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# Fetal Weight–Cerebellar Diameter Discordance as an Indicator of Asymmetrical Fetal Growth Impairment

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*In this study on the effect of fetal growth impairment ≤25th percentile on the transverse cerebellar diameter and its relationship with other fetal biometric parameters, the sample comprised 50 women with singleton pregnancies referred for ultrasound evaluation because of clinically suspected intrauterine growth retardation. The cerebellar diameter of asymmetrically growth-impaired fetuses remained within the normal range although it was found to be reduced when compared with that of normal fetuses (4.4±0.9 versus 4.8±0.7, P<.05). Although other biometric parameters (biparietal diameter, femur length and abdominal and head circumferences) were also reduced in growth-impaired fetuses, the ratios of these biometric parameters to cerebellar diameter were similar to those of unaffected fetuses. Fetal weight was affected to a greater extent than the cerebellar diameter, leading to discordance between the two parameters. This discordance identified almost all asymmetrically growth-impaired fetuses with a sensitivity of 95.6% and specificity of 96.3%. In contrast, the ratio of head circumference to abdominal circumference remained normal in more than half of the fetuses. Fetal weight-to-cerebellar diameter discordance is a very sensitive and specific indicator of asymmetrical fetal growth impairment.*

## Introduction

Since the establishment of ultrasound technology in obstetrics several biometric methodologies have evolved as a result of the continuous effort to diagnose intrauterine growth retardation (IUGR) accurately. Although ultrasonographically estimated fetal weight (EFW) can be accurate in the detection of IUGR when gestational age is well defined, it loses much of its value when precise dating of the pregnancy is not available. Ratios of fetal biometric parameters that are independent of gestational age have been found useful in assessing fetal growth when the gestational age is uncertain.[1,2]

Goldstein et al[3] developed a nomogram for transverse cerebellar measurements throughout the second and third trimesters of pregnancy. Campbell et al[4] reported that the transverse cerebellar diameter (TCD)/abdominal circumference ratio in normal pregnancy is independent of gestational age and that it may be useful in the evaluation of fetal growth in pregnancies with uncertain dating. Reece et al[5] showed that in a group of 19 growth-retarded fetuses cerebellar diameter was unaffected. However, in a recent report Hill et al[6] disputed those findings and demonstrated that the cerebellar size was also affected in a group of fetuses with IUGR.

In an attempt to resolve the controversy, we designed this study to evaluate fetal biometry prospectively and to examine the relationship of cerebellar diameter to the rest of the biometric parameters in fetuses suspected of having growth impairment. In addition, we evaluated the clinical significance of intrafetal discordance between the cerebellum and other biometric parameters in the assessment of fetal growth.

## Materials and Methods

Patients with singleton pregnancies were recruited

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from those referred to the York (PA) Hospital fetal testing unit for growth evaluation and for clinically suspected IUGR. A total of 50 patients were enrolled after it was determined that their pregnancies were accurately dated (i.e., first trimester ultrasound was concordant within one week of dating by the last menstrual period). Among patients examined more than once, only the last examination prior to delivery was used for data analysis.

As part of routine fetal growth evaluation we obtained biparietal diameter, occipitofrontal diameter, femoral diaphyseal length, abdominal circumference and head circumference, and we calculated the head circumference/abdominal circumference ratio (HC/AC). In addition we routinely obtained the TCD. Cerebellar diameters were obtained from axial (transverse) sections of the posterior fossa. We obtained the TCD from the outer-to-outer margins of the cerebellum in a view obtained from the biparietal plane with mild posterior rotation of the transducer.[3] Individual biometric parameters were divided by the cerebellar diameter to obtain various biometric/cerebellar ratios. Ultrasounds were performed using a Toshiba SSA-270A-30 Alpha-Sonolayer machine (Toshiba Medical Systems, Inc., Yonkers, NY). Fetal weight was estimated by the method described by Hadlock et al.[7] All biometric and derived data were stored in a mainframe computerized ultrasound reporting system developed at York Hospital.[8]

Cerebellar diameter percentiles were assigned according to the nomogram reported by Goldstein et al.[3] Fetuses were classified as appropriately grown if the EFW was >25th percentile of York County normal growth[9] curves and as growth impaired if the EFW was ≤25th percentile. We elected to use the 25th versus the 10th percentile because our primary goal was to evaluate fetal biometric asymmetry, not only at the final stages when the typical IUGR (<10th percentile) develops but also at an earlier stage when the growth velocity (weight gain/time) begins to decline.

Statistical analysis using linear simple regression was performed to evaluate the relationships of the various biometric parameters. Student's *t*-test was used to compare means when appropriate, and Fisher's exact test was used to compare frequencies. A $P$ value of ≤.05 was considered significant.

## Results

The study sample comprised 50 patients. The racial distribution was 85% caucasian, 10% black and 5% other. The gestational age at the time of the study (mean±SD) was 35.3±4.2 weeks (range, 22–42 weeks) and at delivery, 37.7±3.6 weeks (range, 23–42 weeks). The mean weight percentile was 9.3±7.5 (range, 0–25) in the group with impaired growth and 54.7±19.4 (range, 27–94) in the group with normal growth. All fetuses with estimated weights ≤25th percentile were at or below the 25th percentile of York County birth weight curves at birth. We noted no growth improvement in infants with fetal growth impairment between the examination and delivery.

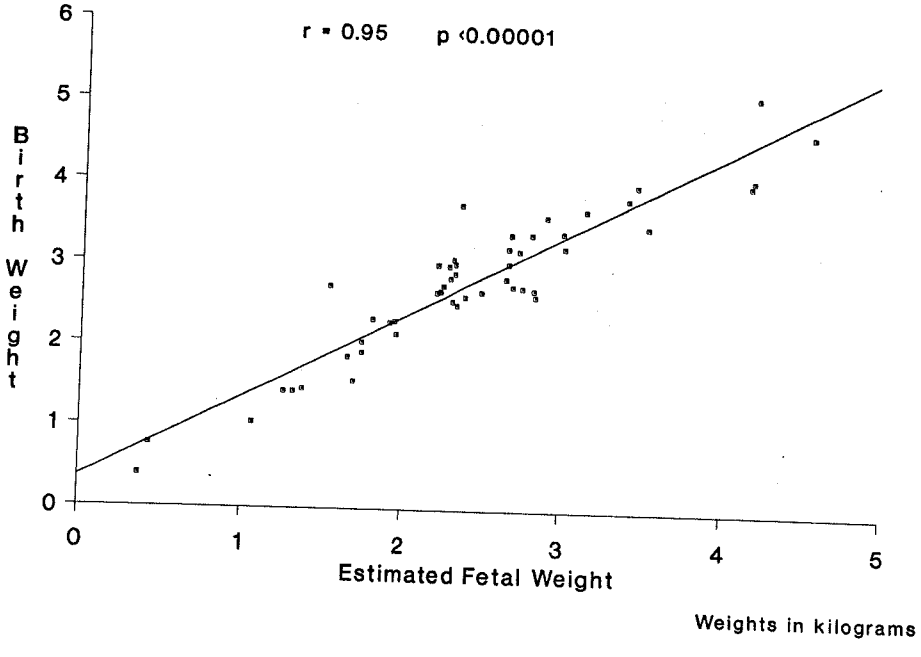


**Figure 1**
Correlation between estimated fetal weight by ultrasound and actual birth weight, n = 50.

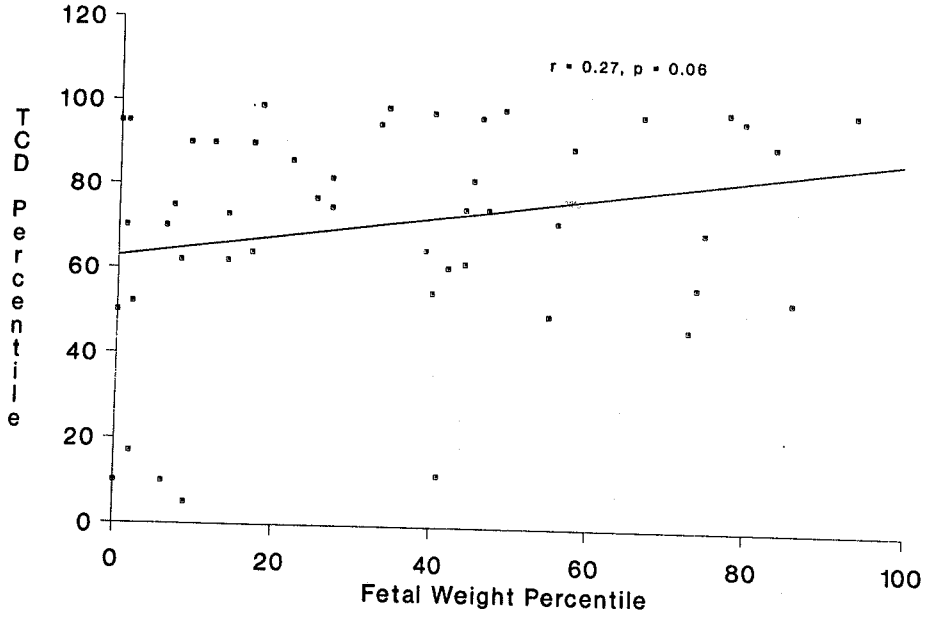


**Figure 2**
Correlation between estimated fetal weight and transverse cerebellar diameter percentile. (Scatter plot contains only 48 points because two identical data pairs overlap [WPCT 8/CPCT 62, WPCT 18/CPCT 99]).

A strong positive linear correlation was noted between the EFW and birth weight, $r = .95$, $P < .00001$ (Figure 1). This degree of correlation was also present when the two groups of patients (growth impaired and normal growth) were analyzed separately. Figure 2 demonstrates a very weak positive correlation between the EFW percentile and cerebellar diameter percentile ($r = .27$, $P = .06$).

Comparisons of the individual biometric parameters for fetuses with impaired growth and those with normal growth are presented in Table I; those between cerebellar ratios, in Table II. In growth-impaired fetuses all biometric parameters, including the cerebellum, were reduced, although the degree of reduction differed. The cerebellar ratios were similar in both groups. The cerebellar diameter of growth-impaired fetuses averaged 10% smaller than that of normal fetuses.

Analysis of the 23 cases with impaired growth revealed that in only one was the cerebellum less than the 10th percentile, and it was concordant with fetal weight percentile. That was a fetus with symmetrical IUGR. In the other 22 fetuses the cerebella were either appropriate for gestational age or smaller, but all were within the normal range. It is apparent that cerebellar diameter decreases in fetuses with asymmetrical impaired growth but remains within the normal range for gestational age, leading to a discordant relationship between weight and cerebellar percentiles. In fact, 22 of the 23 growth-impaired fetuses were identified as such by weight percentile–cerebellar diameter percentile dis-

**Table I** *Comparison of Biometric Parameters in Fetuses With Impaired Versus Normal Growth*

| Parameter | Impaired growth[a] (n = 23) | Normal growth[a] (n = 27) | *P* value[b] |
|---|---|---|---|
| Biparietal diameter (cm) | 7.9 ± 1.0 | 8.6 ± 0.6 | < .02 |
| Head circumference (cm) | 30.0 ± 3.9 | 32.7 ± 2.0 | < .007 |
| Abdominal circumference (cm) | 27.4 ± 4.4 | 32.1 ± 3.7 | < .0004 |
| Femoral diaphyseal length (cm) | 6.0 ± 0.9 | 6.6 ± 0.6 | < .02 |
| Estimated fetal weight (g) | 1,964.2 ± 698 | 2,818.6 ± 835 | < .0003 |
| Birth weight (g) | 2,327.4 ± 818 | 3,100.9 ± 871 | < .003 |
| Transverse cerebellar diameter (cm) | 4.4 ± 0.9 | 4.8 ± 0.7 | < .05 |
| Gestational age at sonography (wk) | 34.4 ± 4.6 | 36.1 ± 3.7 | NS |
| Gestational age at delivery (wk) | 36.0 ± 4.5 | 37.7 ± 3.6 | NS |

[a]Mean ± SD.
[b]NS = not significant.

Table II *Comparison of Biometric Parameter/Cerebellum Ratios in Fetuses With Impaired Versus Normal Growth*

| Ratio | Impaired growth (n = 23) | Normal growth (n = 27) | *P* value[b] |
|---|---|---|---|
| Biparietal diameter/transverse cerebellar diameter | 1.8±0.2 | 1.8±0.2 | NS |
| Head circumference/transverse cerebellar diameter | 6.9±0.8 | 6.8±0.8 | NS |
| Abdominal circumference/transverse cerebellar diameter | 6.3±0.7 | 6.6±0.7 | NS |
| Femoral diaphyseal length/transverse cerebellar diameter | 1.3±0.1 | 1.3±0.1 | NS |

[a]Mean ± SD.
[b]NS = not significant.

cordance (Table III). In fetuses with normal growth only one of 27 had a weight percentile–cerebellar percentile discordance ($P < .00001$, Fisher's exact test). In contrast, the HC/AC ratio was normal in only 12 of the 23 growth-impaired fetuses.

## Discussion

The etiology of IUGR is variable, as is perinatal outcome. Different etiologies affect fetal growth and fetal body symmetry in various ways. The cerebellum as part of the brain was spared along with the rest of the brain[10] in asphyxiated primates. Adlard et al[11] found that in rats subjected to nutritional growth restriction the cerebellar weight was reduced more than that of the rest of the brain. Hill et al[12] subjected monkeys to experimental placental insufficiency during the third trimester of pregnancy and found cerebellar weight reduced by 14.6%.

Our data suggest that the degree of reduction of the cerebellum in asymmetrical growth-impaired fetuses is less than the effect on other biometric parameters, a finding that agrees with that of Reece et al.[5] We found that in 96% of the asymmetrical growth-impaired fetuses the TCD remained within the normal range for gestational age and that the cerebellar diameter percentile was quite discordant when compared with the fetal weight percentile. Compared with the findings of Hill et al, cerebellar growth restriction in our study resulting in the TCD <10th percentile was seen in only 1 of 23 fetuses.

Table III *Sensitivity, Specificity and Positive Predictive Value of Fetal Weight-Cerebellar Diameter Percentile Discordance in Predicting Fetal Growth Impairment*

| | Fetal growth impairment | |
|---|---|---|
| Discordance | Present (no.) | Absent (no.) |
| Present | 22 | 1 |
| Absent | 1 | 26 |
| Total (50) | 23 | 27 |

Sensitivity = 95.6%; specificity = 96.3%; positive predictive value = 95.6%.

Our data suggest that one can utilize the TCD clinically for accurately dated pregnancies complicated by intrauterine growth impairment. It is important to note that discordance between fetal weight and cerebellar size is well established before the HC/AC ratio is disturbed. Weight percentile–cerebellar diameter percentile discordance is a very sensitive, specific indicator of fetal body asymmetry and growth impairment. This information may enhance our confidence in diagnosing fetal growth impairment. By intervening in a timely fashion when indicated we may improve pregnancy outcome.

In human pregnancy, placental insufficiency that leads to decreased placental transport of nutrients and respiratory gases and impaired fetal growth affects all biometric parameters, albeit to a different extent. Therefore, in evaluating fetal growth impairment, one should use all available data derived from altered intrafetal biometric symmetry.

## Conclusion

The TCD is smaller but remains within the normal range in asymmetrically growth-impaired fetuses. This measurement should not be used alone for dating. However, discordance between fetal weight and cerebellar diameter established early in the process of asymmetrical intrauterine growth impairment accurately identifies such fetuses before the HC/AC ratio becomes abnormal. Whether fetal weight–cerebellar size discordance can be useful in detecting fetuses destined to develop asymmetrical IUGR remote from term needs further study.

## References

1. Vintzileos AM, Neckles S, Campbell WA, et al: Three fetal ponderal indexes in normal pregnancy. Obstet Gynecol 65:807, 1985
2. Hadlock FP, Deter RL, Harrist RB, et al: A date-independent predictor of intrauterine growth retardation: Femur length/abdominal circumference ratio. Am J Radiol 141:979, 1983
3. Goldstein I, Reece A, Pilu G, et al: Cerebellar measurements

with ultrasonography in the evaluation of fetal growth and development. Am J Obstet Gynecol 156:1065, 1987

4. Campbell WA, Nardi D, Vintzileos AM, et al: Transverse cerebellar diameter/abdominal circumference ratio throughout pregnancy: A gestational age-independent method to assess fetal growth. Obstet Gynecol 77:893, 1991
5. Reece EA, Goldstein I, Pilu G, et al: Fetal cerebellar growth unaffected by intrauterine growth retardation: A new parameter for prenatal diagnosis. Am J Obstet Gynecol 157:632, 1987
6. Hill LM, Guzick D, Rivello D, et al: The transverse cerebellar diameter cannot be used to assess gestational age in the small for gestational age fetus. Obstet Gynecol 75:329, 1990
7. Hadlock FP, Harrist RB, Sharman RS, et al: Estimation of fetal weight with the use of head, body, and femur measurements—A prospective study. Am J Obstet Gynecol 151:333, 1985
8. Simon NV, Hansberry PA, Shearer DM, et al: Minicomputer-based system for obstetric ultrasound analysis with multiuser and networking capability. J Ultrasound Med 4:545, 1985
9. Simon NV, Levisky JS, Shearer DM, et al: Predictiveness of sonographic fetal weight estimation as a function of prior probability of intrauterine growth retardation. J Clin Ultrasound 16:285, 1988
10. Behrman RE, Lees MW, Peerson ED, et al: Distribution of the circulation in the normal and asphyxiated fetal primate. Am J Obstet Gynecol 108:956, 1970
11. Adlard BPF, Dobbing J, Smart JL: An alternative animal model for the full term small for dates human baby. Biol Neonate 23:95, 1973
12. Hill DE: Experimental growth retardation in rhesus monkeys. *In* Size at Birth. Edited by K Elliott, J Knight. Ciba Foundation Symposium No. 27. Amsterdam, Elsevier Excerpta Medica, 1974