EVALUATION OF THE DOPPLER ULTRASOUND FOETAL VESSELS PARAMETERS IN PREGNANCIES WITH SUSPECTED INTRAUTERINE GROWTH RETARDATION
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ABSTRACT

BACKGROUND
Intrauterine Growth Retardation (IUGR) is conveniently defined as foetal weight less than 10th percentile for gestational age. The term IUGR is often interchangeably used with Small for Gestational Age (SGA). Strictly speaking, not all IUGR foetuses are SGA. SGA foetuses comprise of a heterogeneous group that include foetuses with IUGR, foetuses with small constitution and foetuses with appropriate growth (misdiagnosed as small). Timely diagnosis of foetal compromise offers the best chance to reduce perinatal complications associated with IUGR.

MATERIALS AND METHODS
In the present study, 50 singleton pregnancies of more than 24 weeks of gestational age with estimated foetal weight less than 10th percentile for gestational age were included. Doppler ultrasound on foetal MCA, UA and TA were recorded the PI values obtained from each vessels and any end-diastolic flow changes were obtained. Pregnancies were followed up to termination and assessed the perinatal outcome in terms of gestational age at delivery, caesarean section for foetal distress, birth weight, admission to NICU and perinatal death.

RESULTS
The mean age of the mother was 26.02 years. On Doppler ultrasound study, 58% of the foetuses had some abnormality in the Doppler parameter, abnormal PI values from MCA in 19 cases; from the UA in 17 cases and from TA in 13 cases. Of the 29 foetuses born by cesarean section, 14 cases had abnormal MCA PI, 12 cases had abnormal UA PI, 11 cases had abnormal TA PI and 9 cases had cerebroplacental ratio less than 1.

CONCLUSION
Foetuses with an abnormal PI in MCA or UA or TA are at increased risk of adverse perinatal outcomes.

KEYWORDS
Doppler Ultrasound, Foetal Vessels Parameters, Intrauterine Growth Retardation.

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BACKGROUND
Intrauterine Growth Retardation (IUGR) is conveniently defined as foetal weight less than 10th percentile for gestational age.¹ The term IUGR is often interchangeably used with Small for Gestational Age (SGA). Strictly speaking, not all IUGR foetuses are SGA. SGA foetuses comprise of a heterogeneous group that include foetuses with IUGR, foetuses with small constitution and foetuses with appropriate growth (misdiagnosed as small).² A significant proportion of SGA infants will be constitutionally small and not at increased risk of adverse perinatal outcome. On the contrary, IUGR foetuses are at increased risk of hypoxaemia, acidemia and intrauterine foetal demise.³ The correct detection of compromised IUGR foetus for timely intervention is a main objective of antenatal care. The clinical methods include recognising the high-risk group, serial examination of symphyseal fundal height and abdominal girth.

Doppler ultrasound provides a noninvasive method for the study of foetal haemodynamics. Investigation of the uterine and umbilical arteries gives information on the perfusion of the uteroplacental and fetoplacental circulations respectively, while Doppler studies of selected foetal organs are valuable in detecting the haemodynamic rearrangements that occur in response to foetal hypoxaemia. Doppler ultrasound can detect uteroplacental insufficiency and even acid-base status of the foetus before any other test can do so.¹ Doppler abnormalities occur before abnormal findings on foetal heart rate monitoring of biophysical profile.³ Hence, the present study was conducted to determine the Pulsatility Index (PI) from each vessel and to assess perinatal
outcomes of the foetuses examined by following up the pregnancies up to termination.

MATERIALS AND METHODS
A prospective study was conducted at the Department of Radiology, Institute of Postgraduate Medical Education and Research (IPGME and R) and SSKM Hospital, Kolkata, between February 2008 and June 2009. Pregnant females referred from the Department of Gynaecology and Obstetrics, after clinical suspicion of IUGR were included for the present study once they met the inclusion criteria, i.e. singleton pregnancy, foetal gestational age of 24 weeks or more as confirmed by prior ultrasonography as early as possible and US-estimated foetal weight below the 10th percentile for gestational age or elevated ratio of Head Circumference (HC) to Abdominal Circumference (AC) more than 1.20. Those pregnancies with a documented major congenital or chromosomal abnormality or both were excluded from the present study. Systemic random sampling was done and every 5th case was included for the study after obtaining their written informed consent. Hence, during the study period, 50 cases that fulfilled the above-mentioned criteria were assessed. Detailed history was obtained using a structured pretested questionnaire. It was followed by physical examination and relevant laboratory investigations.

Study parameters included Doppler indices like Pulsatility Index (PI) values of the Umbilical Artery (UA), the Middle Cerebral Artery (MCA) and the descending Thoracic Aorta (TA) of the foetus and the ratio of the PI values of MCA to UA (cerebroplacental ratio). At first, B-mode ultrasound study was performed for measuring foetal biophysical parameters namely the Biparietal Diameter (BPD), HC, AC and Femur Length (FL). The average gestational age, Effective Foetal Weight (EFW), the percentile foetal weight and HC to AC ratio were calculated automatically in the machine. If the EFW at the time of examination was found to be less than 10th percentile for the gestational age calculated from the first trimester, US study for the particular pregnancy and/or HC to AC ratio was more than 1.20, some form of intrauterine growth retardation was present. Such foetuses were further evaluated by pulsed-wave Doppler examination of the selected foetal vessels. Pregnancies were followed up to termination by personal visit to ward, labour room, NICU and phone calls to the patients’ families. Any adverse perinatal outcome was noted as described above.

RESULTS
We performed foetal biometry of about 200 foetuses during the period and 50 foetuses fulfilled our inclusion criteria and were included into the study. All the 50 foetuses had estimated weight less than 10th percentile for the gestational age. Only 3 (6%) foetuses had HC to AC ratio more than 1.2.

| Maternal Health History |  |
|-------------------------|--|
| Age (year)              | 26.02 ± 5.18* |
| Parity                  | 0-3 |
| Gravida                 | 1-6 |

| Complication of pregnancy (no. of cases) | 20 (40) |

| Foetal Health History |  |
|-----------------------|--|
| GA at Doppler examination | 32.46 ± 2.86* |
| GA at delivery         | 34.80 ± 2.28 |

| US Biometry (No. of Foetuses) |  |
|------------------------------|--|
| Estimated weight <10th percentile | 50 (100) |
| HC:AC ratio >1.2              | 3 (6) |

Table 1. Characteristics of the Study Subjects and Foetuses Examined

The mean age of the mother was 26.02 years with a range of 18 to 40 years. 84% of the women were below 30 years of age.

| Age (Year) | 26.02 ± 5.18* |
| Parity (No. of Cases) |  |
| Nullipara | 25 (50) |
| Multipara  | 25 (50) |

| Gravida (No. of Cases) |  |
| Primigravida | 24 (48) |
| Multigravida  | 26 (52) |

Table 2. Details of Maternal Characteristics

Majority of the women (52%) were multigravida. Of them, 16% of the women had some preexisting illness, most commonly heart disease in 8% of cases. In 28% of the women, there was some significant past history. A past history of spontaneous abortion was the most common in 14% cases. A significant proportion (40%) of the women also had at least one pregnancy complication during the study period. We found oligohydramnios in 28% of cases.

| Clinical Age at US Examination (Weeks) |  |
| Average | 36.24 ± 2.82* |
| Range   | 27.0-39.7 |

| Gestational Age by US (Weeks) |  |
| Average | 32.46 ± 2.86* |
| Range   | 24.8-36.4 |

| Estimated Foetal Weight by US Biometry (g) |  |
| Average | 1980.34 ± 532.56* |
| Range   | 757-2867 |

| EFW >3rd to <10th percentile (no. of cases) | 28 (56) |
| EFW ≤3rd percentile (no. of cases)        | 22 (44) |

| HC:AC Ratio |  |
|-------------|--|
| Average     | 1.10 ± 0.06* |
| Ratio >1.2  | 3 (6) |
| Ratio <1.2  | 47 (94) |

Table 3. Details of Foetal Characteristics
Mean foetal gestational age during the time of Doppler ultrasound examination was 32.5 weeks. This lagged by about 3.5 weeks behind the mean clinical age calculated from the Last Menstrual Period (LMP) or from report of prior ultrasound examination. The estimated foetal weight was less than 10\textsuperscript{th} percentile in all the cases. It was less than 3\textsuperscript{rd} percentile in 44% cases. The mean estimated foetal weight was 1980 g.

| PI Values |       |
|-----------|-------|
| UA        | 1.25 ± 0.42* |
| MCA       | 1.52 ± 0.42* |
| TA        | 2.03 ± 0.37* |

| Abnormal PI (No. of Cases) |       |
|----------------------------|-------|
| UA (>2 SD)                 | 17 (34) |
| MCA (<2 SD)                | 19 (38) |
| TA (>2 SD)                 | 13 (26) |

| Distribution of Changes |       |
|-------------------------|-------|
| Only UA                 | 5 (10) |
| Only MCA                | 7 (14) |
| Only TA                 | 1 (2)  |
| UA + MCA                | 4 (8)  |
| MCA + TA                | 4 (8)  |
| UA + TA                 | 4 (8)  |
| UA + MCA + TA           | 4 (8)  |
| Total                   | 29 (58) |

Table 4. Distribution of US Doppler Parameters Among the Study Subjects

On Doppler ultrasound study, 58% of the foetuses had some abnormality in the Doppler parameter. Distribution of the PI abnormalities is detailed in Table 4. We found abnormal PI values from MCA in 19 cases (65% of the total abnormalities) from the UA in 17 cases (58% of the total abnormalities) and from TA in 13 cases (45% of the total abnormalities). In 13 cases (45% of the total abnormalities), the cerebroplacental ratio was also abnormal (i.e. less than 1). In 16 cases, there were abnormalities in more than one vessel. Abnormal PI values were obtained from both MCA and UA; MCA and TA; UA and TA in 4 cases each. In another 4 cases, there were abnormalities in all the three vessels. Isolated abnormality in the MCA, UA and TA was present in 7, 5 and 1 cases, respectively.

| Gestational age at delivery (weeks) | 34.80 ± 2.28 |
|-------------------------------------|--------------|
| Birth Weight (BW)                   | 2271.43 ± 370.22* |
| BW <2500 g (no. of cases)           | 34 (68) |
| Normal delivery                     | 17 (34) |
| CS for foetal distress              | 29 (58) |
| Admission to NICU                   | 20 (40) |
| Only CS                             | 12 (24) |
| Only admission to NICU              | 3 (6)  |
| CS + NICU                           | 17 (34) |
| IUFD                                | 4 (8)  |
| Perinatal death                     | 1 (2)  |

Table 5. Distribution of Perinatal Outcome Among the Study Subjects

DISCUSSION
The demographic characteristics of the present study suggest that IUGR is more common in multigravida women. Majority of the women (84%) were below 30 years of age. This does not seem to be significant because all the women above 30 years of age were multigravida except one. In fact, one woman aged 35 years was in her sixth gravida during our study. There was preexisting maternal illness in 16% cases, a significant past history in 28% of cases and a pregnancy-related complication in 40% cases. These cases represent the “at risk” group in developing IUGR described in the literature. These findings correlate well with the studies on IUGR. In a study of 172 women at risk of developing IUGR, Berkowitz et al\textsuperscript{e} found a mean maternal age of 27.1 years in the abnormal group (26.02 years in our study). They also found maternal medical complications associated with IUGR including hypertension were present in 35% of cases (40% in our study). Oligohydramnios was also present in 35% cases (28% in our study). The detailed demographic characteristics in IUGR has been studied by others, but is not discussed further, because this was not the primary goal of our study.

On performing Doppler ultrasound study, we obtained abnormal PI values from 58% of cases. The most common vessel to show abnormal PI was the MCA (38% of cases showing abnormal PI). In comparison, abnormalities in the UA, TA and cerebroplacental ratio was present in 34%, 26% and 26% cases, respectively. In a study of 293 cases, Fong KW et al\textsuperscript{f} obtained Doppler abnormalities from MCA in 49% cases from UA in 21% cases and an abnormal cerebroplacental ratio in 27% cases. In a study of 123 high-risk pregnancies with a known outcome, Harrington et al\textsuperscript{g} observed that the MCA and UA PI values showed the greatest deviation for any single-velocity parameter. So, our finding that the MCA is the most common artery to show Doppler abnormality in IUGR is being supported.

The most common Doppler abnormality noted was a decrease in End-Diastolic Flow (EDF) in the UA and resultant increase in the PI value (17/50=34% of cases). The reported incidence of abnormal PI in UA varies from 9% in the study by Malhotra N et al\textsuperscript{h} to 21% in the study by Fong KW et al\textsuperscript{i}. In a large retrospective cohort study of 7645 pregnancies, Figueras F et al\textsuperscript{j} found that of the 369 SGA foetuses that had been identified antenatally, 70 (19%) had an abnormal umbilical artery Doppler. This suggests that the incidence of abnormal PI in UA was high in our study.

The decreased PI in the MCA was associated with increased PI in the UA in 5 cases, TA in 1 case and both UA and TA in 4 cases. These cases represent the “redistribution” of blood flow to the more important organ, i.e. the brain from less important organs, e.g. mesentery and periphery. Hershkovitz R et al\textsuperscript{k} studied 47 IUGR foetuses and compared the PI values of MCA to that of UA. 16 (34%) foetuses demonstrated MCA redistribution of which 9 (56%) had normal UA Doppler waveforms. They concluded that redistribution may occur in the presence of normal umbilical artery. This statement also applies to our study, because out
of the 15 cases showing decreased PI in MCA, the UA waveform was normal in 10 cases.

The relationship between the cerebral redistribution and increased impedance in blood flow in the umbilical artery and thoracic aorta can be defined using the ratio of MCA PI to UA PI and MCA PI to TA PI, respectively. In our study, the cerebroplacental ratio (MCA PI:UA PI) was abnormal in 13 (26%) cases. This agrees well with the quoted incidence of 27% for abnormal cerebroplacental ratio in the study by Fong KW et al. Harrington et al. in their study observed that the ratio of Doppler indices (MCA/UA PI ratio and MCA/TA PI ratio) demonstrated greatest deviation from normal range than any individual vessel, though in our study, increased PI in UA was the most common finding.

CONCLUSION

Foetuses with an abnormal PI in MCA or UA or TA are at increased risk of adverse perinatal outcomes. An abnormal cerebroplacental ratio is maximally associated with adverse perinatal outcomes than abnormal PI in any individual vessel.

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