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Original Research Article

Comparison of ultrasound parameters for diagnosis of IUGR

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ABSTRACT

Background: An active approach to the diagnosis of IUGR should be undertaken so that the foetus can be closely monitored and when indicated, be promptly delivered.

Methods: Study was conducted at Department of Obstetrics and Gynaecology, Pushpagiri Institute of Medical Sciences, Thiruvalla. All pregnant women whose gestational ages were assessed by ultrasonography in 1st trimester was included in the study. An ultrasonographic biometric evaluation was done between 22-24 weeks and repeated at 32-34 weeks of gestational age and their ratios compared, using standard formulae.

Results: We have observed that at 22-24 weeks of gestational age abdominal circumference (AC) has a better sensitivity, specificity, NPV and PPV when compared with femur length (FL), head circumference (HC), FL/AC and HC/AC. AC has got lowest FP and FN with a highest accuracy rate of 83% as compared to FL, HC, FL/AC and HC/AC at 22-24 weeks of gestational age. At 32-34 weeks of gestational age AC remains better in sensitivity, specificity, NPV, PPV, FP and FN values as compared to FL, HC, FL/AC and HC/AC.

Conclusions: AC has a better sensitivity, specificity, NPV and PPV for diagnosis of IUGR when compared with FL, HC, FL/AC and HC/AC. AC has got lowest FP and FN with a highest accuracy rate at both 22-24 weeks of gestational age and 32-34 weeks of gestational age. The sensitivity, specificity and accuracy of AC is more at 32-34 weeks of gestation than at 22-24 weeks for diagnosis of IUGR.

Keywords: Abdominal circumference, Fetal growth restriction, IUGR, Ultrasound parameters

INTRODUCTION

A healthy new born is the goal of every expectant mother and her obstetrician. Ultrasound biometry of the fetus is now the gold standard for assessing the fetal growth.

The most commonly used parameters to evaluate fetal growth are biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL).

Fetal growth restriction (FGR)

FGR may be defined as pathological decrease in the rate of fetal growth. This ultimately results in a fetus, which

doesn't achieve its inherent growth potential, putting it at risk for increased perinatal morbidity and mortality.

One of the earliest investigations in the clinical importance of FGR occurred more than three decades ago, when Lubchenco et al first plotted neonatal birth weights against gestational age at delivery and revealed increased perinatal morbidity and mortality in infants with birth weights at or below the 10th percentile for gestational age.¹

The relationship between the size of the fetal abdominal circumference and the fetal head is used to characterize the pattern of FGR as being either symmetric/early onset FGR or asymmetric/late onset FGR.

Symmetric/type 1/early onset FGR

Symmetric growth restriction results from an early insult that impairs fetal cellular hyperplasia. They are at a risk for long term neurodevelopment dysfunction, resulting from deficit in the total number of brain cells.

Asymmetric/type 2/late onset FGR

Refers to the growth-restricted foetus, in which a disproportionate decrease in the size of the fetal abdomen with respect to the fetal head is seen. This pattern is called “head-sparing”. By contrast asymmetric FGR may be caused by a late insult that impairs cellular hypertrophy, which results from fetal nutritional deprivation in association with maternal malnutrition and placental insufficiency.

Reduced glucose delivery to fetus results in depletion of hepatic glucose and subcutaneous fat stores. This leads to earlier reduction in fetal abdominal circumference and later wasting of other fetal tissues. When FGR is caused by asphyxia or reduced uteroplacental blood flow, a redistribution of cardiac output occurs resulting in centralization of fetal circulation and preserving blood flow to the brain at the expense of the trunk.²

Seventy percent of patients with FGR may be classified as having an asymmetric growth pattern. Although these infants may be at a greater risk for perinatal hypoxia and neonatal hypoglycaemia their long-term prognosis with appropriate management is good.³

If a reliable antenatal means of distinguishing between the types of growth restriction could be found. It would help to rationalize some of the more recent therapeutic regimens designed to improve fetal growth (Bonner et al; Varman and Curzen) and would permit a more realistic appraisal of the short term and long-term risks of the small for dates foetus, thus helping to decide the optimal time for delivery.^{4,5}

Ultrasonography for IUGR

Methods of measurement

Head circumference (HC)

The HC can be measured directly by tracing along the outer margin of the calvarium using the ellipse method with the plane of section going through the third ventricle and thalami or indirectly by measuring the shortest and longest axes of the fetal head.

Abdominal circumference (AC)

Abdominal circumference (AC) circumference measurements of the fetal abdomen were obtained by the technique described by Campbell.⁶ In addition, section at the level of the umbilical vein and fetal liver would seem

to be particularly appropriate in studies on the small for date fetus, for the fetal liver is the most affected organ in asymmetrical growth restriction.

Femur length (FL)

The FL is measured in the axis of the femoral diaphysis and metaphysis. Ideally, the ultrasound beam is perpendicular to the shaft of the femur.

Review of clinical studies

The studies done by Warsof SLK et al, Channg TC et al and Ott WJ et al shows that abdominal circumference measurement has got better sensitivity, specificity and accuracy as compared to other parameters of diagnosis of fetal growth restriction.⁷⁻⁹

Campbell and Thomas A studied the mean head to abdomen (HC/AC) circumference ratio in 568 normal pregnancies from 17-41 weeks of gestational age and preferred fetal HC over BPD in determining the ratio between head and abdomen as BPD is only a single dimension of the head and was not a true representative of the total fetal head and brain size.¹⁰

Hadlock et al and Jeanty et al reported that the femur length/abdominal circumference ratio (FL/AC) is constant from 21 weeks gestational age to term in the normally growing fetus with a PPV of 70%.^{11,12} The same was concluded by Vintzileos.¹³

Divon studied the role of femur length/abdominal circumference ratio of ≥ 23.5 in identifying the small for gestational age fetus, reported a sensitivity and specificity of 55% and 90% respectively and a positive predictive value of 38% and NPV 55%, the results of which could be compared favourably with those reported by Hadlock et al.^{14,11}

METHODS

Inclusion criteria

- Pregnant women attending antenatal clinic regularly at our institute.
- Singleton pregnancy.
- Patient with reliable LMP or first trimester dating scan.

Exclusion criteria

- Patients with fetal anomalies.
- Unreliable gestational age.
- Multifetal gestation.

Present study was a prospective follow-up study conducted for a period of 1 year, which included follow-up of patients from 1st trimester to delivery.

Method of collection of data

All pregnant women attending antenatal clinic at our Institution, who fulfilled the inclusion and exclusion criteria and whose gestational ages were assessed by dating scan in 1st trimester or patient with reliable LMP were included in the study. An ultrasonographic biometric evaluation was done between 22-24 weeks and repeated at 32-34 weeks of gestational age and their ratios compared, using standard formulae. All the recruited cases after birth of child were assessed by the neonatologist for gestational age and growth restriction, which were compared with the antenatal diagnosis.

Machine details

LOGIQ 400 PRO series using 3.5 MHz convex probe.

Study size

100 patients were evaluated. They were from age group of 18 to 30 years. Out of that 37 patients were primigravida whereas 63 patients were multigravida.

RESULTS

At 22-24 weeks and at 32-34 weeks AC, HC, FL, FL/AC and HC/AC were measured by USG for diagnosis of FGR. If AC, HC and FL values were <10th percentile for that period of gestation, it was considered abnormal and the fetus was predicted to have IUGR.

The biometric ratios (FL/AC and HC/AC) were taken into consideration and if they were more than the cut-off value, the fetuses were suspected to have IUGR. The head to abdomen ratio was considered abnormal when it was >2 SD above the mean.¹⁵

Whereas femoral length to abdominal circumference ratio was evaluated as a predictor of intrauterine growth retardation using the 90th percentile (23.5) as the upper limit of normal.¹⁶ After birth, the babies were evaluated by the neonatologist and grouped into IUGR, AGA and LGA depending on the percentile of the birth weight.

The predicted growth of the fetus antenatally was compared with the neonatologist's findings.

Table 1: Diagnostic value of study parameters in relation to IUGR at (22-24) weeks.

Parameter	Diagnostic value in relation to IUGR						
	Sensitivity	Specificity	PPV	PNV	FN	FP	Accuracy
AC1	61.11%	87.80%	52.38%	91.13%	38.88%	12.19%	83%
FL1	50%	85.36%	42.84%	88.60%	50%	14.63%	9%
HC1	44.44%	84.14%	39.09%	87.34%	55.55%	15.85%	77%
FL1/AC1	38.88%	85.36%	36.84%	36.81%	61.1%	12.1%	77%
HC1/AC1	38.88%	87.80%	41.17%	86.74%	61.1%	12.19%	79%

Table 2: Mean pattern of study parameter according to estimated fetal age at 22-24 weeks.

Study parameters Mean±SD	Estimated fetal age			P value
	IUGR	AGA	LGA	
AC1	16.97±1.93	18.78±2.11	18.77±1.38	0.004*
FL1	3.94±0.47	4.15±0.48	4.20±0.20	0.206
HC1	20.10±2.25	21.37±1.61	21.28±1.32	0.023*
FL1/AC1	23.04±2.43	22.20±2.40	22.14±1.78	0.326
HC1/AC1	1.18±0.16	1.13±0.10	1.14±0.13	0.306

*P value significant

Table 3: Diagnostic value of study parameters in relation to IUGR at (32-34 weeks).

Parameter	Diagnostic value in relation to IUGR						
	Sensitivity	Specificity	PPV	PNV	FN	FP	Accuracy
AC2	94.44%	96.34%	85%	98.75%	5.5%	3.65%	96%
FL2	66.66%	95.12%	75%	95.12%	33.3%	4.87%	90%
HC2	61.11%	92.68%	64%	91.56%	38.88%	7.31%	87%
FL2/AC2	77.77%	95.12%	77%	95.12%	22.22%	4.87%	92%
HC2/AC2	61.11%	93.90%	68.75%	91.66%	38.82%	6.09%	88%

Table 4: Mean pattern of study parameter according to estimated fetal age at 32-34 weeks.

Study parameters mean± SD	Estimated fetal age			P value
	IUGR	AGA	LGA	
AC2	23.22±1.58	28.87±1.97	29.9±1.18	0.0*
FL2	5.83±0.45	6.36±0.34	6.48±0.28	0.0*
HC2	28.49±1.28	30.00±.08	30.44±0.78	0.0*
FL2/AC2	25.16±2.19	22.10±1.13	21.90±0.81	0.0*
HC2/AC2	1.22±0.08	1.04±0.05	1.01±0.03	0.0*

*P value significant

AC has a better sensitivity, specificity, NPV and PPV when compared with FL, HC, FL/AC and HC/AC. AC

has got lowest FP and FN with a highest accuracy rate at 32-34 weeks of gestational age.

Table 5: Comparative study of the parameter AC at 22-24 weeks and at 32-34 weeks in detection of IUGR.

Parameter	Diagnostic value in relation to IUGR						
	Sensitivity	Specificity	PPV	PNV	FN	FP	Accuracy
AC1	61.11%	87.80%	52.38%	91.13%	38.88%	12.19%	83%
AC2	94.44%	96.34%	85%	98.75%	5.5%	3.65%	96%

Table 6: Mean pattern of birth weight with estimated fetal age.

Estimated age	Birth weight in kg	
	Range	Mean ± SD
IUGR	1.45-2.3	2.00±0.246
AGA	2.4-3.32	2.94±0.240
LGA	3.01-3.75	3.46±0.267
Significance	Birth weight in kg is significantly reduced in IUGR group with p<0.001**	

At 32-34 weeks of gestational age AC has got better sensitivity, specificity, NPV, PPV, FP, FN and accuracy than at 22-24 weeks. The IUGR babies weighed between 1.45-2.3 kg, AGA ranged from 2.4-3.32 kg, LGA were between 3.01-3.75 kg.

DISCUSSION

In our study majority of patients were between 26-30 years of age group (44%) followed by age group 21-25 years (41%). Primigravida accounted for 37% whereas gravida two accounted for 44%. In the present pregnancy 64% had uneventful outcome, of which 12 (60%) patients delivered IUGR babies. In this study 18 cases were diagnosed to have IUGR, 75 as AGA and 7 as LGA.

We have observed that at 22-24 weeks of gestational age AC has a better sensitivity, specificity, NPV and PPV when compared with FL, HC, FL/AC and HC/AC. AC has got lowest FP and FN with a highest accuracy rate of 83% as compared to FL, HC, FL/AC and HC/AC at 22-24 weeks of gestational age.

At 32-34 weeks of gestational age AC remains better in sensitivity, specificity, NPV, PPV, FP and FN values as compared to FL, HC, FL/AC and HC/AC. At 32 to 34 weeks of gestational age the sensitivity and specificity of AC has increased from 61.11% and 87.80% to 94.44% and 96.34% respectively as compared to same at 22-24 weeks of gestational age. The accuracy of AC has increased from 83% to 96

Hadlock FP showed in study that the measurement of AC is the best single measurement to assess fetal growth because, in growth curtailment, the liver is virtually always affected.¹⁷

In a study done by Warsof SLK et al, AC measurements were shown to predict small fetuses better than BPD, HC, or a combination of parameters.

Study done by Channg TC et al has shown that AC and estimated fetal weight (EFW) were the best predictors of fetal weight below the 10th percentile.⁸

Ott WJ has explained that abdominal circumference and estimated fetal weight showed similar specificity, positive and negative predictive value; and lowest false-positive and false-negative results. Brown et al¹⁸ found that highest true positive rate was for abdominal circumference (96%).⁹

Kurjak et al studied the accuracy of 4 ultrasonic parameters and their combined use for detecting fetal growth retardation in a group of 260 small-for-dates infants. Abdominal circumference measurement was the most accurate single ultrasonic technique.¹⁹

Femur length (FL) measurement is technically the easiest and the most reproducible.²⁰ However in this study the FL has got less sensitivity, specificity, PPV and NPV as compared to AC at 22-24 weeks of gestation as well as at 32-34 weeks of gestation.

Fetal HC is preferred in the present study over BPD, in determining the ratio between head and abdomen, as BPD is only a single dimension of the head and is not a true representative of the total fetal head or brain size.^{10,21}

The values of HC will not get affected due to brain sparing effect during last 12 weeks of gestation.²² In the present study the sensitivity, specificity, PPV and NPV of HC has been less as compared to AC at both 22-24 and 32-34 weeks of gestation. However, the ratio of HC/AC was helpful for diagnosis of asymmetrical IUGR during last 12 weeks of gestation.²²

In the present study the HC/AC has shown the accuracy rate of 79% and 88%, sensitivity level of 38.88% and 61.11%, specificity of 87.80% and 93.90%, PPV of 41.17% and 68.75% and NPV of 86.74% and 91.66% at 22-24 and 32-34 weeks respectively; which was comparable with the study of Divon et al and Benson et al with a specificity of 90% and 94%, PPV of 67% and 62%, NPV of 72% and 98% respectively.^{14,23}

Similar results were obtained by Meyer with a sensitivity of 49.3%, specificity of 87.6%, PPV of 75.6% and NPV of 69%.²

However, the sensitivity, specificity, PPV and NPV of HC/AC remained less as compared to AC at respective gestational ages of the foetus.

When a cut off of >23.5% was considered for FL/AC in detection of IUGR the specificity of the present study was 85.36% at 22-24 weeks and 95.12% at 32-34 weeks of GA which correlates well with the studies of Divon and Meyers with a specificity of 90% and 96% respectively.^{14,2} The PPV in the present study at 22-24 weeks of GA is 36.84%, which correlates with 38% of Divon's study and 77% at 32-34 weeks of GA, which compares well with the results obtained by Kushtagi, who had a PPV of 63.9%.²⁴

The study of Divon et al showed that fetal ratios were helpful in identifying IUGR, but fetal weight estimation had the best sensitivity and specificity for identification of the SGA fetuses.¹⁴ Hence the validity of the above sonographic biometric ratios was compared with the neonatologist's findings at birth of the baby, where the 10th percentile of the gestational age was considered for IUGR.

CONCLUSION

AC has a better sensitivity, specificity, NPV and PPV for diagnosis of IUGR when compared with FL, HC, FL/AC

and HC/AC. AC has got lowest FP and FN with a highest accuracy rate at both 22-24 weeks of gestational age and 32-34 weeks of gestational age.

The sensitivity, specificity and accuracy of AC is more at 32-34 weeks of gestation than at 22-24 weeks for diagnosis of IUGR.

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