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Accuracy of Ultrasonic Fetal Abdominal Subcutanous Fat Thickness Measurement in Predicting Intrauterine Growth Restriction (IUGR)

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ABSTRACT

Objective To evaluate the sensitivity and specificity of subcutaneous fat thickness in predicting intrauterine growth restriction (IUGR).

Study design Prospective descriptive study.

Setting Maharaj Nakorn Chiang Mai Hospital, Chiang Mai University.

Subjects Women meeting the inclusion criteria of : (1) singleton pregnancies at 26-37 weeks of gestation; (2) known accurate gestational age; (3) clinically suspected IUGR.

Methods The patients were sonographically examined at 35-37 weeks of gestation for subcutaneous fat thickness. Subcutaneous fat thickness was measured in millimeters on the anterior abdominal wall, at the level of the junction of the umbilical vein and the left portal vein, using fullscreen magnification. The best cut-off value of subcutaneous fat thickness in predicting IUGR was determined by a receiver operating characteristic (ROC) curve. The fetus with asubcutaneous fat thickness less than the cut-off value was antenatally diagnosed as IUGR. The gold standard for diagnosis of IUGR was defined as low birthweight of less than the 10th percentile.

Main outcome measures sensitivity, specificity, positive predictive value and negative predictive value.

Results One hundred and ten pregnancies with suspected IUGR were analyzed. The prevalence of IUGR among the study group was 22.72%. The best cut-off value of the subcutaneous fat thickness for prediction of IUGR was 4.5 mm, giving the sensitivity, specificity, positive predictive value and negative predictive value of 76.0%, 75.3%, 47.5% and 91.4%, respectively.

Conclusion Measurement of subcutaneous fat thickness is a simple technique. It may be used in predicting nutritional status antenatally as an adjunct with other standard parameters.

Key words: IUGR, Subcutaneous fat thickness

Intrauterine growth restriction (IUGR) is usually defined as a subset of neonates with a birth weight of less than the 10th percentile.[1] As a consequence of impaired nutrient and oxygen supply to fetus, perinatal death and associated neonatal morbidity are significantly higher among fetuses with growth

restriction. Furthermore, adaptation to a limited supply of intrauterine nutrient might increase the risk of coronary heart disease, hypertension, and insulin resistance in later life.[2,3]

Antenatal diagnosis of IUGR remains a challenge. Ultrasonography is the best technique in estimating fetal weight and growth using multiple parameters. Parameters used for diagnosis of IUGR include: biparietal diameter (BPD); head circumference (HC); abdominal circumference (AC); femur length (FL): transverse cerebellar diameter (TCD),etc.[4] It has been established that among these parameters, AC appears to give the highest accuracy (84-100%).[5-7] Body proportionality indices such as ratio of head-to-abdominal circumference[8] and Doppler ultrasound studies can provide additional information.[9] Diagnosis is easier at birth because growth-restricted infants show typical changes in body proportionality. Subcutaneous adipose tissue that acts as an energy source and insulator against hypothermia is reduced.[10] The fetus accumulates most of its body fat during the third trimester. Animal data have indicated that fetal fat stores are second only to liver weight in reflecting impaired fetal growth. Large for gestatinal age fetuses, on the other hand, are noted for their increase in subcutaneous tissue11.

Subcutaneous fat can be antenatally evaluated by the measurement of skin fold thickness antenatally with ultrasound. On a transverse section of the fetal abdomen, it appears as a well delineated echogenic line. To date there have been only few reports regarding the efficacy of subcutaneous fat in predicting IUGR, the accuracy was somewhat varied and the cut-off value was different.[12,13] The obfective of this study was to evaluate sensitivity and specificity of subcutaneous fat thickness in predicting IUGR.

Materials and Methods

The study was conducted at Maharaj Nakorn Chiang Mai Hospital, Chiang Mai University, Thailand, from August 2001 to April 2003. The study population were recruited from pregnant women with complete inclusion criteria consisting of(1) singleton pregnancies at 26-37 weeks of gestation; (2) known accurate gestational age based on the history of regular menstruation, exact date of last menstrual period, attending antenatal clinic in the first trimester and clinical estimation of gestational age consistent with menstrual age calculated from dates; and (3) clinically suspected IUGR. All volunteers were recruited with informed written consent. The exclusion criteria included fetal death or anomalies and patients giving birth at other hospitals or loss to follow-up. Sonographic examinations were done several times in most cases, but only the last one, at 35-37 weeks of gestation, was used for analysis. An IUGR infant was typically defined as having birth weight below the 10th perrcentile for gestational age. The intrauterine growth curve for evaluation of newborns was based on the growth curve derived from our population.[14]

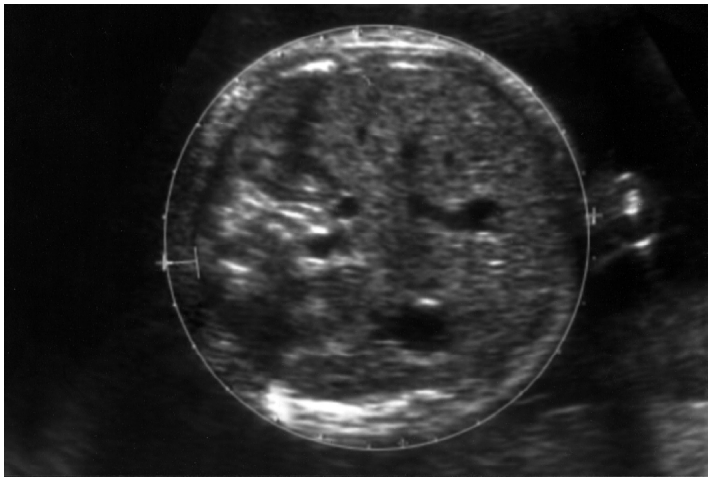

Fig. 1. Standard plane used for abdominal circumference measurement.

All ultrasound scans were performed by the same author, who had no clinical information of the patients, using the same ultrasound machine, a real-time, 3.5-MHz curvilinear scan (model Prosound 5000; Aloka, Tokyo, Japan). Standard plane used for abdominal circumference (AC) was obtained, and subcutaneous fat thickness in abdominal walls was measured in millimeters on the anterior abdominal wall, at the level of the junction of the umbilical vein with the left portal vein, using fullscreen magnification (Fig. 1). Biparietal diameter (BPD), head circumference (HC), and AC and femur length (FL) were also measured routinely. With the exception of subcutaneous fat, all the sonographic findings were reported to clinicians caring for the women. All of the data were prospectively collected for later analysis. The sensitivity and specificity of subcutaneous fat thickness were calculated for various cut-off value. The best cut-off value was determined from receiver operating characteristics (ROC) curve.

Results

Between August 2001 and April 2003, there were 110 pregnant women who met the inclusion criteria. They all gave birth to 25 infants with IUGR and 85 infants without IUGR, were analyzed. The prevalence of IUGR among the study group was 22.72%. The mean maternal age $\pm$ SD was 25.96 $\pm$ 6.40 years. Sixty-nine women (62.73%) were nulliparous and forty-one (37.21%) were multiparous women. The mean gestational age at birth $\pm$ SD was 38.17 $\pm$ 1.42 weeks. Birth weight ranged from 1650 to 3450 grams with average of 2628.72 $\pm$ 415.67 grams. Mean birth weight of IUGR and non-IUGR infants were 2,115.6 and 2,779.647 grams, respectively.

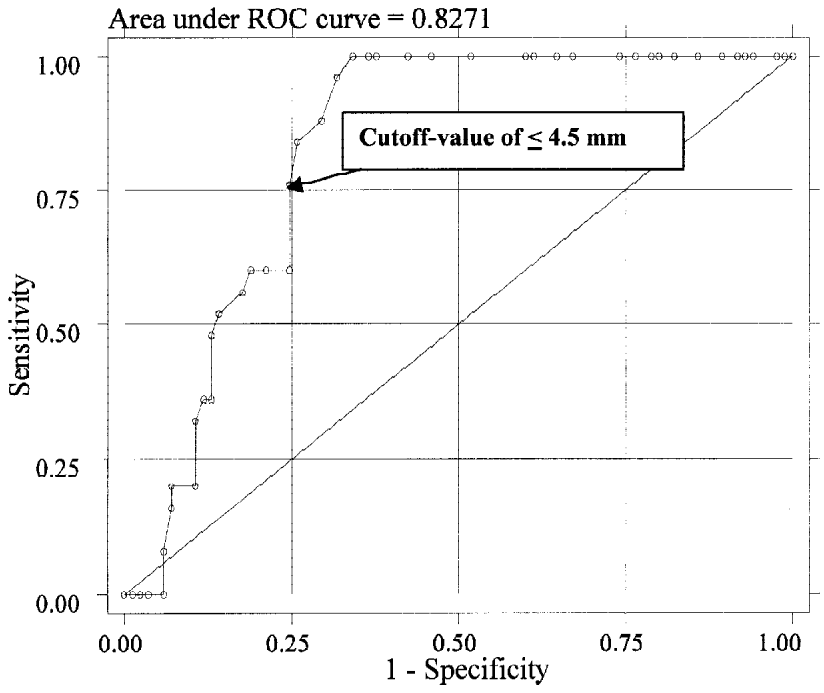

Fig. 2. Best cut-off value of subcutaneous fat thickness for predicting IUGR.

Various cut-off value of subcutaneous fat thickness was used to calculate the sensitivity and false positive and then receiver-operating characteristic (ROC) curve was constructed as shown in figure 2. The best cut-off value of subcutaneous fat thickness for predicting IUGR was 4.5 millimeter, giving the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of 76%, 75.29%, 47.50%, 91.42% and 75.74% respectively . At 35 and 36 weeks of gestation, fetuses with subcutaneous fat thickness of < 4.5 mm have significant lower birth weight than those with subcutaneous fat thickness of > 4.5 mm (p-value = 0.0269 and 0.0000 respectively). (Figure 3). The sensitivity of subcutaneous fat thickness (cut-off value = 4.5 mm) in the patients of delivery within 14 days and > 14 days after ultrasound examination were 70.58% and 85.7%, respectively.

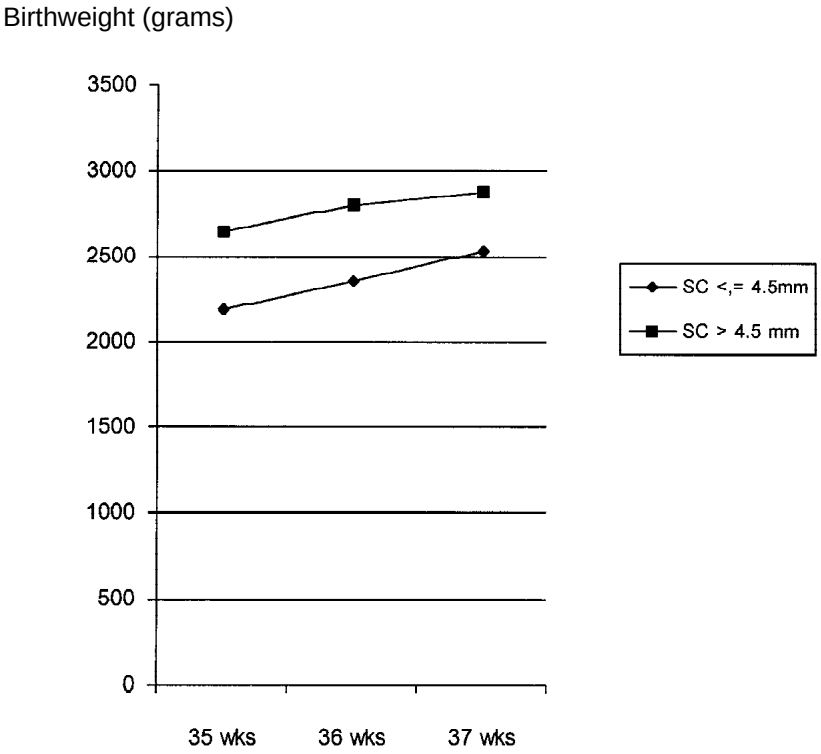

Fig. 3. Comparison of mean birthweight of fetus at 35, 36 and 37 weeks of gestation in fetuses with subcutaneous fat of ≤ 4.5 mm and > 4.5 mm.

But the duration of the time from the day of ultrasound examination to the day of delivery was varied which may affect the accuracy of the test. In the same population samples, the accuracy of abdominal circumference (AC) in predicting IUGR using -2 SD as a cut-off value of the diagnosis was also determined. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of AC were 86.95%, 64.36%, 32.78%, 94.94% and 69.09%, respectively.

Among 25 IUGR infants, 19 (76%) could be detected with subcutaneous fat thickness of ≤ 4.5 mm and 6 (24%) were undetected.

Discussion

Assessment of fetal size and growth is important for antenatal care. Early recognition of this disorder with appropriate surveillance, and intervention will optimize perinatal outcomes. The diagnostic value of conventional ultrasound for

detecting small infants is established, with varying degrees of predictive ability quoted for different ultrasound parameters.[4-7] Our study showed a thin layer of subcutaneous fat (≤ 4.5 mm) at 35 and 36 weeks' gestation associated with significant low birth weight. Using a cutoff point of ≤ 4.5 mm, we could detect 76% of infants of birth weight less than 10th percentile. The sensitivity and specificity were comparable to Gardeil et al.[12] The validity of the subcutaneous fat in diagnosis of IUGR was inconclusive and is difficult to compare among the studies, because of the differences in populations and cut-off values.[12-13] Based on this study, the sensitivity of subcutaneous fat in predicting IUGR was not very high, suggesting it may not be appropriate to use as a single parameter in diagnosis of IUGR or use as a primary screening test because one-forth of IUGR fetuses will be missed. Compared to AC in predicting IUGR in the present study subcutaneous fat has higher specificity, positive predictive value and accuracy. With the rather high negative predictive value, indicating a high chance of having non-IUGR fetuses if the test is negative, it can be used as an adjunct with other parameters in predicting IUGR. In this study, subcutaneous fat thickness measurement was done at 35-37 wk. Measurement of subcutaneous fat thickness at earlier gestation with cutoff point for each gestational age may help to predict IUGR. Appropriate intervention and surveilence can be done in an abnormal fetus to optimize perinatal outcome.

This study raises the possibility that measurement of subcutaneous fat in the abdominal wall might help predict nutrition status antenatally when used as adjunct with other parameters. That could minimize unnecessary obstetric intervention for small, well-nourished fetuses and detect true IUGR in infants of apparently normal weight. However, the sample size of the present study is rather small, a larger study is necessary to determine the more accurate effectiveness.

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