# EFFECTIVENESS OF SINGLE CROSS-SECTIONAL AREA MEASUREMENT OF FETAL ABDOMEN FOR SCREENING FOR FETAL GROWTH RETARDATION

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## SUMMARY

**To assess the effectiveness of cross sectional screening (abdominal area, abdominal circumference and the Head/Abdomen ratio). We studied 4515 pregnant women who were examined using ultrasonic measurement at 34 and 38 weeks gestation. We used the cross sectional areas and ratios for screening obstetric population to diagnose intrauterine growth retardation. We found the abdominal area measurement taken at 34 weeks were able to predict 81.9% of those babies born with IUGR as compared with 87.9% of the measurement of the abdominal area taken at 38 weeks gestation as compared with 67.9% and 78% respectively using abdominal circumference measurement ($P < 0.05$). Similar difference was identified using the head/abdomen ratios ($P < 0.05$).**


The evaluation of abnormal fetal growth presents a difficult clinical problem; therefore ultrasonography is often used to complement the physical examination. The diagnosis of IUGR is only made antenatally in about half of the cases by routine clinical screening (Hall et al, 1980). In the report by Hall et al (1980) 44% of IUGR were detected and for each correct diagnosis there were two and half false-positive diagnoses. Ultrasonography aids in the diagnosis of fetal growth disorders by quantitative and qualitative assessment of multiple parameters that may be compared to known standards. Nevertheless, the detection of both intrauterine growth retardation (IUGR) and the large for gestational age (LGA) infant continues to be a challenge for the ultrasonographer and the obstetrician.

Small for gestational age (SGA) infants have significantly increased perinatal morbidity and mortality rates compared to infants who grow normally (Lugo and Cassady, 1971). Perinatal mortality is 4 to 10 times higher in growth retarded neonates than in those of appropriate weight for age. The infants are also at increased risk for intrapartum fetal distress, neonatal hypoglycemia, polycythemia, meconium aspiration, pneumonia, hypocalcaemia and hyperviscosity syndrome (Dobson et al, 1981). A substantial risk for long term neurologic and

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developmental disorders may exist as well.

In general, detection of IUGR after 37 weeks gestation is an indication for delivery so as to reduce the risk of fetal death (Romero and Jeanty, 1984). The ultimate goal in the pre-term gestation is to extend the pregnancy as long as growth is maintained while avoiding fetal compromise.

Two types of abnormal growth patterns are commonly recognised by sonographic studies. Asymmetrical (late flattening) growth retardation comprises approximately two-thirds of all fetal growth retardation. In there cases, the fetus grows normally until the third trimester. At this stage, fetal abdominal growth slows relative to head growth. In symmetrical (low profile) growth retardation, the entire fetus is porportionately small for gestation age. This condition is recognised earlier in gestation and is usually associated with more severe disorders. Intrauterine infection (herpes, cytomegalo-virus, toxoplasmosis and rubella). chromosomal abnormalities, congenital malformations, and genetic disorders such as Gauchers Disease may be responsible for symmetric growth retardation.

A variety of sonographic parameters may be employed for the evaluation of fetal growth retardation. These include : biparietal diameter (BPD), femur length (FL), abdominal circumference (AC), estimated fetal weight (EFW), total intrauterine volume (TIUV) and volume of amniotic fluid volume (AFV). Serial ratios have also been used to identify growth disturbances, most commonly the head circumference to abdominal circumference (HC/AC) ratio and the femur length to abdominal circumference (FL/AC) ratio.

### *BIPARIETAL DIAMETER (BPD)*

Biparietal diameter was the first parameter used to screen for IUGR. Early reports, as well as more recent ones, have found single and serial BPD measurements to be a poor predictor of growth retardation. The sensitivity is generally considered to be approximately 50-60%. A recent study demonstrated a sensitivity of 57%, but the predictive value of a positive test was only 6% (Hughey, 1984).

### *FEMUR LENGTH (FL)*

The fetal femur length behaves in a similar fashion to the head in that it is usually affected late in cases of asymmetric IUGR (Woo et al, 1985). However, since the fetal femur length has been shown to have a linear relationship to the crown heel length (CHL) at birth, it should be evaluated when assessing fetal growth.

### *ABDOMINAL CIRCUMFERENCE (AC)*

Animal and human studies have shown diminished hepatic glycogen stores and liver mass, associated with IUGR. Since the liver comprises the bulk of the fetal abdomen, this information has stimulated interest in the role of abdominal circumference (AC) as a predictor of fetal size. Most studies have shown the AC to be the best predictor of fetal growth (Warsof et al, 1986). A recent report by Brown et al (1987) which evaluated multiple parameters used to detect IUGR, found the AC to be the best predictor with a sensitivity of 95%, a specificity of 60% and a negative predictive value of 99%. The positive predictive value, however was a disappointing 21%. Warsof et al (1986) found that 34 weeks gestation was the optimal time to apply the AC for the detection of IUGR. Screening at this time had a sensitivity of approximately 70% with the predictive value of a positive test approaching 50%.

### *ABDOMINAL AREA (AA)*

Varma et al (1979) reported that single measurement of the abdomen area at 33 weeks identified only 80% of the infants with IUGR, compared with 82.9% when the measurement was taken within 10 days before delivery or at 36 to 38 weeks of gestation.

### *AMNIOTIC FLUID VOLUME (AFV)*

The association of IUGR with oligohydramnios was evaluated in an early study

by Manning et al (1981) who found that IUGR correlated well with the absence of a pocket of amniotic fluid greater than 1 cm in broadest dimension. Using this index, IUGR was diagnosed with a sensitivity of 93% and a specificity of 89%. Amniotic fluid volume, however, was not found to be a sensitive indicator of IUGR by others (Romero and Jeanty, 1984).

### *ESTIMATION OF FETAL WEIGHT*

Since most definitions of IUGR are based on weight the determination of fetal weight would be a logical method to detect this growth disturbance. Most equations currently used are based on the BPD and AC, but the additions of the FL to the equation may improve the accuracy.

More recent studies utilizing the AC alone for weight estimation have shown an overall variability (1, SD) of 11.1% to 13.7%. Equations based on the BPD and AC have been found to be more accurate. These have an average variability (1, SD) of ± 9%.

### *BODY PROPORTIONALITY INDICES*

The detection of IUGR using the ratio of the HC to AC was first evaluated by Campbell and Thoms (1977). In addition, although the sensitivity of the HC/AC ratio for detecting asymmetric IUGR has been reported to be 70%, high false-positive rates when screening a general population limits its usefulness in these cases as well (Campbell and Thoms, 1977; Deter et al 1983). Varma et al (1979) stated that the head/abdomen area (H/A area) ratio identified 83% of the infants with IUGR at 33 weeks as compared with 85.7% when the measurement was made at 36-38 weeks of gestation or if it was made within 10 days of delivery. If this ratio is used, accurate knowledge of gestational age is crucial since the ratio varies throughout pregnancy.

Another ratio, FL/AC has also been used for the detection of asymmetrically growth retarded fetuses. This ratio was found to be independent of gestational age. Using the 90th percentile as the upper limit of normal, 63% of growth-retarded fetuses were identified. The predictive power of an abnormal ratio for screening a general population, however, was only 25%.

### *MATERIAL AND METHODS*

Over a period of 6 years, 4515 pregnant women were examined using ultrasonic technique to assess fetal age, to exclude multiple pregnancy and fetal abnormalities initially between 16 and 18 weeks gestation followed by subsequent scan at 34 and 38 weeks gestation to assess fetal growth.

The object of this study was to compare the fetal abdominal circumference, abdominal area and head to abdomen ratios as indices of fetal growth and as a predictor of intrauterine growth retardation and whether abdominal area measurement alone can be utilised for screening obstetric population to diagnose IUGR.

### *METHOD*

All ultrasonic examinations were made using Kretz Combison 320, a real time ultrasonic equipment with a sector scanner, using a 3.5 MHZ transducer at a velocity setting 1540 m/s.

With a slight variation we measured the widest transverse diameter of the head at the level of thalami and third ventricle and cavum pellucidum. The head area and the circumference were measured at the same plane. Abdominal circumference and the area were measured at the level where the umbilical vein enters into the liver or at the level of bifurcation of portal vessel in the liver (Varma et al, 1979). Femur length was measured using the technique as described by O'Brien et al (1981).

All the measurements were performed by an experienced obstetrician skilled in diagnostic ultrasonography and by an experienced senior ultrasonographer. All the measurements were repeated two or three times to check the reproducibility. The first examination was performed at about 16 to 18 weeks' gestation having been assessed from the last menstrual period or assessed on the basis of early clinical examination

or from the early scan done to assess the early pregnancy. At the first examination, BPD and FL were measured to confirm the gestational age, and multiple pregnancy and major fetal malformations were subsequently excluded.

Subsequent examinations were performed at 34 and 38 weeks gestation to measure head area (HA), circumference (HC), abdominal area (AA) and circumference (AC), BPD and FL.

## *RESULTS*

Of the 4, 515 patients who underwent routine ultrasonic examination to assess gestational age between 16 and 18 weeks gestation and the growth of the fetus at 34 and 38, 77 women (1.7%) were found to have multiple pregnancy and 26 women (0.58%) were found to have fetus with major anomalies and these 103 women were excluded from the study. Of the remaining 4,415 infants born 405 (9.2%) had a birth weight below the tenth centile below the mean, standardised for the duration of gestation, maternal parity and the sex of the infant.

In this study an infant was considered to be small-for-gestational age (IUGR) if the birth weight was below the tenth centile and the birth weight was considered appropriate if it was at or above the tenth centile.

Figure 1A and 1B show the mean fetal abdominal circumference and ± 2SD from 14 to 41 weeks gestation and the mean abdominal area and ± 2SD from 26 to 40 weeks gestation respectively derived from the local mixed population who had uncomplicated pregnancies and delivered single infant between 37 and 41 completed weeks of gestation. When the measurement of the fetal abdominal circumference or area was found to be below the 2SD below the mean it was considered to be abnormal and was considered to be IUGR.

Figure 2A and 2B show the mean head to abdomen circumference ratio and ± 2SD from 17 to 40 weeks and the mean head to abdomen area ratio and ± 2SD from 26 to 40 weeks respectively. When the ratio was found to be above 2SD

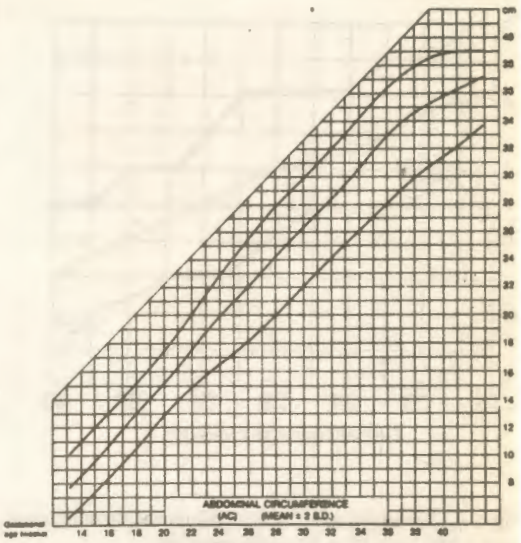


Fig. 1 A : Shows the mean fetal abdominal circumference and ± 2SD from 14 to 41 weeks gestation.

SD = Standard deviation

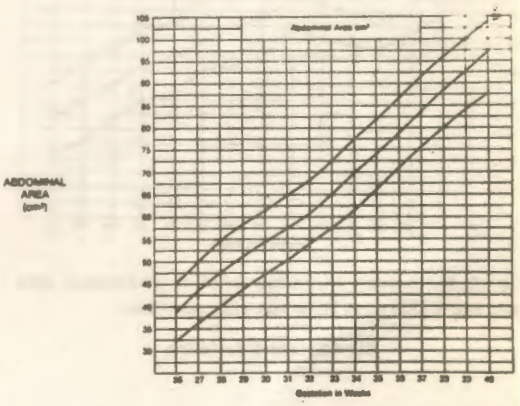


Fig. 1 B : Shows the mean abdominal area ± 2SD from 26 to 40 weeks gestation.

SD = Standard deviation

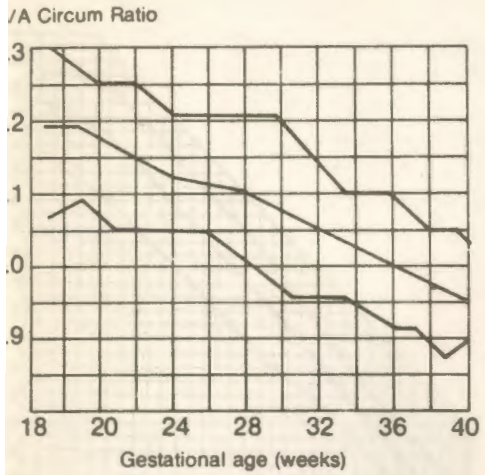


Fig. 2 A : Shows the mean head to abdominal circumference ratio ± 2SD from 17 to 40 weeks gestation.

SD = Standard deviation

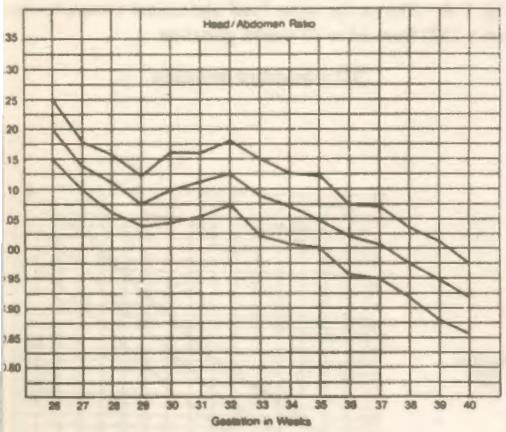


Fig. 2 B : Shows the mean head to abdominal area ratio and ± 2SD from 26 to 40 weeks gestation.

SD = Standard deviation

above the mean it was considered abnormal and was suggestive of asymmetrical IUGR.

Of the 4, 412 babies born 405 infants had a birth weight below the tenth centile below the mean standardized for parity, duration of gestation and the sex of the infant and the remaining 4,007 infants had appropriate birth weight (> tenth centile).

Table I shows that taking a single measurement of abdominal area at 34 weeks gestation would identify 81.9% of those infants born with birth weight below the tenth centile as compared with 67.9% when a single circumference measurement was taken at 34 weeks gestation. The false positive and false negative results were higher using abdominal circumference measurement and the difference was significant ($P < 0.05$).

When the measurement of abdominal area was taken at 38 weeks gestation 87.9% of the infants with IUGR at birth was identified as compared with 78% using abdominal circumference measurement ($P < 0.05$).

Table II shows that that the abdomen/head area ratio taken at 34 weeks identified 86.9% of infants with IUGR at birth as compared with 69.4% using circumference ratio. When the measurement was taken at 38 weeks the area ratio identified 90.1% of infants born with IUGR at birth as compared with 80.9% using circumference ratio ($P < 0.05$). The incidence of false negative and false positive results were higher using the circumference ratio and the difference was significant ($P < 0.05$).

When growth retardation is significant (birth weight < fifth centile) at birth, single measurement of fetal abdominal area at 34 weeks gestation identified the condition in 91% as compared with 72% when the birth weight was above the fifth centile but below the tenth centile. However when abdominal circumference was used to assess growth of the fetus, it identified 82% of those infants born with severe IUGR as compared with 61% of those born with birth weight between fifth and tenth centile.

When the measurement was taken at 38 weeks, the area measurement identified with severe IUGR at birth in 95% as compared with 86% with less severe IUGR (> fifth centile - < tenth centile). The circumference measurement at 38 weeks

gestation identified 86% of infants with severe IUGR as compared with 74% of those with less severe IUGR.

We found in general the measurement of abdominal area is more sensitive and specific to assess fetal growth and to identify IUGR as compared with the measurement of circumference. It is more reliable and accurate nearer the 38 weeks gestation than at 34 weeks gestation. Severe degree of IUGR is identified more reliably at 34 weeks than less severe IUGR. If the interval between the date of measurement and the date of delivery is less than 2 weeks there was better correlation. If the interval is more than 3 weeks the correlation was not good especially if the degree of IUGR was less severe (5th centile - < 10th centile), since the fetus could show catch up growth.

For this study for statistical analysis we used Student's test to assess the significance of the outcome.

## *DISCUSSION*

In different reports, depending on the parameters used, the percentage of correct diagnoses of small fetuses obtained with ultrasound ranges between 50% and 80% (Deter et al, 1982). The highest detection rate is achieved close to delivery (Varma, 1979). The number of correct diagnosis of abnormality increased significantly as the postnatal criterion was changed from the tenth to second centile and the measurement was taken at 38-40 weeks gestation or 2 weeks prior to delivery. Neilson et al (1980) achieved better results by combining measurements of crown-rump length (CRL) and AC using a static scanner operated by one examiner in a prospective study. They identified 94% of fetuses below the fifth centile. Neilson et al (1980) reported that 54.5% of fetuses between the fifth and second centile were not diagnosed at 29-31 weeks, whereas at 35-37 weeks gestation the percentage increased to 80%. Fetuses below the second centile can be detected at 29-31 weeks of gestation, whereas slightly affected fetuses will be diagnosed only at 35-37 weeks of gestation.

Rosendahl and Kivinen (1988) reported that a combined measurement of BPD and transverse abdominal diameter provided efficient antenatal screening for diagnosis of IUGR in the general population. They stated that nonlinear methods, such as the measurement of abdominal circumference, appeared to rule out false-positive cases. They used single measurement of BPD and transverse abdominal diameter (AD) at 34 weeks gestation, the sensitivity of a single measurement was 62.2% and the specificity was 93.2%.

There are only a few randomized controlled studies of the benefits of ultrasound screening for detection of IUGR versus traditional practice, whereby ultrasound examinations are performed only if clinically indicated. Ultrasonic screening was significantly better in diagnosing small-for-dates fetuses in these studies.

Our study suggests that area measurement is more specific and sensitive parameter to identify IUGR and significant IUGR is identified more reliably at 34 weeks gestation. Less severe IUGR may be missed at this stage in pregnancy and a repeat scan between 36 and 38 weeks gestation may identify those infants with less severe IUGR at 34 weeks gestation.

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