



Original Article

Maternal Risk Factors and Imaging findings in Intrauterine Growth Restriction

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Abstract

Introduction: Intrauterine growth restriction (IUGR) designates a fetus that has not reached its growth potential because of genetic or environmental factors. The present study was conducted to assess the maternal risk factors leading to IUGR and the role of ultrasonography and Doppler findings in detecting IUGR in pregnant females presenting to our hospital.

Methodology: The present prospective study at a tertiary care hospital included 50 pregnant females with foetal growth restriction. Data such as demographic information, correct gestational age, parity, estimated fetal weight, ultrasound and Doppler findings were noted. Anthropometric measurements on ultrasonography were compared against the standard values suggested by Hadlock et al at different gestational periods.

Results: The most common risk factor for IUGR was pre-eclampsia (42%). Anaemia was present in 20% of the cases and no risk factor could be detected in 14% of the cases. Majority of the case had asymmetric growth restriction (84%) and 70% of the placenta on gross examination revealed calcifications. Approximately two thirds of the cases had amniotic fluid index between 7 to 9 cm and fundal height and abdominal girth was decreased in 82% of the cases each. Most common Doppler finding was bilateral or ipsilateral diastolic notches in uterine artery (34%). Mean BPD, AC and FL were found to be lower among our cases as compared to Hadlock's standard values among cases of different gestational age.

Conclusions: Ultrasonography and Doppler studies can help in the timely detection of IUGR so that an obstetrician can plan the management accordingly.

Keywords: Doppler; fetal growth; Intrauterine growth restriction; ultrasonography.

Introduction

Intrauterine growth restriction (IUGR) is the term used to designate a fetus that has not reached its growth potential because of genetic or environmental factors. It may be caused by fetal, placental, or maternal factors, with significant

overlap among these entities. A recent population-based study confirmed that IUGR is the single largest risk factor for stillbirth, increasing the stillbirth rate fourfold compared to pregnancies with normally grown fetuses; antenatal non-detection further increases the rate by a factor of

two.¹A Cochrane review concluded that an early antenatal detection, choosing the optimal time and method of delivery, and treatment where appropriate could reduce the risks significantly.² Therefore, part of obstetrician's job is to determine the causes and severity of IUGR, counsel the parents, consult with neonatal colleagues, closely monitor fetal growth and well-being, and select the appropriate time for and route of delivery. Ultrasonography and umbilical artery Doppler examination is the most valuable tool regarding the prediction of perinatal outcome in growth-restricted fetuses and is accepted as the primary assessment tool regarding diagnosis of IUGR.³ The present study was conducted to assess the maternal risk factors leading to IUGR and the role of ultrasonography and Doppler findings in detecting IUGR in pregnant females presenting to our hospital.

Methodology

Study Design and Sampling: The present prospective study was conducted at a tertiary care hospital over a period of two years. Fifty booked, unbooked or referred high risk cases with gestation age of more than 28 weeks with singleton pregnancies with foetal growth restriction were included in the study. Only those cases were included who were sure of their last menstrual period, calculated by Naegle's formula and confirmed by atleast one first trimester ultrasound. Cases with unsure dates, irregular menstrual cycles, history of consumption of oral contraceptive pills within three months of conception and those with multiple pregnancies were excluded from the study.

Classifying IUGR: Antenatally IUGR was diagnosed by abdominal palpation in the outpatient department. Fundal height was measured by tape calibrated in centimetres applied over the abdominal curvature from the upper edge of the symphysis to the upper edge of the uterine fundus, which was identified by palpation. The tape was applied with the markings away from the examiner to avoid bias. If the measurement was

found to be 2 to 3 cm less from the expected height, inappropriate foetal growth was suspected and the patients were admitted. However, even carefully performed fundal height measurements only have a 26 to 76% sensitivity in predicting IUGR. Hence, patients with normal fundal height clinically but with features of IUGR on ultrasonography were also included in the study.

Each patient depending on various parameters was grouped into four categories i.e patients with Normal foetal growth, Mild IUGR, Moderate IUGR and Severe IUGR.

1. Normal growth
 - a. Rate of growth of fundal height more than 1-2cm per week.
 - b. No discrepancy between mean gestational age by ultrasound and by LMP and Normal Doppler findings.
2. Mild IUGR
 - a. Rate of growth of fundal height was 1-2 cm per week.
 - b. A lag of 3 weeks between the mean gestational age by ultrasound and LMP
 - c. Increased S/D ratio in umbilical artery Or bilateral/ipsilateral diastolic notch in uterine artery on Doppler study
3. Moderate IUGR
 - a. Rate of growth of fundal height was 1cm per week.
 - b. A lag of 3-6 weeks between the mean gestational age by ultrasound and LMP
 - c. Decreased S/D ratio in foetal middle cerebral artery or increased s/d ratio in uterine artery on Doppler study.
4. Severe IUGR
 - a. Rate of growth of fundal height was less than 1cm per week or no growth
 - b. A lag of more than 6 weeks between the mean gestational age by ultrasound and LMP
 - c. Absent or Reversal of diastolic flow in umbilical Artery on Doppler study.

Data Collection and Data Analysis

Using a predesigned semi-structured study proforma, data such as maternal age, residential

area, whether booked, unbooked or referred, correct gestational age, parity, estimated foetal weight, ultrasound and Doppler findings were noted. Routine antenatal investigations like blood group, Haemoglobin, viral markers, TORCH titres were ordered for the patients. Any significant medical or obstetric history/ complication was noted as well. Anthropometric measurements on ultrasonography like biparietal diameter, abdominal circumference and femoral length were compared against the standard values suggested by Hadlock et al at different gestational periods.⁴ Data were compiled and presented as frequency distribution for qualitative variables and mean and standard deviation for quantitative variables.

Results

In the present study 74% of the patients were aged less than 25 years and 44% of the cases were primigravida, 40% were gravida 2 and rest were gravida 3 or above (Table 1). The most common risk factor for IUGR in our study population was pre-eclampsia (42%). Anaemia was present in 20% of the cases and no risk factor could be

detected in 14% of the cases. Majority of the case had asymmetric growth restriction (84%) and 70% of the placenta on gross examination revealed calcifications. Approximately two thirds of the cases had amniotic fluid index between 7 to 9 cm (Table 2). Fundal height and abdominal girth was decreased in 82% of the cases each. Ratio of femoral length to abdominal circumference and head circumference to abdominal circumference was increased (> 24) in 98% and 84% of the cases respectively. Doppler studies revealed that 4% of the cases had absent diastolic flow in umbilical artery, 2% had reversal of flow in the umbilical artery, 34% had bilateral or ipsilateral diastolic notches in uterine artery, 6% showed increase in umbilical artery S/D ratio, 28% had increased flow in fetal middle cerebral artery and 24% had increased S/D ratio in uterine artery. Biparietal diameters were below the 10th percentile as compared to the Hadlock's standard values (Table 3). Similarly, abdominal circumferences and femoral lengths were found to be lower among our cases as compared to Hadlock's standard values among cases of different gestational age.

Table 1 Baseline characteristics of the study participants

Variables	N (%)
Distribution according to age (in years)	
< 20	20 (40%)
21 to 25	17 (34%)
26 to 30	10 (20%)
> 30	03 (06%)
Distribution according to parity	
1	22 (44%)
2	20 (40%)
≥ 3	08 (16%)
Maternal past medical history relevant to IUGR	
Pre-eclampsia	21 (42%)
Anemia	10 (20%)
Idiopathic	07 (14%)
History of first trimester bleeding	03 (06%)
Placenta previa	01 (02%)
Diabetes mellitus	03 (06%)
Abruptio placenta	02 (04%)
History of previous IUGR	03 (06%)
Type of Intrauterine growth retardation	
Asymmetric	42 (84%)
Symmetric	08 (16%)
Placenta on gross examination	
Small contracted	01 (02%)
Infarction	14 (28%)
Calcification	35 (70%)

Table 2 Findings of various investigations performed

Variables	N (%)
Amniotic fluid index (in cm)	
1 to 3	02 (04%)
4 to 6	09 (18%)
7 to 9	32 (64%)
> 9	07 (14%)
Distribution according to fundal height	
Normal fundal height	09 (18%)
Decreased fundal height	41 (82%)
Distribution according to abdominal girth	
Normal abdominal girth	09 (18%)
Decreased abdominal girth	41 (82%)
Femoral Length- Abdominal Circumference ratio (FL/AC)	
Normal ($\leq 22 \pm 2$)	01 (02%)
Increased (> 24)	49 (98%)
Head Circumference- Abdominal Circumference Ratio (HC/AC)	
Normal (≤ 1)	08 (16%)
Increased (> 1)	42 (84%)
Doppler findings	
Normal study (F)	01 (02%)
Increased S/D ratio in umbilical artery (A)	03 (06%)
Bilateral/ipsilateral diastolic notch in uterine artery (B)	17 (34%)
Absent diastolic flow in umbilical artery (C)	02 (04%)
Reversal of flow in umbilical artery (D)	01 (02%)
Decreased S/D ratio in fetal middle cerebral artery(D)	14 (28%)
Increased S/D ratio in uterine artery(G)	12 (24%)

Table 3 Ultrasonography measurements of biparietal diameter, abdominal circumference and femoral length

Weeks of gestation	N	Biparietal Diameter (in mm)		Abdominal circumference (in mm)		Femoral length (in mm)	
		Hadlock's standard	Present study	Hadlock's standard	Present study	Hadlock's standard	Present study
28 to 32	02	78	74.10	280	240.30	63	56.72
33 to 36	24	83	79.94	320	266.25	71	60.39
37 to 40	22	88	83.12	360	279.57	79	67.87
> 40	02	95	86.03	380	298.18	80	69.18

Discussion

Among 50 pregnant females included in the present study, 40% were below the age of 20 years and 44% were primipara. The most common maternal risk factor observed in the present study population was pre-eclampsia (42%). The association of IUGR and preeclampsia is well known. Preeclampsia is characterized by primary failure of trophoblast invasion of the spiral arteries leading to failure of dilatation of these vessels, acute atherosclerosis, occlusion, and infarction. General understanding is that the preeclampsia has its cause in abnormal vascular development of the placenta, which then leads to systemic maternal endothelial effects and clinical manifestations of

the disease.⁵ Preeclampsia is characterized by the abnormally shallow extravillous trophoblastic invasion and spiral artery remodeling that is therefore restrictive in their proximal part. After the incomplete modification of the spiral arteries by EVT they keep the ability to contract in their myometrial part. Phases of contraction followed by relaxation lead to cycles of hypoxia-reoxygenation within placenta.⁶

We also found anemia to be the second most commonly observed maternal risk factor for causing IUGR. During pregnancy, hemodilution also affects maternal hemoglobin measures. Plasma volume expands to facilitate utero-placental circulation, and proper expansion has

been associated with better pregnancy outcomes.⁷ Multiple studies reported a U-shaped relationship between maternal hemoglobin and preterm birth and low birthweight, respectively.⁸ A separate meta-analysis found maternal anemia determined in the first and second trimesters significantly associated with preterm birth [OR = 1.32 (95% CI: 1.01–1.74)] but not with low birth weight.⁹ The author also found no association between haemoglobin and IUGR; however, it only included 3 studies. There are some plausible biological mechanisms linking maternal anemia to IUGR. Low hemoglobin levels restrict oxygen circulation in the body, creating an environment of oxidative stress or chronic hypoxia, which could then cause fetal growth restriction. Another possible mechanism with iron deficiency anemia is that iron deficiency causes an increased production of norepinephrine, which then stimulates production of corticotropin-releasing hormone and in turn possibly restricts fetal growth.¹⁰ In developing countries, a majority of low birthweight outcomes can be attributed to IUGR, and low birth weight is associated with ~60–80% of neonatal deaths in those regions.¹¹ Ultrasonography revealed that biparietal diameter, abdominal circumference and femoral length in our study population was lower as compared to the Hadlock's standard values. Similar observations were made by Lee et al, who found that abdominal circumference and estimated fetal weight (EFW) accounted for only 24.8% and 30.4% of the variance in %body fat of the neonate, respectively.

The use of Doppler ultrasound to investigate the pattern of waveforms in the umbilical artery during pregnancy was first reported in 1977 from Dublin.¹² The indices are calculated as ratios between peak systolic velocity (A), end-diastolic peak velocity (B) and mean velocity. The most common in clinical practice are pulsatility index (PI = (A - B)/mean) and resistant index (RI = (A - B)/A).¹³ We observed bilateral/ipsilateral diastolic notch in uterine artery to be the most common Doppler finding in our study population (34%).

Decreased S/D ratio in fetal middle cerebral artery and increased S/D ratio in uterine artery were other common Doppler findings in our study. Nagar et al found 40 patients had IUGR babies, which was predicted by abnormal uterine artery Doppler in 25 cases with a sensitivity of 37.5%, 25% and 50% for S/D ratio, RI, and notch, respectively.¹⁴ Velauthar et al did meta-analysis (18 studies of 55,974 women) and found that the sensitivities of abnormal uterine artery Doppler for predicting preeclampsia and fetal growth restriction were 26.4% and 15.4%, respectively, and specificities were 93.4% and 93.3%, respectively.¹⁵ However, caution should be used against relying solely on the presence of a notch in the uterine artery Doppler waveform to define an abnormal uterine circulation given the subjectivity involved in its identification.

Conclusion

The results of our study show that maternal conditions such as pregnancy induced hypertension, anemia, diabetes, placenta previa and abruptio placenta are important risk factors for IUGR. In addition, ultrasonography measurement of biparietal diameter, head circumference and abdominal circumference aid in prenatal diagnosis and Doppler findings serve as sensitive tool for diagnosis of IUGR.

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