Abstract
Background
Intra Uterine Growth Restriction (IUGR) is an important and particularly challenging problem for obstetricians and pediatricians. IUGR is a leading contributor in perinatal morbidity and mortality affecting 23.8% newborns around the world and 75% are born in Asia alone. In India the incidence of low birth weight varies from 15 to 25% and more than 50% of them are IUGR.

Methods
The present article consists of a study of 100 cases of intrauterine growth restriction with periodic color Doppler during the period of 1st July 2011 to 30th August, 2013 in Obstetrics and Gynecology Department of a tertiary care center. Detail history taken. General and obstetrical examination was done along with routine hematological and urine investigations. Ultrasound examination was done for growth, liquor and placental localization. Fetal well-being was assessed with Doppler studies and daily fetal movement count.

Results
In present study moderate to severe pregnancy induced hypertension (53.9%) and lack of proper weight gain (23%) are found to be the commonest causes of IUGR. Out of 69 IUGR cases having abnormal Doppler, about 63.8% had abnormality in uterine artery flow, 85.5% had abnormality in umbilical artery flow, 88.4% had abnormality in middle cerebral artery flow, 55% had abnormality in uterine and umbilical artery and 75.4% had abnormality in umbilical artery and MCA. Incidence of fetal demise (13%) was higher in patients with abnormal Doppler flow compared to normal flow (3.2%). Surgical intervention in form of caesarean was required in 69.6% of patients with abnormal Doppler flow compared to normal flow (3.2%). Surgical intervention in form of caesarean was required in 69.6% of patients with abnormal Doppler flow. Cerebro-placental ratio (CPR) <1 is associated with 14.7% fetal demise in contrast to CPR >1 where fetal demise is 2.6%. Incidence of AEDF/REDF (Absent End Diastolic flow/Reversed End diastolic flow) in IUGR was 8% that resulted in 50% loss of fetus.

Conclusions
Color Doppler is a useful mode to predict fetal outcome in IUGR. Color Doppler allows better understandings of hemodynamic changes in feto-placental and utero-placental circulation. The cerebro-placental ratio (CPR), which measures the proportion of flow supplying the brain and placenta, is now the most powerful parameter for assessment of IUGR and hypoxia.

Keywords
Intra Uterine Growth Restriction, Doppler in Pregnancy

Introduction
Intra Uterine Growth Restriction (IUGR) is an important and particularly challenging problem for obstetricians and pediatricians. IUGR refers to deviation and reduction in expected fetal growth pattern. Small for gestational age (SGA) infants are those having birth weights below the 10th percentile for their gestational age. Not all IUGR infants are small for gestational age.

IUGR is a leading contributor in perinatal morbidity and mortality affecting 23.8% newborns around the world and 75% are born in Asia alone. Perinatal mortality rates are 4.8% higher for growth restricted infants and morbidity is present in 50% of surviving infants. In India the incidence of low birth weight varies from 15 to 25% and more than 50% of them are IUGR.

Doppler is an important tool as far as IUGR is concerned. Most important diagnostic method in pregnancy complicated by IUGR is Doppler flow velocimetry. Doppler velocimetry helps in early detection, prompt follow up, and timely decision making in management of IUGR. The most useful diagnostic criteria are umbilical artery PI and cerebro-placental ratio. (CPR).

Abnormal uterine artery waveform is that with S/D ratio > 2.7 and persistence of diastolic notch beyond 26 weeks of gestation predicts developing IUGR later in pregnancy.

Umbilical artery Doppler wave forms reflect the status of the placental circulation and the increase in end diastolic flow that is seen with advancing gestation is a direct result of an increase in the number of tertiary stem villi that takes place with placental maturation.

Study of MCA (Middle Cerebral artery) is useful as it provides an opportunity to assess the brain sparing effect in IUGR babies. The preferential flow to the brain results in an increased diastolic flow during fetal asphyxia. Normally, diastolic component in cerebral arteries is lower than in umbilical arteries at any gestational age. Therefore, cerebral vascular resistance is higher.
than placental resistance and CPR>1.0. Major advantage of using CPR instead of RI or PI values is that the effect of increased HR is nullified.

Aims

- To identify the high risk patients likely to have IUGR fetuses
- To monitor this group by regular antenatal checkup and recognize IUGR as early as possible.
- To study the utility of Color Doppler as diagnostic and prognostic tool.
- To select appropriate mode and time of delivery under optimal conditions of fetus at risk.
- To evaluate outcome of pregnancy in cases of established IUGR in terms of perinatal morbidity and mortality.

Methods

In present study 100 cases of suspected IUGR were studied in detail and followed with periodic color Doppler in a tertiary care hospital. Detailed personal history including socioeconomic status, past and present obstetric history, past medical and surgical history was noted. All the patients had first trimester ultrasound from which exact gestational age could be decided and IUGR was possible to stamp. Detail of present pregnancy was noted specially in terms of,

- No. of antenatal visits
- Immunization
- Any complications like:
  1. Anemia
  2. Hypertension in previous or present pregnancy
  3. Multiple pregnancy
  4. Bleeding in any trimester of pregnancy
  5. Other

Apart from general and obstetrical examinations and routine laboratory investigations patients were checked for weight gain. Fetal well-being assessment was done in terms of daily fetal movement count, non-stress test and serial ultrasound and color Doppler. Mode of delivery was decided on condition of fetuses and labor was followed up closely and any complications were noted. Neonates were examined in terms of weight, height, APGAR at 1 min and 5 min Score and Ponderal index, perinatal morbidity was noted.

Results & Discussion

Possible etiologies of IUGR are placental disorders, maternal conditions associated with placental insufficiency, fetal chromosomal abnormality, and intra-uterine infections. The placental abnormalities are most common cause (75-80%).

### Table 1

<table>
<thead>
<tr>
<th>Possible Etiology of IUGR</th>
<th>No. of cases (total 113)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIH (Pregnancy induced hypertension)</td>
<td>61</td>
</tr>
<tr>
<td>Failure of weight gain (malnutrition)</td>
<td>26</td>
</tr>
<tr>
<td>Mal-presentation</td>
<td>07</td>
</tr>
<tr>
<td>Placenta previa</td>
<td>03</td>
</tr>
<tr>
<td>Cardiac disease</td>
<td>01</td>
</tr>
<tr>
<td>Viral encephalitis</td>
<td>01</td>
</tr>
<tr>
<td>Idiopathic</td>
<td>14</td>
</tr>
</tbody>
</table>

Total no of cases are more as few patients have more than one causative factor.

In present study PIH is associated more commonly than any other factor followed by malnutrition.

### Doppler Study:

Uterine artery and umbilical artery Doppler velocimetry studies enable the assessment of utero-placental and feto-placental unit, fetal responses and adaptation to changes in intra uterine environment especially in middle cerebral artery. In this study 69% of IUGR fetuses have abnormal color Doppler flow indices in either uterine artery, umbilical artery or middle cerebral artery.

### Table 2

| Abnormal Doppler Flow in Relation with Oligohydramnios (AFI < 5 cm) (n=100) |
|-------------------------------|--------------------------|
| AFI | Doppler |
| Normal (total 31) | Abnormal (total 69) |
| >5 | 24 (77.5%) | 28 (41.6%) |
| <5 | 07 (22.5%) | 41 (59.4%) |

About 59.4% of IUGR babies with abnormal Doppler flow indices have Oligohydramnios (AFI<5 cm) as associated ultrasound finding in contrast to 22.5% of IUGR babies with normal Doppler flow. This association is based on last trimester ultrasound monitoring with Doppler flow only.

### Table 3

| Doppler Indices and Route of Delivery (n=100) |
|-------------------------------|--------------------------|
| Doppler | Vaginal Route | Caesarean Section |
| Abnormal | 21 (30.4%) | 48 (69.6%) | 69 |
| Normal | 16 (51.6%) | 15 (48.4%) | 31 |
| Total | 37 | 63 | 100 |

($\chi^2=4.11, p<0.05$) (Statistically significant)
69.6% of IUGR fetuses having abnormal Doppler flow were delivered by caesarean section, remaining 30.4% (21) delivered vaginally. Out of which 3 had intrauterine death, 3 babies expired in NICU so yielding only 15 viable fetuses through vaginal route in IUGR babies with abnormal Doppler flow i.e.21.7%.

These results are comparable with Lakhakar et al, showing 62% of caesarean rate in abnormal Doppler flow and 38% vaginal birth in their study. As immediate delivery is must in patients with severely compromised fetus in utero, the incidence of operative intervention is higher in this group. Approximately 51.6% of IUGR babies with normal Doppler flow delivered vaginally and 48.4% delivered by caesarean section for IUGR with associated obstetric indication.

13% of pregnancies with abnormal Doppler flow ended in the form of fetal demise compared to normal Doppler flow, where fetal demise is 3.2%. Thus Doppler plays a crucial role in reducing perinatal mortality if timely decision is taken.

### Table 4
Comparison of Uterine artery, Umbilical artery and Middle Cerebral artery abnormal flow indices with perinatal outcome

<table>
<thead>
<tr>
<th>Perinatal outcome</th>
<th>Abn UT A flow n=44</th>
<th>% Abn UT A flow</th>
<th>Abn UmA flow n=59</th>
<th>% Abn UmA flow</th>
<th>Abn MCA flow n=61</th>
<th>% Abn MCA flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live</td>
<td>15</td>
<td>34.1</td>
<td>20</td>
<td>33.9</td>
<td>23</td>
<td>37.7</td>
</tr>
<tr>
<td>NICU admitted and discharged</td>
<td>24</td>
<td>54.5</td>
<td>30</td>
<td>50.8</td>
<td>32</td>
<td>52.5</td>
</tr>
<tr>
<td>NICU expired</td>
<td>04</td>
<td>9.1</td>
<td>06</td>
<td>10.6</td>
<td>03</td>
<td>4.9</td>
</tr>
<tr>
<td>IUD</td>
<td>01</td>
<td>2.3</td>
<td>03</td>
<td>5.1</td>
<td>03</td>
<td>4.9</td>
</tr>
</tbody>
</table>

[Abbreviations: abn: abnormal, UT A: uterine artery, UmA: Umbilical artery, IUD: Intra uterine death]

It is obvious that abnormal flow in uterine artery is responsible for 63.6% of NICU admissions while umbilical artery abnormal flow and middle cerebral artery abnormal flow is responsible for 61% and 57.4% NICU admission respectively, while perinatal mortality is around 15.6% with abnormal umbilical artery flow in contrast to uterine and idle cerebral artery flow is 11.4% and 9.8% respectively. Thus umbilical artery is a crucial component of fetal circulation and flow in umbilical artery serves better for fetal prognosis.

Perinatal Outcome associated with Abnormal Umbilical and MCA artery flow: Out of 69 IUGR babies with abnormal flow, 75.4% of these babies had abnormality in umbilical artery and middle cerebral artery flow which suggested brain sparing effect and lead to about 65.5% NICU admission and 13.5% perinatal deaths. Neonatal survival rate was 86% among them. All of the expired babies had birth weight <1.8 kg and 3 of them had meconium stained liquor and metabolic acidosis.

### Table 5
Perinatal outcome and absent / reverse end diastolic flow in umbilical artery (n=8)

<table>
<thead>
<tr>
<th>Perinatal Outcome</th>
<th>AEDV/ REDV Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live</td>
<td>04/ 50</td>
</tr>
<tr>
<td>Expired</td>
<td>04/ 50</td>
</tr>
<tr>
<td>Total</td>
<td>08/ 50</td>
</tr>
</tbody>
</table>

AEDV: Absent End Diastolic Volume  
REDV: Reversed End Diastolic Volume

Absent or reversed end diastolic flow is associated with adverse fetal outcome in 50% cases. It causes catastrophic increase in death of fetuses in utero and in early neonatal period. This finding is comparable to the study by Battaglia et al having 50% mortality with absent/reverse end diastolic flow.

### Table 6
Comparison of Diagnostic efficacy of umbilical artery Doppler Velocimetry in IUGR cases.

<table>
<thead>
<tr>
<th>Author</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dandolo Gramellini et al</td>
<td>64</td>
<td>90.7</td>
<td>72.7</td>
<td>86.7</td>
</tr>
<tr>
<td>Lakhakar et al</td>
<td>56</td>
<td>59</td>
<td>66.6</td>
<td>45.4</td>
</tr>
<tr>
<td>Present study</td>
<td>64.4</td>
<td>84.4</td>
<td>85.4</td>
<td>62.5</td>
</tr>
</tbody>
</table>

Perinatal mortality is significantly higher in birth weight <1.5 kg that was 58.3% while in >1.5 kg birth weight perinatal mortality was 3.4%. In 61 cases of IUGR babies had CPR<1 which lead to 60.5% NICU admission compared to 38.5% when CPR >1. CPR <1 is responsible for 14.7% perinatal death in contrast only 2.6% when CPR >1. This finding is compatible with Embrashy A. Azmy U. Ibrahim (2005) who showed that CPR<1 identifies new born at risk of increased morbidity.
Conclusions
Color Doppler is a useful mode to predict fetal outcome in IUGR. Color Doppler allows better understanding of hemodynamic changes in fetoplacental and utero-placental circulation associated with hypertensive pregnancies. As changes in uterine and umbilical artery circulation strongly correlate with pregnancy outcome, Doppler is a primary tool for feto-maternal surveillance in these pregnancies. State of umbilical artery is more predictive than that of uterine artery circulation in term of neonatal outcome. The cerebro-placental ratio (CPR), which measures the proportion of flow supplying the brain and placenta, is now the most powerful parameter for assessment of IUGR and hypoxia as firstly it takes into account the cause and consequences of placental insufficiency and secondly it is not heart rate dependent. Among the characteristics of umbilical artery Doppler waveform, end diastolic velocity is of primary clinical significance. There is an ominous association between AEDF/REDF in umbilical artery and adverse perinatal outcome. There is not only a high rate of perinatal loss, but the surviving fetus demonstrates signs of profound compromise. If umbilical and uterine Doppler indices are positive then the study should be extended to other fetal vessels also like ductus venosus and fetal aorta. Lots of study and research are still needed to be done in the potential field of IUGR and color Doppler to improve maternal and perinatal outcome.

References