ROLE OF REAL TIME ULTRASOUND AND DOPPLER STUDY OF UMBILICAL ARTERY IN EVALUATION OF INTRAUTERINE GROWTH RETARDATION

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ABSTRACT

This one-year prospective study was carried out at a tertiary care hospital in Ludhiana, Punjab, on patients visiting antenatal OPD (Outpatient Department) in the third trimester with clinical suspicion of IUGR (Intrauterine Growth Retardation) by using high resolution Doppler ultrasound scanner, Model EUB-450, Hitachi. The objective of this study was to evaluate the role of ultrasound in detection of intrauterine growth retardation and to assess and compare different parameters in order to determine best ultrasonic parameter to assess IUGR. The patients included were studied under two groups: Test group of patients suspected to have IUGR on obstetrical examination (n=75) and control group of 148 subjects showing signs of normal foetal development, i.e. not suspected to have IUGR clinically. Four parameters were taken into account namely the Abdominal Circumference (AC), ratio of AC and head circumference (HC:AC), ratio of AC and femur length (FL:AC) and umbilical artery systolic to diastolic ratio (S:D). The sensitivity of ultrasound in detecting IUGR was 86.9%. Umbilical artery flow velocimetry correctly identified 24 of 46 IUGR infants, but on no occasion did this technique detect IUGR, otherwise missed by real time sonography. The sensitivity and specificity of all the four parameters can be summarized as: AC -82.6% and 89.6%, HC: AC -50% and 86.2%, FL:AC -47.8% and 82.7% and umbilical artery S:D ratio - 52.1% and 93.1%. Five patients showed absent diastolic flow and three patients showed reversal of diastolic flow. None of the fetus survived in whom there was reversal of flow. We conclude that sonography is a safe, reliable, non-invasive tool in assessment and management of suspected IUGR at or beyond 32 weeks of gestation for obstetrician and the neonatologist.

KEYWORDS

IUGR, Umbilical Artery Flow Velocimetry.

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INTRODUCTION

Sonographic assessment of foetal growth and development has been one of the stable and reliable tools, especially in cases where foetal growth retardation (IUGR) has been suspected. It gives valuable information regarding foetal biometry and foetal circulation using various modes, which have been extensively used by the radiologists in the last decade. With the advent of newer advances in imaging and Doppler along with development of many available software, which collate the digital images and measure various parameters translating it in an easy presentation, the assessment of IUGR has taken new dimension and refined the objectivity of the maternal, placental, foetal and circulatory parameters. It may not be purely because of our ability to better visualise and diagnose decelerations and foetal growth that has led to increased documentation and available data on IUGR in the last two decades but may also be due to several changes in the environment, lifestyle, dietary habits, medications or genetic factors which have contributed to increased incidence of reported IUGR. Over the last three decades, the definition of IUGR has been changing and is generally defined as an Estimated Foetal Weight (EFW); at one point in time during pregnancy found equal to or below the 10th percentile for gestational age.⁽¹⁾ However, few authors define the term IUGR

when foetal biometric parameters fall under the 5th percentile or fall below two standard deviations.⁽²⁾ Many authors use this definition synonymous with the term Small for Gestational Age (SGA) in infants where their birth weight measures less than 3% to 10% using standard growth curves.⁽³⁾ IUGR may arise from a variety of causes including placental insufficiency, maternal diseases and foetal anomalies. It is associated with stillbirth, neonatal death and perinatal morbidity as well as delayed effects including Cerebral Palsy (CP) and adult diseases.⁽⁴⁻⁶⁾ Sonographic evaluation divides the IUGR into two main types. Type I: In which foetus is observed to be having symmetrical intrauterine growth restriction and Type II: Where asymmetrical intrauterine growth restriction is noted. A third type is also documented by some authors, which is termed as femur sparing intrauterine growth restriction.⁽⁷⁾ If foetal growth is impaired during the first or second trimester, the infant will have symmetric growth restriction. This proportional lack of growth is caused by reduced foetal cellular proliferation of all organs and occurs in approximately 20% to 30% of IUGR infants.⁽⁸⁾ In contrast, asymmetric growth retardation is one in which an infant has a smaller abdominal size compared to head size and generally occurs if the decrease in growth velocity happens in the last trimester. This head-sparing phenomenon is the most common form of IUGR (~70%-80%)⁽⁸⁾ and is attributed to the ability of the foetus to adapt, redistributing its cardiac output to the spleen, adrenal, coronary and cerebral circulations. The early identification of IUGR and evaluation of anticipated problems in such foetuses forms one of the main objectives of antenatal care. The detection of IUGR by clinical means alone is subjective and prone to wide margin of error. Use of ultrasonography helps to eliminate these errors and establish the diagnosis of IUGR objectively.

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AIMS

1. To evaluate the role of ultrasound in detection of intrauterine growth retardation.
2. To assess and compare the different parameters in order to determine which is the best ultrasonic parameter to detect intrauterine growth retardation.

MATERIALS AND METHODS

This one-year prospective study was done on patients visiting antenatal OPD in a tertiary care hospital in Punjab presenting in the third trimester with clinical suspicion of IUGR. The patients included were studied under two groups: Test group which comprised of patients suspected of having intrauterine growth retardation on obstetrical examination (n=75) and control group of 148 subjects showing signs of normal foetal development, i.e. not suspected to have IUGR clinically.

Control Group (n=148) Criteria for Inclusion in this Group were:

1. Those who were sure of last menstrual period.
2. Those who have had history of regular menstrual cycles. All patients underwent routine history documentation, systemic examination and obstetrical assessment. All stable patients having consented to be part of the study were referred to Radiology Department for ultrasonographic examination.

Following Categories of Patients were excluded from the Test Group

1. Patients who came in active uterine contractions or labour.
2. Multiple pregnancy.
3. Gestational age less than 32 weeks.

Seventeen cases with normal pregnancy in each gestational week from 32 to 40 weeks of gestational were selected at random for ultrasonographic examination.

Those normal patients having multiple gestations, clinically suspected to have small or large for date's babies and those not sure of their last menstrual period were not included in this group. All ultrasound examinations were performed on the high resolution Doppler ultrasound scanner, Model EUB-450, Hitachi in the test group and normal group.

Confirmation of IUGR was done after taking the birth weight and examination of the neonate after the delivery.

Test Group

Morphometric measurements of head circumference, abdominal circumference and femur length was made by using the real time scanning equipment. Umbilical artery flow velocity waveform was analysed by using the pulsed wave Doppler.

Following Four Parameters were determined

1. Ratio of head-to-abdominal circumference.
2. Ratio of femur length-to-abdominal circumference.
3. Abdominal circumference.
4. Umbilical artery Systolic/Diastolic (S/D) ratio.

Following Cut-Off Levels were used to define an Abnormal Test

1. Value below 2 S.D (Standard deviation) for abdominal circumference than the mean for that gestational age.

2. Femur length-to-abdominal circumference ratio above 23.5%.
3. Head circumference to abdominal circumference ratio more than 2 S.D. above the mean for gestational age.
4. Umbilical artery S/D ratio above 3.

Repeat sonographic examination was conducted in 18 patients.

Normal Group

Head circumference and abdominal circumference measurements were made by using the real time scanning equipment. The mean value and standard deviation for the abdominal circumference and the ratio of head circumference to abdominal circumference were calculated in this group. Confirmation of intrauterine growth retardation was done after taking the birth weight and examination of neonate.

Ultrasound Measurements

Head Circumference: It was made by taking an axial section of foetal head in which falx cerebri, cavum septum pellucidum, thalamus or cerebral peduncles were included.

Abdominal Circumference

The lie and the angle of the foetal abdomen was initially determined and appropriate transverse sections were made at the level of the liver having a portion of the umbilical vein or at the level of the gas bubble in the fundus of the stomach perpendicular to the foetal spine. Abdominal circumference was taken from outer to outer margin of echoes.

Femur Length

Femur length was measured after taking the long axis view of linear ossified shaft (Diaphysis) of femur. The both ends of the calcified diaphyseal portion of the femur was defined. The measurement was made from one end to the other end of the diaphysis and the distal femoral epiphysis were not included in the measurement.

Umbilical Artery Flow Velocity Waveform

Umbilical artery flow velocity waveform were analysed by using the pulsed wave Doppler. The location of the umbilical cord was determined by a real time ultrasound scanner and the Doppler transducer was aimed in the direction of umbilical cord. The readings for analysis were accepted only after obtaining a steady state of at least five consecutive pulsatile arterial wave forms. The umbilical flow velocity waveform was characterized by the ratio of peak systolic to end diastolic frequencies (S/D ratio). No waveforms were obtained during periods of foetal breathing movements or body movements.

RESULTS**Normal Group**

Seventeen cases with clinically normally progressing pregnancies in each gestational week from 32 to 40 weeks were selected randomly for ultrasonographic measurements of foetal growth and development in utero. A total of 148 cases were selected and in 143 cases sonographic examination was done once, whereas in 5 cases repeat ultrasonographic examination was also done at different gestational weeks to calculate the mean and standard deviation for abdominal circumference and ratio of head-to-abdominal circumference.

In this group, there was no clinical suspicion of small or large sized baby.

Period of Gestation in Weeks	No. of Cases	Abdominal Circumference	
		Mean±S.D.	-2. S.D.
32	17	278.0mm±13.28	251.4mm
33	17	284.5mm±14.35	255.8mm
34	17	293.7mm±16.75	260.2mm
35	17	297.4mm±17.14	263.1mm
36	17	310.8mm±13.85	283.1mm
37	17	320.6mm±15.46	289.6mm
38	17	331.8mm±17.45	296.9mm
39	17	335.7mm±16.93	301.8mm
40	17	344.0mm±15.19	313.6mm

Table I: Shows the Mean Abdominal Circumference, Standard Deviation and -2 S.D. related to Gestational Age from 32 to 40 Weeks

Period of Gestation in Weeks	No. of Cases	HC/AC Ratio	
		Mean± S.D.	+2. S.D.
32	17	1.061±0.039	1.139
33	17	1.050±0.0434	1.136
34	17	1.041±0.0404	1.121
35	17	1.031±0.036	1.103
36	17	1.021±0.040	1.101
37	17	1.010±0.0397	1.089
38	17	1.003±0.0321	1.067
39	17	0.994±0.0359	1.065
40	17	0.980±0.0398	1.059

Table II: Shows the Mean HC/AC Ratio, S.D. and +2 S.D. Related to Gestational Age from 32 to 40 Weeks in Normal Cases

Clinically suspected growth retardation group: This group consisted of 75 women clinically diagnosed to have IUGR in whom ultrasonographic evaluation was done after 32 weeks of gestation. In this group, maximum numbers of patients were between 21-24 years (45%) of age. This was followed by the age group 25-28 years (26%). There was only one patient at the age group of 38 years in the age group of 37-40 years. In this study, 32 cases (42%) were primigravida and 43 cases (58%) were multigravida and out of them 10 cases (13%) were grand multipara. In 22.66% of patients (17 cases), there was past obstetrical history of either IUGR or stillbirths. Various antenatal complications are found in the study group.

The predominant antenatal complication was pregnancy-induced hypertension, which was found in 27 (36%) patients and out of these 21 patients delivered SGA babies. Heart diseases were found in 5 patients and 2 patients delivered SGA babies. Anaemia was present in 3 cases and 2 cases delivered SGA babies. Enteric fever was found in one patient and she delivered SGA baby. Pyrexia of unknown origin was found in 2 patients and only one patient delivered SGA baby. Tuberculosis and cholestatic jaundice was found in one case each and both of them delivered AGA (Appropriate Gestational Age) baby. APH (Antepartum Haemorrhage) was found in one patient and she delivered SGA baby. Hyperemesis gravidarum was found in one patient and she delivered AGA baby. Maximum number of patients 13 (17.33%) were scanned at

the gestational age of 35 weeks, which is closely followed by 12 cases (16%) at the gestational age of 37 weeks. Repeat ultrasonographic examination was done in 18 patients. In only one patient, repeat ultrasound examination was done at 37 weeks of gestation revealed IUGR by showing abnormal parameters, whereas all the ultrasonographic parameters were normal at the gestation of 32 weeks.

Sonographic Examination

In 75 patients there was clinical diagnosis of IUGR; 46 patients had delivered IUGR babies; 29 patients had delivered AGA babies. Abdominal circumference was below 2 S.D. for that gestational age. Femur length-to-abdominal circumference ratio was above 23.5%. Head circumference to abdominal circumference ratio was more than 2 S.D. for that gestational age. Systolic-to-diastolic ratio of umbilical artery was above 3 (These cut-off levels were used to define an abnormal test result).

Ultrasonic Parameters	True Positive		False Negative	
	No.	% Age	No.	% Age
AC	38	82.6	8	17.3
FL/AC	22	47.8	24	52.1
HC/AC	23	50	23	50
S/D	24	52.1	22	47.8

Table III: Demonstrates the Results of Various Ultrasonic Parameters in 46 Gravidae who Delivered IUGR Babies

AC correctly identified 38 out of 46 fetuses, thereby having a sensitivity of 82.6%. Sensitivity of S/D ratio, HC/AC ratio and FL/AC ratio was 52.1%, 50% and 47.8% respectively. In one patient the umbilical artery S/D ratio and FL/AC ratio were abnormal, whereas HC/AC ratio and AC were within normal limits. Similarly, in another patient HC/AC and FL/AC ratio were abnormal, whereas AC and umbilical artery S/D ratio were normal. By combining all these parameters, ultrasound showed sensitivity of 86.9%. In two patient's antenatal diagnosis of renal agenesis were made. In one patient, antenatal diagnosis of duodenal atresia was made. The ultrasonic parameters (AC, FL/AC, HC/AC and S/D) were studied in 29 gravidae who delivered AGA babies. Among all these four parameters, umbilical artery had the highest specificity of 93.1% followed by specificity of AC-89.6%, HC/AC - 86.2% and FL/AC - 82.7%. In 8 cases extreme form of umbilical artery velocity wave form, i.e. absent or reversal of diastolic flow was seen. Only one case delivered AGA baby who had reversal of diastolic flow. Correlation between extreme forms of umbilical artery velocity waveform and perinatal outcome was seen and none of the foetus survived in whom there was reversal of diastolic flow. With absent diastolic flow stillbirth occurred in one patient only. The correlation between birth weight, gestation and perinatal outcome in patients who were having absent diastolic flow was also seen. Out of these five patients, three delivered SGA babies at the gestation of 35 weeks. In no patient birth weight was more than 1600 gms. Stillbirth occurred in one patient in whom renal agenesis was detected by ultrasound. But the diagnosis could not be confirmed as the parents of ill-fated baby refused for autopsy. The correlation between birth weight, gestation and perinatal outcome in patients who were having reversal of

diastolic flow was also studied. No foetus was survived with reversal of diastolic velocity component. Two patients were delivered SGA babies, while one patient was delivered AGA baby. Patient who delivered AGA baby was not sure of her LMP (Last menstrual period). IUD occurred in two patients, while neonatal death occurred in one patient.

DISCUSSION

Sonographic assessment and use of Doppler has been one of the tools for evaluation of IUGR for more than a decade. Different measurements and corresponding ratios have been used to establish correctly the diagnosis which helps the obstetrician and neonatologist to be prepared for the outcome. Previous studies have demonstrated that sonographically measured abdominal circumference has a high sensitivity for diagnosis IUGR. In the present study, AC correctly identified 82.6% of IUGR infants. Since it is measured from a section made at the level of umbilical vein and foetal liver, it is particularly appropriate in studies on IUGR as the foetal liver is the organ mostly affected in IUGR. AC is relatively close predictor of weight and IUGR is defined as the birth weight less than 100th percentile for that gestational age. The results are comparable with the results of other workers carried out in Western population.^(9,10)

A well-documented method of prenatal Doppler diagnoses of Intrauterine growth restriction has been described by Galan et al in 2002.⁽¹¹⁾ It was initially reported by Hadlock et al in 1983, as gestational age independent parameter.⁽¹²⁾ In this study, the sensitivity and specificity of FL/AC ratio is 47.8% and 82.7%, respectively. With the help of this parameter, 22 of 46 IUGR infants were correctly identified. Similarly using HC/AC ratio 23 of 46 IUGR infants were correctly identified, thereby showing the sensitivity and specificity of 50% and 86.2%. Adequate foetoplacental blood flow is essential for normal foetal growth. Animal research has suggested that increased placental resistance is associated with reduced umbilical blood flow and impaired foetal growth.⁽¹³⁾ But in this study, we got the sensitivity and specificity of S/D ratio as 52.1% and 93.1%. Our results differ widely with results of some workers, but correlates well with the results of the others. The variation in the results of some authors can be explained on the fact that placental insufficiency is commonly associated with asymmetrical growth retardation; Doppler velocimetry would be more likely to detect this category of IUGR.

CONCLUSION

Objective evaluation of foetal growth and well-being in the third trimester, which routinely includes umbilical Doppler assessment is indicated in scenarios where there is increased

risk of foetal growth restriction or poor perinatal outcome. Sonography serves as safe, reliable, non-invasive and cost effective method in assessment of suspected IUGR at or beyond 32 weeks of gestation and helps the obstetrician and the neonatologist to be prepared for the expected outcome of the gestation.

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