
Total	36	36	36

Among 36 examinations done 9 had early diastolic notch and 27 had no diastolic notch in right uterine artery, 10 had diastolic notch and 26 had no diastolic notch in left uterine artery and 5 had diastolic notch in both uterine arteries whereas 31 had no both uterine arteries affected.

**Graph7.** Showing the Distribution of Diastolic Notch in Uterine Arteries



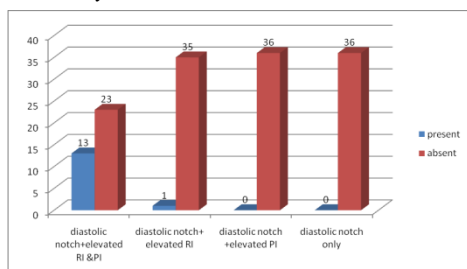
Changes in Uterine Artery Using Ri, Pi, Diastolic Notch Parameters

**Table7.** Doppler Findings in Uterine Artery Using All Parameters (RI, PI and Diastolic Notch) in Right Uterine Artery

Right Uterine Artery	Present	Absent	Total
Diastolic Notch + Elevated Ri & Pi	13	23	36
Diastolic Notch+ Elevated Ri	1	35	36
Diastolic Notch + Elevated Pi	0	36	36
Diastolic Notch Only	0	36	36

13 had both RI and PI elevated with diastolic notch, 1 had diastolic notch and elevated RI, none had diastolic notch and elevated PI and none had only diastolic notch with normal RI and PI

**Graph7.** Doppler Findings in Uterine Artery Using All Parameters (RI, PI and Diastolic Notch) in Right Uterine Artery

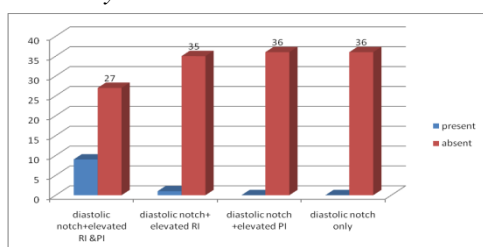


**Table8.** Doppler Findings in Uterine Artery Using All Parameters (RI,PI And Diastolic Notch) in Left Uterine Artery

Left Uterine Artery	Present	Absent	Total
Diastolic Notch + Elevated Ri & Pi	9	27	36
Diastolic Notch+ Elevated Ri	1	35	36
Diastolic Notch + Elevated Pi	0	36	36
Diastolic Notch Only	0	36	36

9 had both RI and PI elevated with diastolic notch, 1 had diastolic notch and elevated RI, none had diastolic notch and elevated PI and none had only diastolic notch with normal RI and PI

**Graph8.** Doppler Findings in Uterine Artery Using All Parameters (RI,PI and Diastolic Notch) in Left Uterine Artery



## 2. Umbilical Artery Doppler Studies

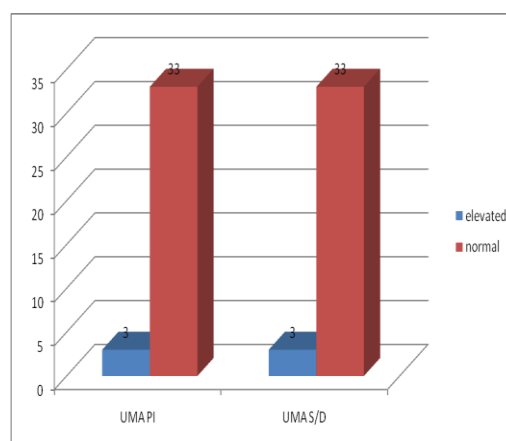
a. Umbilical Artery Pulsatility Index and S/D Ratio

**Table9.** Findings of Umbilical Artery Doppler Examination

Umbilical Artery	Elevated	Normal	Total
Pi	3	33	36
S/D Ratio	3	33	36

Out of 36 examinations 3 had elevated and 33 had normal UMA PI and 3 had elevated and 33 had normal S/D ratio

**Graph9.** Findings of Umbilical Artery Doppler Examination



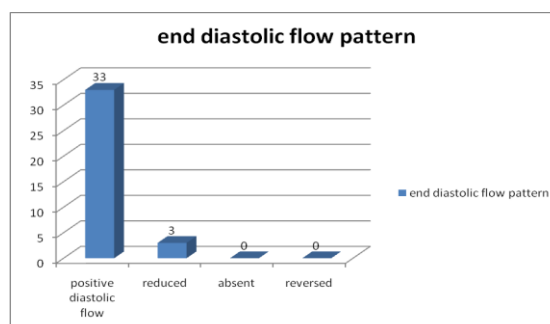
b. Umbilical Artery End Diastolic Velocity Flow Pattern

**Table10.** Showing Patterns of Umbilical Artery End Diastolic Velocity Flow Pattern

End Diastolic Flow Pattern	Number
Positive Diastolic Flow	33
Reduced	3
Absent	0
Reversed	0
<b>Total</b>	<b>36</b>

In between 24-30 weeks, among total 36 examinations done 3 has reduced end diastolic flow velocity where as 33 had positive diastolic flow velocity pattern. And none had absent or reversed diastolic flow velocity pattern

**Graph10.** Patterns of End Diastolic Flow in Umbilical Artery



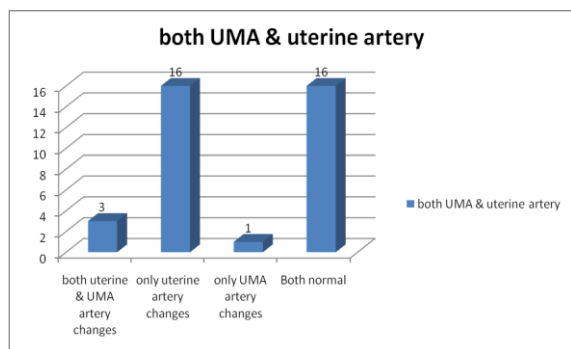
### 3. Analysis of both Umbilical and Uterine Artery

**Table11.** Analysis of both Umbilical and Uterine Artery

Both Uterine Artery & Umbilical Artery Changes	3
Only Uterine Artery Changes	16
Only Umbilical Artery Changes	1
Both Normal	16

Out of 36 examinations between 24-30 weeks, 3 had abnormal changes in both uterine and UMA 16 had only abnormal uterine artery changes and 1 had only abnormal UMA changes whereas 16 had normal uterine and UMA changes.

**Graph11.** Analysis of both Umbilical Artery and Uterine Artery



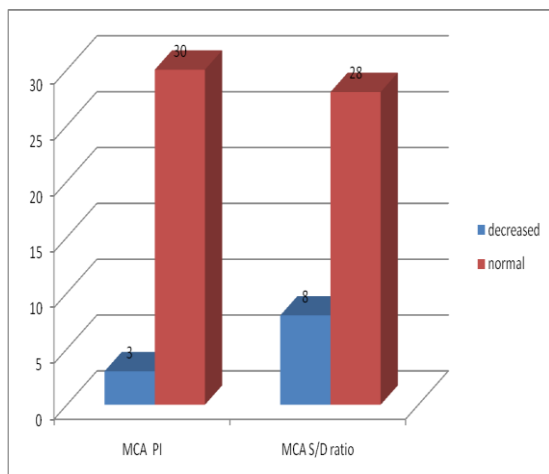
### 4. Fetal Middle Cerebral Artery Doppler Changes

**Table12.** Fetal middle cerebral artery pulsatility index and S/D ratio changes

Mca	Decreased	Normal
Pi	3	30
S/D	8	28

3 had decreased MCA PI and 8 had decreased S/D ratio whereas 20 had normal MCA PI and 28 had normal S/D ratio in total 36 examinations done

**Graph12.** Changes in Fetal MCA PI and S/D Ratio



### 5. Fetal Ductus Venosus Flow Pattern

**Table13.** Showing Changes in Ductus Venosus "A Wave" Flow Pattern

Pattern	Number
Normal	35
Reduced	1
Absent	0
Reversed	0

35 had normal ductus venosus flow" a wave" pattern only 1 had reduced and none had absent and reversed ductus venosus a wave values

(B) From 31 -36 Weeks

#### 1. Uterine Artery Doppler Studies

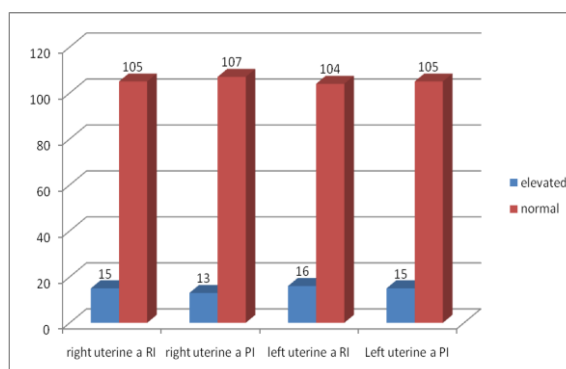
a. Changes in Ri and Pi Value Changes

**Table14.** Changes in Right and Left Uterine Artery RI and PI Value

	Right uterine a RI	Right uterine a PI	Left uterine a RI	Left uterine a PI
Elevated	15	13	16	15
Normal	105	107	104	105
Total	120	120	120	120

Among 120 examinations done between age 31-36 weeks elevated RI and PI in right uterine artery is 15 and 13 and left uterine artery is 16 and 15 respectively and rest showed normal RI and PI values

**Graph13.** Changes in Right and Left Uterine Artery RI and PI



b. Distribution of Persistent Diastolic Notch in Uterine Arteries

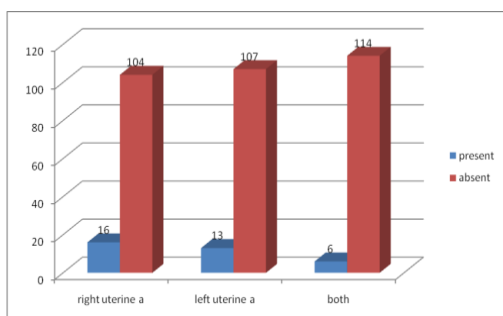
**Table15.** Showing Distribution of Diastolic Notch in Uterine Arteries

Diastolic Notch	Right Uterine A	Left Uterine A	Both
Present	16	13	6
Absent	104	107	114
Total	120	120	120

Among 120 examinations done 16 had early diastolic notch and 104 had no diastolic notch in right uterine artery, 13 had diastolic notch and

107 had no diastolic notch in left uterine artery and 6 had diastolic notch in both uterine arteries whereas 114 had no both uterine arteries affected

**Graph14.** Showing Distribution of Diastolic Notch in Uterine Arteries



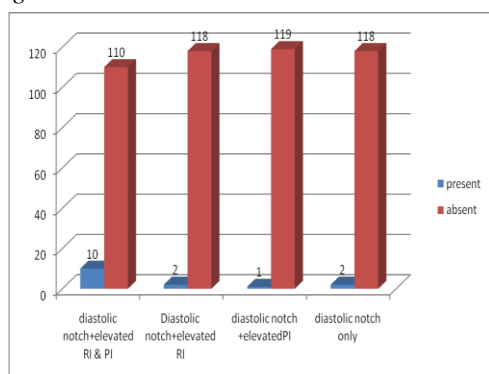
c. Changes in Uterine Artery Using Ri, Pi, Diastolic Notch Parameters

**Table16.** Doppler Findings in Uterine Artery Using All Parameters (RI, PI and Diastolic Notch) in Right Uterine Artery

Right Uterine Artery	Present	Absent
Diastolic notch + elevated RI & PI	10	110
Diastolic notch+ elevated RI	2	118
Diastolic notch + elevated PI	1	119
Diastolic notch only	2	118

10 had both RI and PI elevated with diastolic notch, 2 had diastolic notch and elevated RI, 1 had diastolic notch and elevated PI and 2 had only diastolic notch with normal RI and PI

**Graph15.** Doppler Findings in Right Uterine Artery Using All Parameters

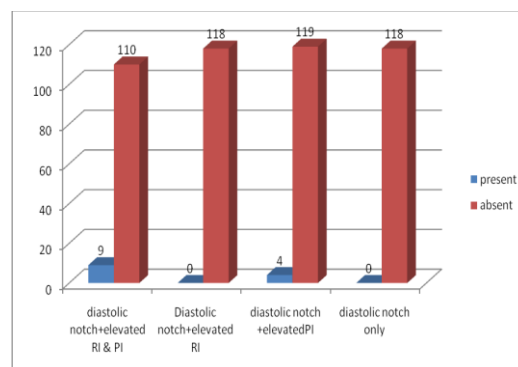


**Table17.** Doppler Findings in Uterine Artery Using All Parameters (RI, PI and Diastolic Notch) in Left Uterine Artery

Left Uterine Artery	Present	Absent
Diastolic Notch + Elevated Ri & Pi	9	111
Diastolic Notch+ Elevated Ri	0	120
Diastolic Notch + Elevated Pi	4	116
Diastolic Notch Only	0	120

9 had both RI and PI elevated with diastolic notch, none had diastolic notch and elevated RI, 4 had diastolic notch and elevated PI and none had only diastolic notch with normal RI and PI

**Graph16.** Doppler Findings in Uterine Artery Using All Parameters (RI, PI and Diastolic Notch) in Left Uterine Artery



2. Umbilical Artery Doppler Studies

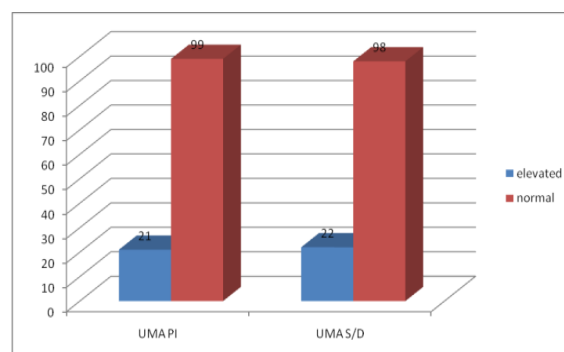
a. Umbilical Artery Pulsatility Index Aand S/D Ratio

**Table18.** Findings of Umbilical Artery Doppler Examination

Umbilical Artery	Elevated	Normal
Pi	21	99
S/D Ratio	22	98

Out of 120 examinations 21 had elevated and 99 had normal UMA PI and 22 had elevated and 98 had normal S/D ratio

**Graph17.** Findings of Umbilical Artery Doppler Examination



3. Umbilical Artery End Diastolic Velocity Flow Pattern

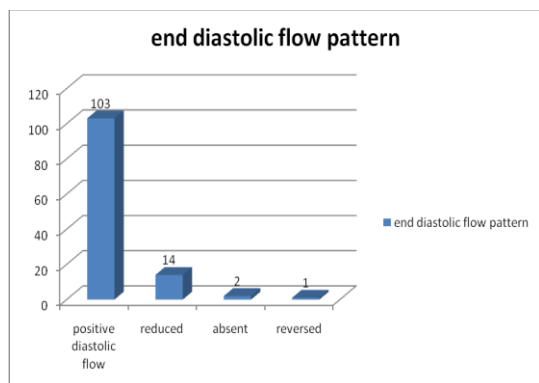
**Table19.** Distribution of End Diastolic Flow Patterns in Umbilical Artery

End Diastolic Flow Pattern	NUMBER
Positive Diastolic Flow	103
Reduced	14
Absent	2
Reversed	1
<b>TOTAL</b>	<b>120</b>

In between 31-36 weeks, among total 120 examinations done 103 had positive diastolic flow pattern, 14 had reduced and 2 had absent and 1 had reversed end diastolic flow patterns.



**Graph18.** Showing the Distribution of Patterns of End Diastolic Flow in Umbilical Artery



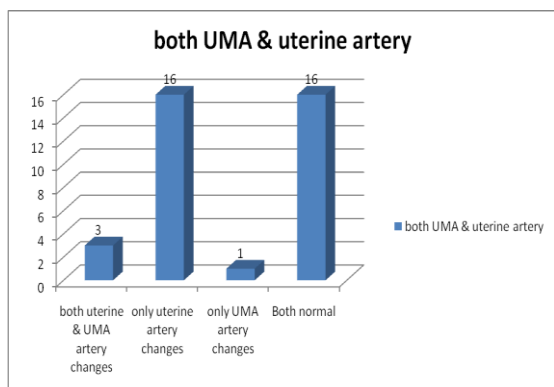
**4. Analysis of both Umbilical and Uterine Artery**

**Table20.** Analysis of both Umbilical and Uterine Artery

Both Uterine Artery & Umbilical Artery Changes	9
Only Uterine Artery Changes	13
Only Umbilical Artery Changes	11
Both Normal	87

Out of 36 examinations between 24-30 weeks, 3 had abnormal changes in both uterine and UMA 16 had only abnormal uterine artery changes and 1 had only abnormal UMA changes whereas 16 had normal uterine and UMA changes.

**Graph19.** Analysis of both Umbilical Artery and Uterine Artery



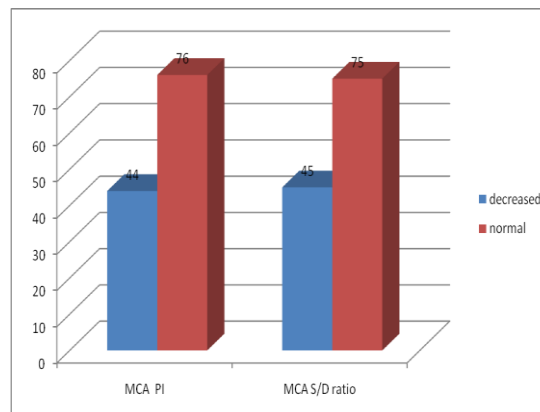
**5. Fetal Middle Cerebral Artery Doppler Changes**

**Table21.** Fetal Middle Cerebral Artery Pulsatility Index and S/D Ratio Changes

Mca	Decreased	Normal
Pi	44	76
S/D	45	75

44 had decreased MCA PI and 45 had decreased S/D ratio whereas 76 had normal MCA PI and 75 had normal S/D ratio in total 36 examinations done

**Graph20.** Changes in Fetal MCA PI and S/D Ratio



**6. Fetal Ductus Venosus Flow Pattern**

**Table22.** Showing Changes in Ductus Venosus "A Wave" Flow Pattern

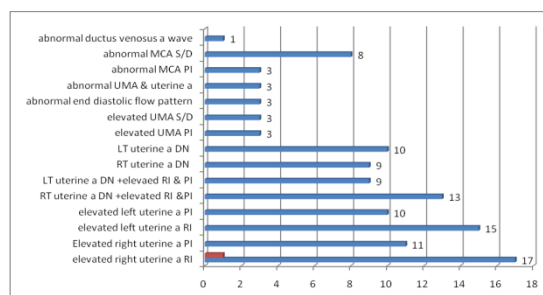
Pattern	Number
Normal	117
Reduced	1
Absent	1
Reversed	1

117 had normal ductus venosus flow" a wave" pattern, 1 had reduced, 1 had absent and 1 had reversed ductus venosus a wave values.

**Table23.** Showing Performance Characteristics of Doppler Indices between 24-30 Weeks

Elevated right uterine RI	17
Elevated right uterine PI	11
Elevated left uterine artery RI	15
Elevated left uterine artery PI	10
Right uterine diastolic notch	9
Left uterine diastolic notch	10
Right uterine a Diastolic notch+elevated RI and PI	13
Left uterine a diastolic notch + elevated RI and PI	9
Elevated UMA PI	3
Elevated UMA S/D ratio	3
Abnormal end diastolic flow pattern	3
Abnormal UMA and uterine artery	3
Abnormal MCA PI	3
Abnormal MCA S/D	8
Abnormal ductus venosus a wave	1

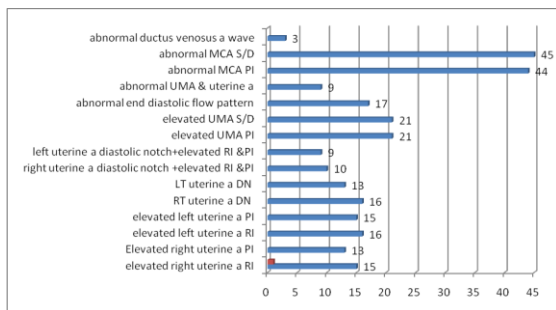
**Graph21.** Showing Performance characteristics of Doppler indices between 24-30 weeks



**Table24.** Showing performance characteristic of Doppler indices between 31-36 weeks

Elevated right uterine PI	15
Elevated right uterine RI	13
Elevated left uterine arteryPI	16
Elevated left uterine artery RI	15
Right uterine diastolic notch	16
Left uterine diastolic notch	13
Right uterine a Diastolic notch+elevated RI and PI	10
Left uterine a diastolic notch + elevated RI and PI	9
Elevated UMA PI	21
Elevated UMA S/D ratio	21
Abnormal end diastolic flow pattern	17
Abnormal UMA and uterine artery	9
Abnormal MCA PI	44
Abnormal MCA S/D	45
Abnormal ductus venosus a wave	3

**Graph22.** Showing performance characteristic of Doppler indices between 31-36 weeks



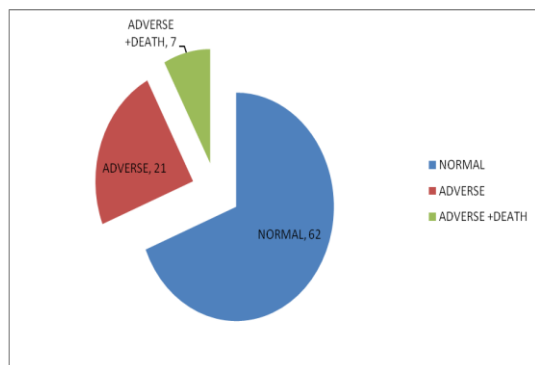
**Analysis of Perinatal Outcome**

**Table25.** Showing the analysis of perinatal outcome

Normal	62
Adverse	21
Adverse +death	7
TOTAL	90

There were 7 intrauterine deaths and 83 live births. Of these 83 live births 21 had adverse perinatal outcome as 16 had emergency cesarian section and 5 were submitted to the NICU

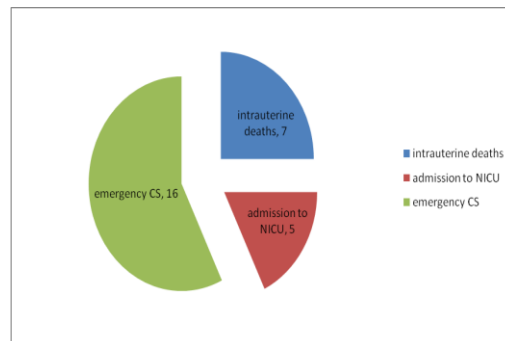
**Graph23.** Analysis of perinatal outcome



**Table26.** Showing the distribution of adverse outcomes

ADVERSE OUTCOME	NO. OF CASES
Intrauterine deaths	7
Admission to NICU	5
Emergency Caesarian section	16

**Graph24.** Showing the distribution of adverse outcomes



The cuff-off value for Doppler parameters in 28 adverse perinatal outcomes

In uterine artery, RI value at which maximum fetuses had adverse outcome is near 1 (>0.7 abnormal) whereas PI value at which maximum foetuses had adverse perinatal outcome was 1.9 (>1.4 abnormal)

**Table no 27** –showing the distribution of UMA PI value in adverse perinatal outcome fetuses

UMA PI	NUMBER
<1.45(NORMAL)	10
>1.45	18
TOTAL	28

18 babies had adverse perinatal outcome when UMA PI value was above 1.45 with maximum adverse outcome at PI value at near 1.6 whereas 10 babies had who had adverse perinatal outcome had PI within normal limits.

**Table no 28** –showing the distribution of UMA S/D ratio in adverse erinatal outcome fetuses

UMA S/D ratio	NUMBER
<3	9
>3	19
TOTAL	28

19 babies had adverse perinatal outcome when UMA S/D ratio value was above 3 with maximum adverse outcome at PI value at near 3.5 whereas 9 babies had who had adverse perinatal outcome had PI within normal limit

**Table29.** Perinatal outcome v/s UMA reduced /absent/ reversed diastolic flow

Diastolic flow	No. of cases	Adverse outcome	Deaths	Mortality
Reduced	17	11	1	5.8%
Absent	2	2	-	0%
Reversal	1	-	1	100%

Above table shows there 20 fetuses has reduced/absent/reversed diastolic flow in our study. There were 7 deaths in whom 1 had reduced diastolic flow and 1 had reversed diastolic flow.

**Table30.** Showing the distribution of MCA PI in adverse perinatal outcome fetuses

MCA PI	NUMBER
<1.2	25
1.2-1.45	1
>1.45(NORMAL)	2
TOTAL	28

25 babies with adverse outcome including the deaths were observed in MCA PI value below 1.2 were as only 2 babies with adverse perinatal outcome had MCA PI above 1.2 but below the normal value for MCA PI (>1.45). And 1 baby

**Table32.** Showing the Copmparism of Doppler Indices with Adverse Perinatal Outcome

**24-30 Weeks-Total 36 Examinations**

DOPPLER INDEX	TP	TN	FP	FN	SENSI-TIVITY	SPECI-FICITY	PPV	NPV	DIAG. ACCU-RACY
Uterine artery RI	11	12	10	3	78.57%	54.54%	52.38%	80%	63.8%
Uterine artery PI	12	18	4	2	85.71%	81.81%	75%	90%	83.33%
Uterine artery DN	11	20	3	2	84.6%	86.95%	78.57%	90%	86%
UMA PI	11	22	0	3	78.57%	88%	100%	88%	91.6%
UMA S/D	11	22	0	3	78.57%	88%	78.5%	88%	91.6%
MCA PI	6	21	2	7	46.15%	91%	75%	75%	75%
MCA S/D	7	21	1	7	50%	93%	87.5%	75%	77.77%

**Table33.**Between 31-36 Weeks-Total 120 Examinations

DOPPLER INDEX	TP	TN	FP	FN	SENSI-TIVITY	SPECI-FICITY	PPV	NPV	DIAG. ACCU-RACY
Uterine artery RI	10	75	12	23	30.30%	86.2%	45.45%	76.5%	70.8%
Uterine artery PI	10	73	16	21	32.2%	84.8%	38.4%	77.6%	70%
Uterine artery DN	10	76	13	21	32.2%	87.3%	43.47%	84.6%	71.6%
UMA PI	17	83	5	15	53.12%	94.3%	77.2%	84.69%	83.3%
UMA S/D	17	71	7	15	53.12%	91%	70.8%	82.5%	73.3%
MCA PI	27	73	17	3	90%	82%	61.36%	96%	84%
MCA S/D	28	73	15	4	87.5%	83%	65%	94.8%	84.16%

**5. 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 pathophysiology but merely a result of a series of events occurring along several possible pathways. Hence,

had adverse outcome though MCA PI was normal.

**Table31.** Showing the distribution of MCA S/D ratio value in adverse perinatal outcome fetuses

MCA S/D ratio	Number
2-2.5	16
2.5-3	8
>3(NORMAL)	4

16 babies with adverse outcome including the deaths were observed in MCA S/D ratio value between 2-2.5 maximum at value of 2.2 whereas 8 babies with adverse perinatal outcome had MCA S/D ratio between 2.5-3 and 4 babies born with adverse perinatal outcome has normal MCA S/D ratio.

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).

Our study was done in 90 pregnant women, who were diagnosed as having fetuses with intrauterine growth restriction based on clinical suspicion and grey scale ultrasound examination. Numerous studies with varying results have been published and difficult to compare. This controversy can partly be explained by small number of patients enrolled, varying sample sizes and techniques as well as different criteria used to define the adverse perinatal outcome. In addition some studies were performed in high risk and some in low risk population, similarly major and minor perinatal outcome.

As can be seen yet no universally accepted standard for defining an abnormal Doppler flow velocity waveforms as well as the pregnancy outcome measure, so conflicting observations might continue to emerge.

### Age Incidence

It is observed that the maximum number of pregnant women were in the age group of 21-25 years. This can be attributed probably for the increased pregnancy rate in these age groups. PIH is more common in primigravida due to first time exposure to chorionic villi.

### Distribution of Gestational Age

In this study all patients underwent Doppler study ranging from 24 weeks to 36 weeks onwards till the termination of pregnancy. Total 156 examinations were done among which 120 examinations were between 31-36 weeks.

The earliest study was done at 24th week of gestation. Hence most pregnancies were monitored between 31-36weeks, when the fetus would have begun developing sufficient lung maturity to survive outside the uterus. Symmetrical IUGR accounts for 20-30% and asymmetrical IUGR accounts for 70-80%. In asymmetrical IUGR insult begins later than symmetrical IUGR, usually after 28 weeks of gestation. Hence 31-35 weeks of gestation probably could be more common.

### Distribution of Clinical Presentation in 90 Antenatal Patients

Among women where a cause for IUGR was identified. 28 had pregnancy induced hypertension (PIH), 3 had anemia complicating pregnancy. This can be attributed to asymmetrical IUGR which accounts for 70-80% in which uteroplacental insufficiency (PIH) was the most common cause. Hypertensive disorders are present in 30% to 40% of pregnancies complicated with IUGR. Bad obstetric history as a cause is seen in 5 patients, 3 had pregnancy

induced hypertension with anemia and only 1 had PIH with bad obstetric history. 51 patients of the study group had no detectable cause for IUGR.

### Distribution of Amniotic Fluid in 90 Antenatal Patients

#### Uterine Artery

Total 150 examinations were done between 24-36 weeks in 90 patients. 36 examinations were between 24-30 weeks and 120 examinations between 31-36 weeks.

The sensitivity of **RI** was 78.57% in our study between 24-30 weeks and sensitivity of **RI** between 31-36 weeks was 30.3 % which showed uterine artery to be a better predictor of intrauterine fetal growth restriction in earlier periods of gestation than later weeks of pregnancy because of pregnancy induced hypertension which starts developing after 24 weeks and maximum examinations which had abnormal **RI** in between 24-30 weeks on follow up improved with time. In comparison with that of Benson and Doublie<sup>73</sup> which had overall 67% sensitivity between 24-36 weeks which is less than the sensitivity we found in our study between 24-30 weeks. This discrepancy may be contributed to different cut of levels of resistive index, varying between 0.5 to 0.7. Best screening test is measuring placental site uterine artery **RI**. If the placenta is situated at the midline, the highest **RI** is best predictor.

The following compares the results of the present study with other studies:

#### Uterine Artery **RI** in Predicting Perinatal Outcome

##### Study Sensitivity

Benson and Doublie<sup>75</sup> 67%

Present study\*

24-30weeks-78.57%

31-36weeks-30.3%

#### Uterine Artery **PI** in Predicting Perinatal Outcome

Jamal A and co-workers<sup>79</sup>-61.23%

Present study\*

24-30 weeks-85.71%

31-36 weeks-31.2%

In our present study sensitivity of uterine artery **PI** was 85.71% and between 31-36 weeks was 31.2% which is more than previous study done.

Hence, present study concludes uterine artery **PI** to be a better predictor and more significant than uterine artery **RI** in early weeks of gestation in

intrauterine fetal growth assessment and in predicting perinatal outcome.

In the present study, the persistent early diastolic notch beyond 24 weeks of gestation showed a sensitivity of 84.6%. This is much higher than the study by Colemann et al 74 who showed sensitivity of the uterine artery notch as 76% for adverse perinatal outcome. This may be because of the included women was with bilateral notches in Colemann study, whereas in present study presence of diastolic notch either left or right or both were included. However, the analysis done by Farrell et al 75 for reliability of early diastolic notch in uterine artery as predictor for uteroplacental insufficiency revealed a sensitivity of 88%. The following compares the results of the present study with other studies: uterine artery PI appears to be more significantly superior than other parameters

#### **Study Sensitivity**

Colemann et al 74 76%

Farrell et al 75 88%

Present study\* 84.6%-24-30 weeks

However, uterine artery diastolic notch according to our study showed sensitivity of only 32.2% in study between 31-36 weeks showing very less number of persistence of diastolic notch in later weeks of pregnancy.

There were three cases who had been detected with diastolic notch in early weeks of pregnancy but timely interventional management at that time with bed rest and medications and follow up caused the disappearance of diastolic notch at follow ups and termination of pregnancy was uneventful

#### **Umbilical Artery**

In the present study the umbilical artery PI had a sensitivity of 78.57% in between 24-30 weeks and 53.12% between 31-36 weeks.

According to D. Gramellini et al 59, the overall sensitivity of PI in the Umbilical artery in predicting perinatal outcome was 64%. Umbilical artery was the main vessel used for monitoring high risk pregnancies. This is because umbilical artery represents fetoplacental system and primarily reflects placental resistance. In present study as there is more number of PIH cases probably this can be attributed for difference in the studies. Another study by K W Fong et al 76 showed the sensitivity of PI in the umbilical artery as 58.3%. The following compares the results of the present study with other studies.

#### **Umbilical artery PI in predicting perinatal outcome**

##### **Study Sensitivity**

D Gramellini et al 59 64%

K W Fong et al 76 44.7%

BN Lakhkar et al 77 50%

Present study\* 78.57% between 24-30 weeks

53.12% between 31-36 weeks

Hence, our study concludes that umbilical artery PI showed more sensitivity in between 24-30 weeks than 31-36 weeks.

In our present study umbilical artery S/D ratio between 24-30 weeks showed sensitivity of 78.57% and between 31-36 weeks 53.12% which was similar to the performance of the umbilical artery S/D ratio between 31-36 weeks

##### **Fetal Blood Circulation and Redistribution**

In the present study fetal middle cerebral artery PI had a sensitivity of 46.15% in between 24-30 weeks of gestation whereas the sensitivity of the middle cerebral artery PI in between the 31-36 weeks gestation was found to be 90%. This outstanding performance of the middle cerebral artery PI in between 31-36 weeks of pregnancy is because changes of IUGR in the the artery become prevalent in later weeks of pregnancy as in earlier weeks there is brain sparing effect which protects the fetal brain from the profound effects of hypoxia .

In Arduini and Rizzo<sup>78</sup> study the sensitivity of MCA in predicting perinatal outcome was 68%.

Obviously the present study cannot be compared with the above study in view of difference in considering the intra cranial artery as it is clearly established that PI varies in relation to the intra cranial artery considered. So it is important that the artery be identified precisely and with certainty.<sup>70</sup> The following compares the results of the present study with other studies:

##### **Middle Cerebral Artery PI in Predicting Perinatal Outcome**

###### **Study Sensitivity**

K.W Fong et al<sup>76</sup> 72.4%

Arduini and Rizzo<sup>78</sup> 68%

BN Lakhkar et al 77 41.6%

Present study- 24-30 WEEKS- 46.15%

31-36 WEEKS-90%

###### **Prediction of Perinatal Outcome**

Among those 28 fetuses there were 7 Intra uterine deaths and 21 live births. Out of 21 live births 5 were admitted to NICU, 16 were born

by emergency caesarian section. These results are slightly higher Gramellini et al<sup>59</sup> This can be contributed to difference in perinatal mortality and morbidity rates from western standards to Indian standards. By using Doppler ultrasound results for analysis, the MCA pulsatility index had a higher sensitivity and positive predictive value for predicting the adverse perinatal outcome than the Umb A pulsatility indices and uterine artery PI

Our findings agree with the results of the studies that have shown MCA PI Doppler to be more useful than Uma PI or uterine artery in predicting the adverse outcome. Comparison between different studies would be meaningful if uniform of standardized criteria were used.

**Comparison of Diagnostic Accuracies in those Parameters Showing Highest Sensitivity**

WEEKS	24-30	31-36
UTERINE ARTERY PI -	83.33%	70%
MCA PI-	75%	84%

Hence, our study confirmed that the uterine artery PI has the best diagnostic accuracy. In between 24-30 weeks and MCA PI proved to have better diagnostic accuracy between 31-36 weeks.

Cuff-off values were observed for the Doppler parameters below or above which these parameters were significantly associated with perinatal outcome. In uterine artery, RI value at which maximum fetuses had adverse outcome is near 1(>0.7 abnormal) whereas PI value at which maximum foetuses had adverse perinatal outcome was 1.9 (>1.4 abnormal). maximum adverse outcome was seen when UMA PI value was found to be near 1.6 (>1.45 abnormal) whereas maximum adverse outcome was seen when UMA S/D ratio value was found to be above 3.5. adverse outcome including the deaths were observed in MCA PI value below 1.2 whereas adverse outcome including deaths were observed in MCA S/D ratio at value below 2.2(<3 abnormal)

**6. CONCLUSION**

The umbilical-placental and cerebral vascular beds are directly involved in the haemodynamic adjustments of fetal growth restriction. A Doppler index that reflects both of these areas can be useful for identifying fetuses with increased placental and/or decreased cerebral resistance.

Assessment of both the uteroplacental circulation and the fetoplacental circulations

together is more sensitive to predict to perinatal outcome, than assessment of each alone.

In suspected IUGR, uterine artery PI proved to be a better predictor in early weeks of pregnancy than uterine artery RI and diastolic notch and umbilical artery and middle cerebral artery.

Best results are obtained when we use MCA PI , which is more sensitive in detecting IUGR in later weeks of geatation from 31-36 weeks rather than umbilical artery and uterine artery And the diagnostic accuracy of the middle cerebral artery is maximum between 31-36 weeks.

Cuff-off values were observed for the Doppler parameters below or above which these parameters were significantly associated with perinatal outcome. In uterine artery, RI value at which maximum fetuses had adverse outcome is near 1(>0.7 abnormal) where as PI value at which maximum foetuses had adverse perinatal outcome was 1.9 (>1.4 abnormal). Maximum adverse outcome was seen when UMA PI value was found to be near 1.6 (>1.45 abnormal) where as maximum adverse outcome was seen when UMA S/D ratio value was found to be above 3.5. Adverse outcome including the deaths were observed in MCA PI value below 1.2 whereas adverse outcome including deaths were observed in MCA S/D ratio at value below 2.2(<3 abnormal) presence of reversal of diastolic flow in Umbilical artery is an ominous sign since it carries a grave prognosis and high mortality.

Doppler imaging is of value for monitoring the pregnancy because it can provide indirect evidence of fetal compromise and is known to improve outcomes of high risk pregnancies with Intrauterine growth restriction. Hence Doppler evaluation is complementary to all other surveillance modalities.

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