Diagnosis of Intrauterine Growth Restriction: Comparison of Ultrasound Parameters

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ABSTRACT

The objective of this study is an attempt to evaluate the best ultrasonic method of diagnosing intrauterine growth restriction (IUGR); a retrospective study of patients with singleton pregnancies who had been scanned at the author's institution within 2 weeks of their delivery was undertaken. Estimated fetal weight, abdominal circumference, head circumference/abdominal circumference ratio, abdominal circumference/femur length ratio, and umbilical artery S/D ratio were compared for accuracy in prediction IUGR in the neonate using both univariant and multivariant statistical analysis. Five hundred one (501) patients were analyzed. One hundred fourteen (114) neonates were classified as IUGR (22.8%). Doppler evaluation of the umbilical artery showed the best sensitivity while both abdominal circumference alone and estimated fetal weight showed similar specificity, positive and negative predictive value, and lowest false-positive and -negative results. Logistic regression analysis confirmed the univariant results and showed that, when used in combination, abdominal circumference and Doppler, or estimated fetal weight and Doppler resulted in the best predictive values. Either estimated fetal weight or abdominal circumference (alone) are accurate predictors of IUGR. Combined with Doppler studies of the umbilical artery either method will provide accurate evaluation of suspected IUGR.

KEYWORDS: IUGR, perinatal mortality, perinatal morbidity, ultrasound parameters

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Intrauterine growth restriction (IUGR) is a significant contributor to perinatal mortality and morbidity.[1–6] The antenatal diagnosis of IUGR can enable obstetricians to prevent or minimize many of the adverse sequelae of this pathological condition. A number of ultrasound parameters have been proposed for the antenatal diagnosis of IUGR.[7] In 1986 Benson et al[8] analyzed a number of these parameters and reported that estimated fetal weight was the most sensitive criterion for the diagnosis of IUGR; while an elevated head circumference/abdominal circumference ratio (HC/AC) was the most specific criterion, and had the best positive predictive value.

Although other ultrasound parameters have been used to diagnose IUGR, calculation of estimated fetal weight has been one of the most common methods used.[9,10] Recently, however, Smith et al[11] suggested that abdominal circumference (alone) is a better method of screening for IUGR, while Dashe et al[12] stressed the importance of the HC/AC. To evaluate our experience with ultrasound for the diagnosis of IUGR and to determine the best ultrasound parameter(s) to use for its diagnosis, we undertook a retrospective study of patients who had been referred to our institution for the evaluation of suspected IUGR.

MATERIALS AND METHODS

The database of the Perinatal Biology Laboratory at the author's institution was queried for all patients with singleton pregnancies that had been scanned and delivered at the institution during a 6-year interval from July 1, 1991 through June 30, 1997; and met the following criterion: delivered within 2 weeks of their last examination, and had head circumference, abdominal circumference, femur length, fetal weight estimation, and umbilical artery Doppler velocity studies (systolic/diastolic ratio; S/D ratio) done at this last examination. In addition, the following ratios were calculated for each fetus: head circumference/abdominal circumference (HC/AC); and abdominal circumference/femur length (AC/FL). These patients were part of a previously published study of the use of Doppler ultrasound to distinguish growth restricted fetuses from constitutionally small (but not growth-restricted) fetuses.[9] The majority of these patients had been referred because of risk factors for IUGR.

Fetuses were classified as IUGR if their estimated weight was less than the 10th percentile of the weight for gestational curve of Hadlock and Ott.[13] They were also classified as IUGR if their abdominal circumference fell below the 10th percentile, or their HC/AC fell above the 90th percentile, or their AC/FL fell below the 10 percentile or their umbilical artery S/D ratio fell above the 90th percentile of the normal curves used at the author's institution.[14]

Neonates were classified as IUGR if their birth weight was less then the 10th percentile of the Hadlock and Ott weight curve. Outcome data for all neonates were obtained from the neonatal intensive care (NICU) database and/or individual chart review. The following outcome parameters were analyzed: gestational age at delivery, birth weight, presence of significant congenital anomalies, and length of stay in the NICU.

Comparisons were made between the various ultrasound parameters for the diagnosis of IUGR using Chi-squared analysis or Fisher's exact test for discrete data, and two sample student *t*-test or analysis of variance (ANOVA) with comparison of means using Bonferroni's adjustment for continuous data. A p value <0.05 was considered to be significant for all the above-mentioned tests. Logistic regression analysis was also used to evaluate the relationship between the ultrasonic parameters and the diagnosis of an IUGR neonate.

RESULTS

During the study interval, there were five hundred one (501) patients that met the inclusion criterion. One hundred fourteen (114) neonates were classi-

fied as IUGR (22.8%), and Table 1 shows the expected differences in outcome for the IUGR neonates when compared with the non-IUGR infants.

Table 2 shows the sensitivity, specificity, positive and negative predictive values, and false-positive and -negative results for the ultrasound parameters used to identify IUGR. Doppler evaluation of the umbilical artery showed the best sensitivity, though this was not a statistically significant improvement. Both abdominal circumference alone and estimated fetal weight showed similar specificity, positive and negative predictive value, and lowest false-positive and -negative results. Logistic regression analysis (Table 3) confirmed the univariant results. When used in combination, both abdominal circumference and Doppler, or estimated fetal weight and Doppler showed almost identical improvements in all of the predictive values (Table 4). Table 5 compares the difference in outcome between symmetrical (normal HC/AC ratios) and asymmetrical (elevated HC/AC ratios) neonates.

Table 1 Comparison of IUGR and Non-IUGR Neonates

	Non-IGUR	IGUR	*p* Value
Number	387	114	
Gestational age at delivery	35.0 wk (3.8)	34.4 (4.0)	0.1285
Birth weight	2682 g (767)	1756 (607)	0.00001
Days in the NICU	8.0 (15.4)	24.6 (31.6)	0.00001
Major congenital anomalies	4.4%	5.3%	0.6963

Table 2 Ultrasound Parameters and the Diagnosis of IUGR

	Fetal Weight (%)	AC (%)	HC/AC (%)	AC/FL (%)	Doppler (%)
Sensitivity	65.8	62.2	49.1	28.9	66.7
Specificity	88.9	90.7	83.7	47.8	68.5
Positive predictive value	63.6	67.3	47.1	47.8	38.4
Negative predictive value	89.8	89.8	84.8	81.3	87.5
False positive	8.6	7.2	12.6	7.2	24.4
False negative	7.8	8.0	11.6	16.2	7.8

Table 3 Logistic Regress: Ultrasound Parameters and IUGR

Variable	Coefficient	Std Error	*p* Value	Odds Ratio (95% Confidence Limits)
Constant	−2.90198	0.24577	0.0000	—
Estimated weight	1.38779	0.38350	0.0003	4.01 (1.89–8.49)
Abdominal circ.	1.614485	0.44549	0.0003	5.03 (2.10–12.04)
Doppler	1.21537	0.27234	0.0000	3.37 (1.98–5.75)
HC/AC	0.25487	0.32605	0.4334	1.29 (0.68–2.44)
AC/FL	0.01930	0.38347	0.9599	1.02 (0.48–2.16)

Table 4 Ultrasound Parameters and the Diagnosis of IUGR: Combined Use of AC and Doppler or Estimated Fetal Weight and Doppler

	Both Abnormal (%)	Either Abnormal (%)
AC and Doppler		
Sensitivity	43.9	87.8
Specificity	95.9	63.3
Positive predictive value	75.8	41.3
Negative predictive value	85.3	94.6
False positive	3.2	28.3
False negative	12.8	2.8
Estimated weight and Doppler		
Sensitivity	46.5	86.0
Specificity	95.9	61.5
Positive predictive value	76.8	39.7
Negative predictive value	85.9	93.7
False positive	3.2	29.7
False negative	12.2	3.2

DISCUSSION

Fetal weight estimation is an ultrasonic parameter that has been frequently used to diagnose IUGR. The sensitivity, specificity, and predictive values found in the current study for fetal weight estimation are almost identical to those reported by DeJong et al.[10] Although abdominal circumference (alone) gave slightly better predictive values than fetal weight estimation, the differences were minimal (Table 2), and would not support the recommendation of Smith et al[11] who suggested using abdominal circumference alone to predict IUGR.

Contrary to the report of Dashe et al,[12] HC/AC ratios did not improve the accuracy of the diagnosis of IUGR. Comparison of the outcomes of IUGR infants who had normal (symmetrical) or abnormal (asymmetrical) HC/AC ratios showed that half of the IUGR infants had elevated HC/AC ratios, and there were no differences in the neonatal outcome between infants with normal or elevated HC/AC ratios (Table 5). Dashe et al's study did use a different cutoff (95th percentile) and a different HC/AC curve. Whether or not this is sufficient to explain the different results is uncertain; however, the current study did show that HC/AC ratios were less accurate than fetal weight estimation or abdominal circumference for the antenatal diagnosis of IUGR.

Combining either abdominal circumference (alone) or fetal weight estimation with Doppler studies of the umbilical artery did improve the accuracy in diagnosing IUGR. These findings are consistent with previous studies at our own institution and reports from other investigators; however, because the majority of patients included in this study were at increased risk for IUGR, some caution should be used in the interpretation of the statistics.[9,13,15,16]

In summary, fetal weight estimation remains an important ultrasound parameter that can be used to diagnose IUGR. Combining fetal weight estimation with Doppler evaluation of the umbilical artery improves the accuracy of the diagnosis of IUGR. The other ultrasound parameters evaluated in the current study did not appear to add any additional accuracy to the diagnosis.

Table 5 Comparison of Symmetrical and Asymmetrical IUGR Neonates

	Symmetrical (Normal HC/AC)	Asymmetrical (Elevated HC/AC)	*p* Value
Number	58	56	
Gestational age at delivery	34.0 wk (2.4)	34.9 (3.8)	0.2607
Birth weight	1753 g (644)	1759 (571)	0.9588
Days in the NICU	27.6 (32.6)	21.6 (30.4)	0.3082
Major congenital anomalies	3.4%	7.1%	0.3772

REFERENCES

1. Allen MC. Developmental outcome and follow up of the small for gestational age infant. Semin Perinatol 1984;8: 123–134
2. Goldenberg RL, Nelson KG, Koski JF, et al. Low birth weight, intrauterine growth retardation, and preterm delivery. Am J Obstet Gynecol 1985;152:980–987
3. Jones RAK, Roberton NRC. Problems of the small-for-dates baby. Clin Obstet Gynecol 1984;11:499–504
4. Seeds JW. Impaired fetal growth: definition and clinical diagnosis. Obstet Gynecol 1984;64:303–307
5. Palo P. Significance of antenatal detection and the choice of the delivery place of severely small for gestational age fetuses. Am J Perinatol 1992;9:135–138
6. Blair E, Stanley F. Intrauterine growth and spastic cerebral palsy. Am J Obstet Gynecol 1990;162:229–237
7. Ott WJ. The diagnosis of altered fetal growth. Obstet Gynecol Clin North Am 1988;15:237–249
8. Benson CB, Doubilet PM, Saltzman DH. Intrauterine growth retardation: predictive value of US criteria for antenatal diagnosis. Radiology 1986;160:415–417
9. Ott WJ. Intrauterine growth restriction and Doppler ultrasound. J Ultrasound Med 2000;19:661–665
10. DeJong CLD, Francis A, VanGeijn HP, Gardosi J. Customized fetal weight limits for antenatal detection of fetal growth restriction. Ultrasound Obstet Gynecol 2000;15: 36–40
11. Smith GCS, Smith MFS, McNay MB, Fleming JEE. The relation between fetal abdominal circumference and birthweight: findings in 3512 pregnancies. Br J Obstet Gynecol 1997;104:186–190
12. Dashe JS, McIntire DD, Lucas MJ, Leveno KJ. Effects of symmetric and asymmetric fetal growth on pregnancy outcomes. Obstet Gynecol 2000;96:321–327
13. Ott WJ. Altered fetal growth. In: Ott WJ, ed. Clinical Obstetrical Ultrasound. New York: Wiley-Less; 1999: 229–262
14. Ott WJ. Reference curves. In: Ott WJ, ed. Clinical Obstetrical Ultrasound. New York: Wiley-Less; 1999:353–384
15. Soothill PW, Bobrow CS, Holmes RP. Small for gestational age is not a diagnosis. Ultrasound Obstet Gynecol 1999;13:225–228
16. Craigo SD, Beach ML, Harvey-Wilkes KB, D'Alton ME. Ultrasound predictors of neonatal outcome in intrauterine growth restriction. Am J Perinatol 1996;13:465–471