Fetal growth velocities in pregnancies with neonatal features of intrauterine malnourishment

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Summary

Measurements of neonatal morphometry provide a better indicator of fetal growth achievement than birthweight for gestational age. This study describes the intrauterine growth velocities of the fetal head and trunk of 33 infants with skinfold thickness measurements below the tenth percentile; 16 (48%) of the infants had birthweights above the tenth percentile. Growth velocity of the head was not significantly different from the reference population whereas the trunk growth velocity was significantly reduced ($p<0.001$). This study demonstrates for the first time that infants with morphometric features of intrauterine malnourishment, regardless of birthweight, are subject to differential growth restriction in utero.

Key words: Intrauterine growth retardation; Neonatal morphometry; Growth velocity.

Introduction

The distinction between the small for gestational age infant and that which has been subject to intrauterine growth constraint is seldom fully appreciated [1]. Neonatal morphometry is a more meaningful criterion for the diagnosis of growth failure than birthweight since it is of greater relevance to the prediction of adverse short and long-term sequelae [2, 3, 4, 5]. An important consideration therefore is the relationship between intrauterine fetal growth velocity and subsequent neonatal morphometry. The construction of reference ranges for intrauterine fetal growth velocity enables the calculation of growth rates for various fetal parameters [6]. The purpose of this study is to quantify the intrauterine growth velocities of the head and trunk measurements against standard reference data of pregnancies subsequently delivered of infants with low skin-fold thickness measurements.

Subjects

Thirty-three infants were identified with either a subscapular or triceps skin-fold thickness measurement below the tenth percentile; amongst these 33 cases, 17 had **both** subscapular and triceps skinfold thickness measurements below the tenth percentile. Twenty nine cases were from low-risk pregnancies participating in a previously described prospective study of fetal growth [6]. Four other cases were identified from a group of fifty pregnancies considered at high-risk of abnormal intrauterine growth on the basis of recognised obstetric criteria, who had been undergoing serial scanning at two weekly intervals.

Gestational age was determined in all cases by either first trimester crown-rump length measurements or bi-parietal diameter estimation before twenty weeks of gestation.

Methods

All ultrasound measurements were made using an Aloka SSD-650 real-time machine by the author. The bi-parietal diameter was estimated from leading edge to leading edge at the level of the cavum septum pellucidum [7]. The fetal abdominal area was measured at the level of the umbilical vein [8] by tracing the outline of the trunk on-screen. Three measurements were made of each parameter and the mean for each was recorded.

Growth velocity standard deviation (Z) scores were calculated for the BPD and FAA for each pregnancy. The last two measurements for each parameter were used to calculate velocity by employing the following formula;

$$\text{Velocity Z score} = \frac{\text{Daily increment - Reference mean increment}}{\text{Standard Deviation}}$$

The reference mean increment and standard deviation refer to the gestational age specific values determined from previously published reference ranges for fetal growth velocity [6]. The gestational age refers to the number of weeks gestation at which the second measurement was made. Twenty eight and fourteen day interval reference data was employed as appropriate for each fetus.

Skinfold thickness was measured by the author on the second day of life with Holtain calipers employing a standard technique [9]. Three measurements were made at the subscapular and triceps areas on the child and the mean measurement recorded. A centile position was accorded with reference to standard charts after adjustament for gestational age and sex [10]. Birthweight was adjusted for birth order, sex, gestational age and maternal characteristics and accorded a Z score from published nomograms [11].

Results

The mean birthweight for the 33 cases was 2830 grammes (range; 2100 to 3410 g). The mean adjusted birthweight Z score was –1.13 (range; 0.2 to –2.6). Sixteen of the 33 cases (48%) had adjusted birthweights above the tenth percentile. The mean gestational age at delivery was 279 days (range 264 - 292).

Due to technical difficulties in obtaining satisfactory measurements of the fetal head in the third trimester, only twenty eight of the 33 cases (85%) had sufficient data to estimate BPD velocity; FAA velocity could be determined in all cases. The mean BPD velocity Z score is –0.19 (sd = 1.77; t = 0.57, $p > 0.05$) and the mean FAA velocity Z score is –1.18 (sd = 1.04; t = 6.5, $p < 0.001$). The mean BPD velocity of this group is not statistically significantly different from the reference population whereas the FAA velocity is highly significantly different ("t" test).

The relationship between the BPD velocity Z scores and the FAA velocity Z scores for individual pregnancies is presented in figure 1. This demonstrates that nearly all cases have FAA growth velocities below the reference mean whereas 12 cases (43%) have a BPD velocity above the reference mean.

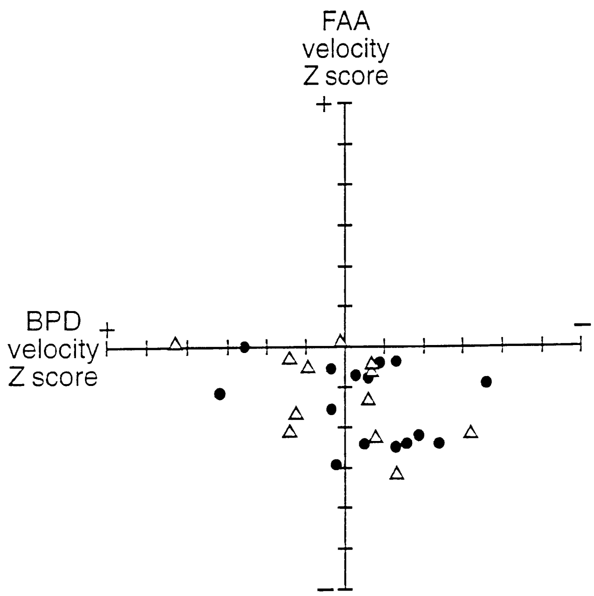

Figure 1. — Scattergraph of bi-parietal diameter (BPD) velocity standard deviation score (Z score) against fetal abdominal area (FAA) velocity Z score for cases with skinfold thickness measurements below the tenth percentile (circles = one skinfold <10th. centile; triangle = two skinfolds <10th. centile).

Discussion

The results of this study confirm the hypothesis that differential growth *in utero*, or the "brain sparing" effect [12, 13] is a feature of pregnancies resulting in the birth of a child demonstrating features of intrauterine malnourishment. The mean head growth reflected by the bi-parietal diameter velocity measumrents, whilst reduced, were not significantly different from the reference population mean. In contrast, the growth velocity of the FAA is significantly less than the population reference mean.

The relationship between prenatal ultrasound estimates of fetal size and ultimate growth achievement has only been reported by a small number of studies; most reports have used birthweight for gestational age rather than neonatal morphometry as the determinant of final intrauterine growth achievement. Single estimates of fetal size perform poorly in the prediction of neonates with low skinfold thickness [14] although estimated fetal weight correlates best, which is not surprising since there is inevitably a relationship between skinfold thickness and birthweight [15].

Attempts at correlating intrauterine growth determined by serial ultrasound to neonatal morphometric appearances suggestive of true intrauterine malnourishment is limited to the current study and the study of Chang *et al.* [16] who collected ultrasound data and neonatal measurements among 104 fetuses identified as being small in the third trimester. Change in estimated fetal weight Z score and change in abdominal circumference Z score were predictive of low Ponderal index and reduced skinfold thickness; the test performance was significantly superior to a single measurement of E.FWt. or AC prior to delivery.

Conclusions

This study has described, for the first time, intrauterine growth velocities of pregnancies subsequently delivered of infants with morphometric features of intrauterine malnourishment, regardless of birthweight. The results provide further evidence to suggest that estimates of fetal growth velocity based upon serial estimates of fetal size have considerable potential for accurately predicting neonates with evidence of preceding intrauterine malnourishment. The ability of ultrasound fetal growth velocity to predict these infants needs be established by prospective studies before growth velocity can be claimed to have direct clinical application. However, in terms of advancing our understanding of the evolution of intrauterine growth retardation, measuring fetal growth velocity appears to be a promising investigative tool.

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