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## OBSTETRICS

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# Sonographic Measurement Fetal Abdominal Circumference and Fetal Abdominal Subcutaneous Tissue Thickness for Predicting Fetal Macrosomia

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### ABSTRACT

**Objective:** To evaluate the value of the sonographic measurement of fetal abdominal circumference (AC) and fetal abdominal subcutaneous tissue thickness (FASTT) for predicting fetal macrosomia.

**Material and Method:** This prospective study was studied in term singleton pregnant women between February 2013 and January 2014. The fetal AC and FASTT were examined in all cases and fetal deliveries were within 24 hours. The fetal birth weight greater than 4,000 g. is macrosomia. Fetal AC and FASTT cut off values for predicting fetal macrosomia were analyzed.

**Results:** This study included 302 pregnant women with median gestational age of 39 weeks (range 37 - 41). The prevalence of fetal macrosomia was 6.9%. At the cut off values of fetal AC  $\geq 36.7$  cm and FASTT  $\geq 10.0$  mm, the sensitivity, specificity, positive predictive value, negative predictive value and accuracy were 95.2% and 81.0%, 93.2% and 86.8%, 51.3% and 31.5%, 99.6% and 98.4% and 93.4% and 86.4%, respectively.

**Conclusion:** The sonographic measurements of fetal AC and FASTT were useful for predicting fetal macrosomia.

**Keywords:** fetal abdominal circumference, fetal abdominal subcutaneous tissue thickness, fetal macrosomia

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### Introduction

It is well known that fetal macrosomia has

increased maternal morbidity and mortality, such as prolonged labor, increased rates of perineal laceration,

postpartum hemorrhage, operative vaginal delivery and cesarean section. It also has increased perinatal morbidity and mortality, such as shoulder dystocia, fetal distress, birth asphyxia and neonatal death<sup>(1-7)</sup>.

Newborn weight exceeding 4000 g. is also a frequently used threshold to define macrosomia. Because there are no methods presently available to estimate excessive fetal size accurately, macrosomia cannot be definitively diagnosed until delivery<sup>(1)</sup>. The common methods to estimate fetal birth weight are clinical and sonographic estimation, with a wide range of accuracy<sup>(8-14)</sup>. The single measurement which correlates most strongly with fetal birth weight is fetal abdominal circumference<sup>(15-17)</sup>. Fetal subcutaneous tissue thickness correlates with fetal growth and metabolic state<sup>(18-21)</sup>. Several studies have shown that sonographic measurements of fetal abdominal circumference and fetal abdominal subcutaneous tissue thickness are useful for predicting fetal macrosomia<sup>(17, 21-26)</sup>.

The purpose of this prospective study was to evaluate the value of sonographic measurements of fetal abdominal circumference (AC) and fetal abdominal subcutaneous tissue thickness (FASTT) for predicting fetal macrosomia.

## Material and Method

This prospective study was conducted between

February 2013 and January 2014 at Department of Obstetrics and Gynecology, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand. It was approved by the Ethical Clearance Committee on Human Rights Related to Researches Involving Human subjects, Faculty of Medicine Ramathibodi Hospital.

This study enrolled pregnant women who delivered at Ramathibodi Hospital. The inclusion criteria were viable singleton pregnancy and gestational age 37-42 weeks. The exclusion criteria were pregnant women who had fetal congenital anomalies, fetal hydrops, oligohydramnios, did not deliver within 24 hours after sonographic measurement, denied to participate, or sonographic measurement of fetal AC or FASTT could not be clearly determined.

The corrected gestational age of the patient was collected from the last menstrual period or ultrasound confirm at first or second trimester.

The fetal AC was measured in centimeters of circumference of fetal abdomen in the cross sectional view by ultrasonography through the liver at level of portal vein, stomach, and vertebral spine. The FASTT was measured in millimeters at anterior third of abdominal circumference by placing the cursor at outer and inner edges of the echogenic subcutaneous fat line (Fig. 1). The sonographic measurement was performed by Voluson GE ultrasound unit, 2-5 MHz wide band convex, curved array transducer.



**Fig. 1.** Sonographic measurement of FASTT. The arrows describe the outer and inner edges of the echogenic subcutaneous fat line.

After informed consent had been obtained, the sonographic measurements of fetal AC and FASTT were performed twice (AC1, AC2 and FASTT1, FASTT2, respectively) by only one investigator and averaged values (AC1 + AC2/2 and FASTT1 + FASTT2/2, respectively) were recorded. After the ultrasound had been performed, labor management was followed as usual protocol.

Fetal macrosomia is defined as fetal birth weight of greater than 4,000 g<sup>(1)</sup>. Each neonate was weighed on metric scale immediately after delivery. The maternal and neonatal demographics and actual fetal birth weight were recorded after delivery.

Sample size estimation was calculated using the formula  $N = Z^2\alpha/2 \times P(1-P)/d^2$ , P was the expected specificity (0.75)<sup>(22)</sup>, then N was a number of non-fetal macrosomia. The prevalence of macrosomia in Ramathibodi Hospital was 4%. Total sample size required was 302 pregnant women.

### Statistical analysis

All statistical analyses were done with STATA

version 13.0. Descriptive statistics including mean and standard deviation (SD), median with range, and percentage were used to describe data. The optimal cut off level of fetal AC and FASTT values were analyzed as receiver operating characteristic (ROC) curve. Sensitivity, specificity, positive predictive value (PPV), negative positive predictive value (NPV) and accuracy were analyzed.  $P < 0.05$  was considered statistically significant for comparing area under ROC curve.

### Results

Total 2466 term singleton pregnant women delivered between February 2013 and January 2014 at Ramathibodi Hospital. This study included 302 singleton pregnant women. The demographic data are presented in Table 1. The mean maternal age and BMI were  $29.0 \pm 6.2$  years and  $21.8 \pm 3.6$  kg/m<sup>2</sup>, respectively. The median gestational age was 39 weeks (range 37 - 41). The prevalence of macrosomia was 6.9% (21/302). The median fetal macrosomia weight was 4,160 g (range 4,030 - 4,420) whereas the mean fetal birth weight was  $3,251.7 \pm 429.8$  g.

**Table 1.** Demographic data.

Characteristics	N = 302 cases
Demographic data	29 ± 6.01
Maternal pre-pregnancy weight	54 ± 14.72
Total weight gain	21 ± 17.98
Gestational age at birth	37 ± 2.62
Maternal underlying disease [N (%)]	
GDMA1*	61 (20.2)
GDMA2*, Pregestational DM†	10 (3.3)
Preeclampsia	5 (1.7)
Chronic hypertension	5 (1.7)
Fetal macrosomia [N (%)]	21 (6.9)
Fetal macrosomia weight: g [median(range)]	4,160 (4,030 - 4,420)
Fetal birth weight: g [mean ± SD]	3,251.7 ± 429.8
Sex [N (%)]	
Male	147 (48.7)
Female	155 (51.3)

\*Gestational diabetes mellitus (GDM), †Diabetes mellitus (DM)

**Table 2.** The diagnostic value of AC > 36.7 cm and FASTT > 10 mm for predicting fetal macrosomia.

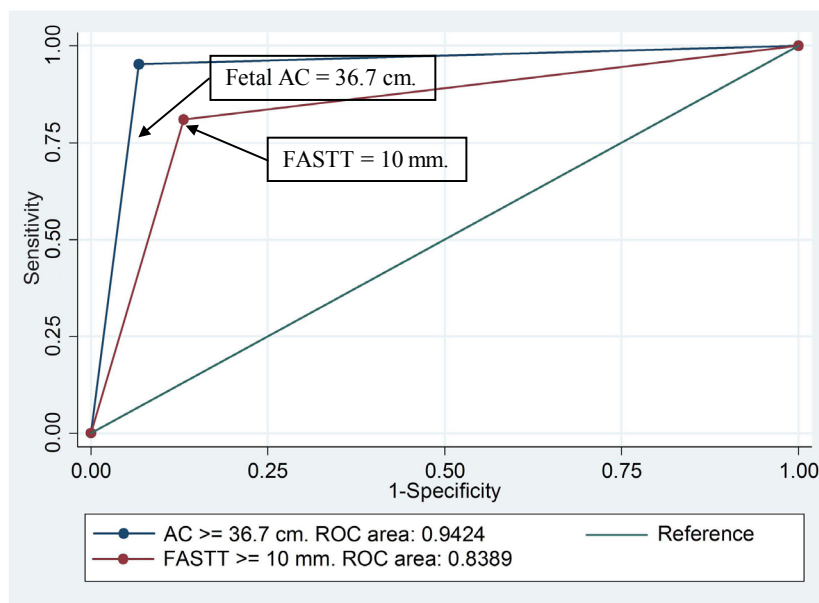
	Sensitivity(%)	Specificity(%)	PPV(%)	NPV(%)	Accuracy(%)
Fetal AC > 36.7 cm.	95.2	93.2	51.3	99.6	93.4
FASTT > 10 mm.	81.0	86.8	31.5	98.4	86.4

The ROC curve was drawn to determine the sensitivity and specificity of fetal AC and FASTT for use in predicting fetal macrosomia. The area under ROC curve of fetal AC and FASTT to predict fetal macrosomia were 0.97 (95% CI 0.95 - 0.99) and 0.93 (95% CI 0.89 - 0.96), respectively. The optimal cut off values of fetal AC and FASTT to predict fetal macrosomia were 36.7 cm, and 10.0 mm, respectively.

Table 2 shows sensitivity of fetal AC  $\geq$  36.7 cm

and FASTT  $\geq$  10.0 mm to predict fetal macrosomia were 95.2% and 81.0%, specificity were 93.2% and 86.8%, PPV were 51.3% and 31.5%, NPV were 99.6% and 98.4% and accuracy were 93.4% and 86.4%, respectively.

The area under ROC curve of fetal AC  $\geq$  36.7 cm to predict fetal macrosomia (0.94, 95% CI 0.89 - 0.99) was higher than FASTT  $\geq$  10.0 mm (0.84, 95% CI 0.75 - 0.93),  $p = 0.05$ . (Fig. 2)



$P = 0.05$

**Fig. 2.** Comparison of the area under ROC curve of fetal AC  $\geq$  36.7 cm and FASTT  $\geq$  10.0 mm for predicting fetal macrosomia

## Discussion

Fetal macrosomia is associated with maternal and perinatal morbidity and mortality, especially in pregnant women who are vaginally delivered<sup>(5)</sup>. An accurate diagnosis of fetal macrosomia is critical in the management of labor in order to minimize these adverse outcomes. Inaccuracy in clinical estimates of fetal weight by physical examination is often attributable. The sonographic estimates of fetal weight are used to improve the accuracy<sup>(1)</sup>. A variety of formulae based on fetal anthropometric (biparietal diameter, head and abdominal circumferences, femur length) have been published and have a wide range of accuracy<sup>(8-10)</sup>. The accuracy of these estimates can be affected by variation in the shape of the head or other structures, an engaged fetal head in intrapartum period, lie of the fetus, oligohydramnios, etc.

In previous studies, the fetal AC has the strongest correlation with fetal birth weight and was useful for predicting fetal macrosomia with high sensitivity, specificity, NPV, and accuracy<sup>(15-17,22-23)</sup>. There was a significant positive correlation between FASTT and birth weight. The FASTT was useful for estimating fetal weight and ruling out macrosomia<sup>(20-21,24-26)</sup>. Therefore, the fetal AC and FASTT are of interest as single parameter for predicting fetal macrosomia.

In this study, we found that the sonographic measurement of fetal AC  $\geq 36.7$  cm and FASTT  $\geq 10.0$  mm were showed high sensitivity (95.2% and 81.0%), specificity (93.2% and 86.8%), NPV (99.6% and 98.4%) and accuracy (93.4% and 86.4%) to predict fetal macrosomia. The cut off values of fetal AC and FASTT were consistent to the studies of Al-Inany et al (fetal AC  $\geq 37$  cm was found to have a sensitivity 77% and a specificity 75%)<sup>(22)</sup> and Petrikovsky et al (FASTT  $\geq 10$  mm was found to have a sensitivity 70% and a specificity 84%)<sup>(24)</sup>.

The PPV was low but high NPV was observed. It is important to emphasize that the PPV and NPV depend on prevalence rate of fetal macrosomia in the population being assessed. The higher the prevalence rate, the higher PPV and the lower NPV. The fetal AC  $\geq 36.7$  cm or FASTT  $\geq 10.0$  mm might be fetal

macrosomia, so it should be concerned with the partogram and pelvis diameters to consider appropriate route of delivery. Moreover, we found that the sonographic measurement of fetal AC  $\geq 36.7$  cm was more accurate than FASTT  $\geq 10.0$  mm for predicting fetal macrosomia.

It must be emphasized that this study was a prospective one and the sonographic measurement was performed within 24 hr before delivery, this was to eliminate the possible effect of the time elapsed between examination and delivery for actual fetal birth weight.

The limitations of this study were the difficulty in measuring fetal AC and FASTT in obese pregnant women. The transducer of ultrasound machine pressure on abdomen was also a limitation since it could affect the accuracy of fetal AC. In our opinion, measurement of FASTT is easier than fetal AC. Therefore the FASTT can use as single parameter for predicting fetal macrosomia if the fetal AC cannot be clearly determined.

## Conclusion

The sonographic measurements of fetal AC and FASTT were useful for predicting fetal macrosomia, especially in ruling out this abnormality.

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## การวัดเส้นรอบท้องและความหนาของผนังหน้าท้องทารกในครรภ์ด้วยเครื่องตรวจคลื่นความถี่สูงเพื่อทำนายภาวะทารกตัวโต

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**วัตถุประสงค์และวิธีการ:** เพื่อศึกษาหาค่าเส้นรอบท้องและความหนาผนังหน้าท้องทารกในครรภ์ที่วัดได้จากเครื่องตรวจคลื่นเสียงความถี่สูงที่สามารถทำนายภาวะทารกตัวโต

**เครื่องมือและระเบียบวิธีวิจัย:** การศึกษาไปข้างหน้าในหญิงตั้งครรภ์ครบกำหนดระหว่างเดือนกุมภาพันธ์ 2556 ถึงมกราคม 2557 ได้ทำการวัดเส้นรอบท้องและความหนาของผนังหน้าท้องของทารกในครรภ์ และทารกคลอดภายใน 24 ชั่วโมงถัดมา โดยทารกตัวโตมีน้ำหนักแรกเกิดมากกว่า 4,000 กรัม จากนั้นนำมาวิเคราะห์หาค่าที่เหมาะสมเพื่อทำนายภาวะทารกตัวโต

**ผลการศึกษา:** การศึกษาในหญิงตั้งครรภ์ทั้งสิ้น 302 คน โดยมีฐานอายุครรภ์ที่ 39 สัปดาห์ (37-41 สัปดาห์) มีความสูงของทารกตัวโต 6.9% โดยพบว่าเส้นรอบท้องของทารกในครรภ์มากกว่าเท่ากับ 36.7 เซนติเมตร และความหนาผนังหน้าท้องทารกในครรภ์มากกว่าเท่ากับ 10 มิลลิเมตร มีค่าความไวในการทำนายภาวะทารกตัวโตเท่ากับ 95.2% และ 81.0% ค่าความจำเพาะเท่ากับ 93.2% และ 86.8% ค่าทำนายผลบวกเท่ากับ 51.3% และ 31.5% ค่าทำนายผลลบเท่ากับ 99.6% และ 98.4% และค่าความแม่นยำเท่ากับ 93.4% และ 86.4% ตามลำดับ

**สรุป:** การวัดเส้นรอบท้องและความหนาของผนังหน้าท้องทารกในครรภ์ด้วยเครื่องตรวจคลื่นความถี่สูงสามารถใช้ในการทำนายภาวะทารกตัวโต

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