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## Antepartum Detection of Macrosomic Fetus Clinical Versus Sonographic Including Humeral Soft Tissue Thickness

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### Abstract

**Background:** Neonatal mortality rates decrease with increasing birth weight until approximately 4000g, after which mortality increases. Maternal diabetes and obesity are among the predisposing factors for fetal macrosomia for which there are many fetal and maternal consequences like increasing incidence of birth injuries and caesarean section rates respectively.

**Objective:** To compare clinical & sonographic estimation of birth weight using Hadlock's (1) equation with other estimation technique that involve measurement of fetal humeral soft tissue thickness to identify newborns with excessive birth weight of at least 4000 grams.

**Patients & Methods:** This study was conducted at the department of Gynaecology & Obstetrics in Al-Yermouk Teaching Hospital, Baghdad, Iraq.

Ninety pregnant women were studied. They had gestational ages of 37 weeks or more and a suspicion of fetal macrosomia based on the presence of one or more of certain risk factors. About 24 hours prior to delivery of the fetus clinical estimation of fetal body weight using Leopold's manoeuvre was done followed by sonographic fetal weight estimation using Hadlock's (1) equation. Fetal humeral soft tissue thickness was measured by ultrasound three times and an average of the three readings was taken. Then a comparison of the three methods mentioned above was done regarding their validity in predicting fetal macrosomia.

**Results:** Sonographic fetal humeral soft tissue thickness correlates with birth weight and found to be higher in macrosomic than the non-macrosomic newborns (14.35mm versus 11.6mm) and the difference was statistically significant (P value <0.001). The sonographic fetal humeral soft tissue thickness measurement was more sensitive in predicting fetal macrosomia than the sonographic fetal weight estimation (87.2 versus 75%) but less specific (74.2 versus 86%). The clinical estimation has the lowest accuracy in predicting fetal macrosomia compared with sonographic fetal weight estimation and sonographic fetal humeral soft tissue measurement.

**Conclusion:** The sonographic measurement of fetal humeral soft tissue thickness positively correlates with newborn birth weight. It is more accurate than the clinical fetal weight estimation in predicting fetal macrosomia. On the other hand it is more sensitive but less specific than the sonographic fetal weight estimation using Hadlock's (1) equation in predicting fetal macrosomia.

**Keywords:** *Fetal Macrosomia, humeral soft tissue thickness*

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### Introduction:

Fetal macrosomia has been defined in different ways, including birth weight of 4000-4500g (8lb 13 oz to 9 lb 15 oz)<sup>(1)</sup>, birth weight greater than 90th percentile for gestational age after correcting for neonatal sex and ethnicity<sup>(2,3,4)</sup>, birth weights two standard deviations above the mean<sup>(1,4)</sup>. However the most clinically useful definition of macrosomia is a weight below which "macrosomic" complications, such as shoulder dystocia, do not occur<sup>(5)</sup>. Fetal macrosomia affects between 3-15% of all pregnancies<sup>(6)</sup>.

The pathophysiology of fetal macrosomia is related to the associated maternal or fetal condition that accounts for its development and these include maternal obesity and excessive maternal weight gain during pregnancy, diabetic pregnancy<sup>(4,7)</sup> and advanced gestational age (this results in larger birth weight at delivery by allowing the growth process to continue in utero)<sup>(4,8)</sup>.

There are risk Factors for fetal macrosomia such as diabetes Mellitus<sup>(4,9,10)</sup>, genetic factors<sup>(1,11)</sup>, multiparity<sup>(12)</sup>, prolonged gestation<sup>(13)</sup>, male fetus<sup>(4,14)</sup>, previous infants weighing more than 4000 gram<sup>(4,15)</sup>, race and ethnicity<sup>(1,4)</sup>, maternal birth weight<sup>(11)</sup>, positive 50-gram glucose screen with a negative result on the 3-hour glucose tolerance test<sup>(1,11)</sup>.

The fetal and maternal consequences of fetal macrosomia include shoulder dystocia, birth injuries (such as cervical and brachial plexus injuries, fractured clavicles, cephalohematomas), intrapartum asphyxia, neonatal hypoglycemia, neonatal hypocalcaemia, macrosomic cardiomyopathy<sup>(16,17,18,19)</sup>, increased incidence of operative vaginal delivery, caesarean section, risk of third or fourth degree perineal lacerations and postpartum hemorrhage<sup>(4,6)</sup>.

The three major strategies used to predict fetal macrosomia are: clinical risk factors, clinical estimation by Leopold's manoeuvre,

ultrasonography. Each method has substantial limitations<sup>(4)</sup>.

When two or more of risk factors are present, the risk of macrosomia is only 32%. Further more, 34% of macrosomic infants are born to mothers without any risk factor<sup>(20)</sup>.

Clinical estimation of fetal weight means tactile assessment of fetal dimensions through the maternal abdomen. It involves palpating the fetal parts directly through the maternal abdominal and uterine walls to estimate fetal weight. This method is both convenient and costless, but it possesses large predictive errors, especially for large infants<sup>(5,6)</sup>.

Fetal measures made by ultrasound in pregnancy include the biparietal diameter (BPD), the femur length (F L) and the abdominal circumference (AC) which is the single most important measurement to make in late pregnancy. It reflects more of the fetal size and weight rather than age. It is the most sensitive of the individual fetal parameters for the detection of growth abnormalities<sup>(21,22)</sup>.

The sonographic measurements of multiple linear and planar dimensions of the fetus provide sufficient parametric to allow for accurate algorithmic reconstruction of the 3-dimensional fetal volume of varying tissue density<sup>(23)</sup>.

Different models of ultrasound estimation of fetal weight have been proposed by Hadlock's (1)&2, Birnholz, Deter et al, Jordan, Shepard, and Warsof et. al, using biparietal diameter (BPD), occipitofrontal diameter (OFD), anteroposterior and transverse abdominal diameters (AD1 and AD2) and femur length (FL) in centimeters.

However, Hadlock's (1) method is superior predictor of birth weight compared to the other methods and is a method of choice to estimate the birth weight in term pregnancies where the measurement of fetal head is inaccurate either because of engagement or molding, as it incorporates only FL and AC measurements which are not affected by these changes<sup>(24)</sup>.

Estimated fetal weight by Hadlock's (1) formula:

$$\text{Log}_{10} (\text{BW}) = 1.3598 + 0.051 (\text{AC}) + 0.1844 (\text{FL}) - 0.0037 (\text{AC} * \text{FL})$$

Several technical limitations of the sonographic technique for estimating fetal weight are well known, among these are maternal obesity, anterior placentation, and oligohydramnios, therefore, investigations have been attempted to improve the accuracy of ultrasound in predicting fetal weight. Landon et al<sup>(25)</sup> showed that fetal humeral soft tissue thickness measurement may distinguish disproportionately large fetuses that may be at risk for difficult delivery. Because macrosomic infants tend to have increased subcutaneous adipose tissue, we sought to determine usefulness of an objective assessment of fetal humeral soft tissue thickness in estimating birth weight in a population at risk for macrosomia.

#### **Aim of study:**

To compare clinical & sonographic estimation of birth weight using Hadlock's (1) equation; with other estimation technique that involves measurement of humeral soft tissue thickness to identify newborns with excessive birth weight of at least 4000 gm.

#### **Patients and Methods:**

This study was conducted for a period of one year starting from January 2004 through January 2005 in the obstetrics and gynecology department of Al-Yermouk Teaching Hospital. The study included 90 pregnant women with gestational ages of 37 weeks or more (according to sure last menstrual period and /or an early dating scan) with singleton gestation, having intact fetal membranes and there is no evidence of fetal congenital abnormality by ultrasound and after delivery.

Those patients have at least one of the following risk factors for fetal macrosomia: gestational diabetes, pre-existing diabetes, postdate pregnancy and prior delivery of a macrosomic infant. They were presenting in early labor or for induction of labor or for caesarean section (i.e. prior to delivery).

For those patients who were selected, detailed obstetrical and medical history were taken. General examination including maternal body weight and height was performed; clinical estimation of fetal body weight was done using Leopold's maneuver and blood for measuring

2-hours postprandial blood sugar was sent. Ultrasound examination was performed by the same sonologist to obtain morphometric measurements including the fetal abdominal circumference and femoral length.

Abdominal circumference measurement was made from an axial section of the fetal trunk at the level of the liver. The main landmark is the portal-umbilical venous plexus, with the fetal stomach as a secondary landmark if the vein cannot be visualized. The image of the abdomen should be as round as possible to preclude the possibility of an off-axis or oblique section.

For femoral length measurement, the entire shaft of the femur should be perpendicular to the ultrasound beam. The measurement was made for the entire diaphysis. Inclusion of the distal femoral epiphysis was avoided. Care also was taken to avoid foreshortening of the femur with a tangential section, or including soft tissue reflections in the measurement, particularly those at the distal end of the femur. Estimated fetal weight (EFW) was calculated using Hadlock's (1) formula.

The fetal humerus was visualized in a longitudinal view, and the transducer was rotated then moved cephalad until the head of the humerus was found. The measurement was taken by (mm) immediately below the humeral head from the outer edge of the bone to the skin surface.

Care was taken to ensure that the view was perpendicular to the humerus. The humeral soft tissue thickness measurement was performed three times, and the average of the three values was compared with the estimated fetal weight for its ability to predict macrosomia.

After delivery the baby's body weight were accurately assessed using the neonatal weight scale.

Data were analyzed with unpaired t test and correlation analysis. Sensitivities and specificities were calculated from 2x2 tables. P value <0.05 was considered statistically significant.

**Results:**

Ninety pregnant women with one or more risk factors for fetal macrosomia were included in the study. Fifty-five women delivered infants weighing 4000g or more and thirty-five women delivered infants weighing less than 4000g.

Table (1) shows the accuracy of clinical estimation of fetal weight using Leopold's maneuver in prediction of fetal macrosomia.

The sensitivity & specificity were 63.6% & 77.1% respectively. The positive predictive value was 81.3% & the negative predictive value was 57.4%.

**Table (1):** The accuracy of clinical estimation in predicting fetal macrosomia

Clinical Estimation	True Fetal weight		
	≥ 4000 g	< 4000 g	Total
<b>Total</b>	<b>55</b>	<b>35</b>	
<b>≥ 4000 g</b>	35	8	43
<b>&lt; 4000 g</b>	20	27	47

Sensitivity = 63.6%

Specificity = 77.1%

Positive predictive value = 81.3%

Negative predictive value = 57.4%

Table (2) shows the accuracy of sonographic fetal weight estimation using Hadlock's (1) equation in prediction of fetal macrosomia.

The sensitivity & specificity were 74.5% & 85.7% respectively. The positive predictive value was 89% & the negative predictive value was 68%.

**Table (2):** The accuracy of sonographic fetal weight estimation in predicting fetal macrosomia

U/S Fetal Weight Estimate	True Fetal Weight		
	≥ 4000 g	< 4000 g	
<b>≥4000 g</b>	41	5	46
<b>&lt; 4000 g</b>	14	30	44
<b>Total</b>	55	35	90

Sensitivity = 74.5%

Specificity = 85.7 %

Positive predictive value = 89%

Negative predictive value = 68 %

Table (3) shows the mean (± standard deviation) of the sonographic fetal humeral soft tissue thickness in different categories of women.

The mean humeral soft tissue thickness was statistically higher in infants weighing at least 4000 g than in those weighing less than 4000g (14.35 mm versus 11.6 mm) P value <0.001. The difference in HSTT between diabetic and non-diabetic was not statistically significant.

**Table (3):** The sonographic measurement of fetal humeral soft tissue thickness

	Fetal Humeral Soft Tissue Thickness	
	Mean (mm)	±Standard deviation
<b>All subjects</b>	13.27	1.79
<b>Birth weight &lt; 4000 g</b>	11.6	1.24
<b>Birth weight ≥ 4000g</b>	14.35	1.20

The difference between macrosomic & non macrosomic groups was statistically significant. P value using unpaired t test < 0.001

Figure (1) shows the correlation between sonographic fetal humeral soft tissue thickness measurement and birth weight which was statistically significant (p value < 0.001).

Figure (1): Birth weight versus sonographic fetal humeral soft tissue thickness measurement

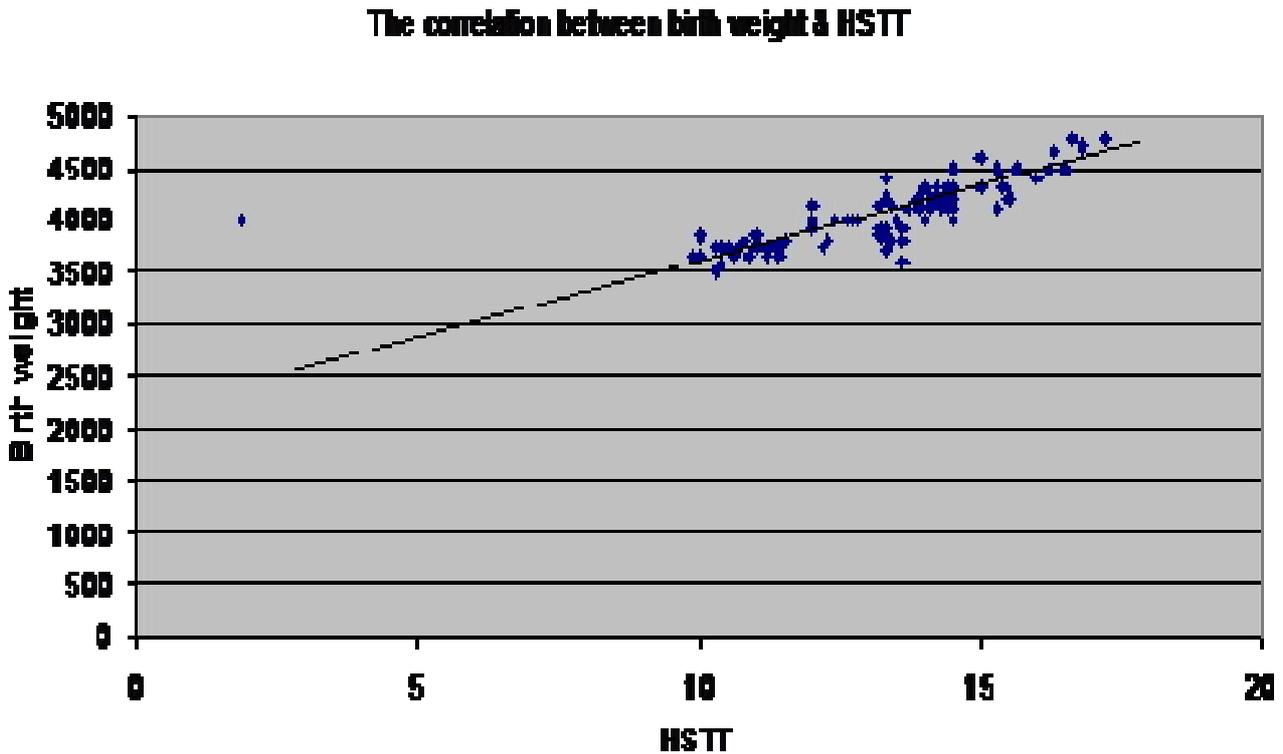


Table (4) Accuracy of sonographic measurement of fetal humeral soft tissue thickness in prediction of fetal macrosomia.

Table (4): The accuracy of sonographic fetal humeral soft tissue thickness in predicting fetal macrosomia

HSTT	True Fetal Weight		
	≥ 4000 g	< 4000 g	Total
≥ 13 mm	48	9	57
< 13 mm	7	26	33
Total	55	35	

HSTT: Humeral Soft Tissue Thickness.

Sensitivity = 87.2%      Specificity = 74.2%      Positive predictive value = 84.2%

Negative predictive value = 78.7%

Table (5) shows the accuracy of clinical estimation of fetal weight in prediction of fetal macrosomia in comparison with sonographic fetal weight estimation and sonographic measurement of fetal humeral soft tissue thickness. Sonographic measurement of fetal humeral soft tissue thickness had the highest sensitivity (87.2%) and negative

predictive value (78.7%), while the sonographic fetal weight estimation had the highest specificity (85.7%) and positive predictive value (89%). While the clinical estimation of fetal weight had the lowest accuracy compared with sonographic fetal weight estimation and sonographic fetal humeral soft tissue thickness measurement.

**Table 5: Comparison of the accuracy of clinical estimation, sonographic fetal weight estimation & sonographic fetal humeral soft tissue thickness in predicting fetal macrosomia**

	Sensitivity	Specificity	Positive predictive value	Negative predictive value	Accuracy
<b>Clinical estimation</b>	63.6%	77.1%	81.3%	57.4%	68%
<b>sonographic fetal weight estimate</b>	75%	86%	89%	68%	80%
<b>sonographic fetal HSTT</b>	87.2%	74.2%	84.2%	78.7%	82%

When the actual weight cut off point is 4000 g,  
HSTT: Humeral Soft Tissue Thickness

**Discussion:**

Identifying newborns who weigh 4000g or more is important because fetal macrosomia is associated with adverse peripartum outcome (maternal and fetal).

To avoid these complications, an accurate diagnosis of fetal macrosomia before birth is helpful as this will modify the plan of management of delivery and care of the newborn<sup>(4)</sup>.

Pregnant women were selected, in our study, on the basis of the presence of one or more of certain risk factors. These risk factors include diabetes (gestational or pre-gestational), prolonged pregnancy and history of previous delivery of macrosomic infant.

Chauhan et al<sup>(26)</sup> had studied 661 patients and compared the accuracy of different methods for prediction of term fetal macrosomia of greater than 4000g. He found that clinical estimation of fetal weight had a sensitivity and specificity of 54 and 95% respectively, a positive predictive value of 60% and a negative predictive value of 93%.

In our study clinical estimation of fetal weight by Leopold's maneuver found to have a sensitivity and specificity of 64 and 77% respectively, a positive predictive value of 81% and a negative predictive value of 57%.

The difference may be because we were more cautious and our attention was more directed toward the prediction of fetal macrosomia.

In addition, we have assessed in our study the accuracy of the sonographic fetal weight estimation in prediction of fetal macrosomia and found it to have a sensitivity and specificity of 74.5% and 85.7% respectively, a positive predictive value of 89% and a negative predictive value of 69%.

O'Reilly & Divon<sup>(27)</sup> had evaluated areas under receiver operating characteristic curves for sonographic estimated fetal weight as a predictor of fetal macrosomia in prolonged pregnancies. The

sensitivity, specificity, positive and negative predictive values were 85, 72, 49, and 94% respectively.

This wide variation in the validity of the test may be due to different sonographic scanner machines used and different sonographers' i.e. interobserver bias.

In a study done by Landon et al<sup>(25)</sup>, sonographic measurements of fetal humeral soft tissue thickness was performed for 93 women with gestational diabetes mellitus during the third trimester. He proved that this measurement was the most accurate predictor of excessive birth weight compared with other standard ultrasound parameters (i.e. abdominal circumference, femoral length and others). It had a sensitivity and specificity of 82 and 95% respectively and a positive predictive value of 90%.

In our study, we assessed the accuracy of sonographic measurement of fetal humeral soft tissue thickness in predicting fetal macrosomia in comparison with clinical and sonographic fetal weight estimation. It had the highest sensitivity (87.2%) and negative predictive value (78.7%) while the specificity was 74.2% and the positive predictive value 84.2% which were less than that of sonographic fetal weight estimation.

**Conclusion:**

The sonographic measurement of fetal humeral soft tissue thickness correlates positively with newborn birth weight and found to be more accurate than the clinical estimation of fetal weight in prediction of fetal macrosomia. As well as it was found to be more sensitive but less specific than the sonographic fetal weight estimation using Hadlock's (1) equation in prediction of fetal macrosomia, so we recommend sonographic measurement of fetal humeral soft tissue thickness as additional parameter to predict fetal macrosomia .

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