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

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Abstract:

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

Patients & Methods: A prospective study conducted in Gynaecology & Obstetrics Department in Al-Yarmook Teaching Hospital, Baghdad, Iraq. Ninety pregnant women were studied between October 2003 and September 2004. 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. 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 (the distance from the outer edge of the humerus to the skin surface on transverse views of the upper arm) was measured by ultrasound. 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 positive predictive value was 84.2 versus 89% and the negative predictive value was 78.7 versus 68% respectively while 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.

Introduction:

Macrosomia is a term used rather imprecisely to describe a very large fetus-neonate. [1]Fetal macrosomia has been defined in different ways, including birth weight of 4000-4500 g or greater than 90th percentile for gestational age after correcting for neonatal sex and ethnicity. [2,3] For example, the 90th percentile at 39 weeks is 4000 g whereas the corresponding birth weight at 42 weeks is 4400.[1]

Fetal macrosomia affects between 3% and 15% of all pregnancies, depending upon the racial and socioeconomic composition of the population under study. [4]

Risk Factors for Fetal Macrosomia:

1. Diabetes Mellitus: Delivery of an infant weighing greater than 4500 g occurs ten times more often in diabetic women than in a non-diabetic population .[5]
2. Genetic Factors : Large size of the parents especially obesity of the mother [1]. Overweight and obese women are at increased risk for having large for gestational age infant and cesarean delivery. [6]
3. Multiparity.
4. Prolonged gestation: As many as 45% of the fetuses undelivered at their expected date of delivery continue to grow in utero. With each additional week, more babies have a birth weight greater than 4000 g.
5. Male Fetus: Male infants typically weigh more than female infants at any gestational age. [7, 8]
6. Previous infants weighing more than 4000 gram: Women with a previous delivery of an infant weighing >4000 g are at increased risk of giving birth to a large for gestational age infant. [9]
7. Race and ethnicity: Studies have demonstrated that Hispanic women have a higher risk of fetal macrosomia compared with white, African, American or Asian women [1].

Consequences of Fetal Macrosomia:

Fetal Consequences:

I- Shoulder dystocia: It describes a range of difficulties encountered with delivering the shoulder after delivering the head. It is the most feared complication of macrosomia and up to one forth of infants with shoulder dystocia experience brachial plexus or facial nerve injuries, or fractures of the humerus or clavicle. Also it can lead to asphyxia and hypoxic encephalopathy. [10]

II-Birth Trauma: Injuries to the infant resulting from mechanical factors (compression, traction) during the process of birth are categorized as birth trauma.

Other consequences include: intrapartum asphyxia [4], neonatal hypoglycemia [11], neonatal hypocalcemia [12] & macrosomic cardiomyopathy. [11]

Maternal Consequences:

1. Increased incidence of operative vaginal delivery and cephalopelvic disproportion.
2. Increased incidence of cesarean section.
3. The risk of third or forth degree lacerations are increased five folds. [13]
4. Increased incidence of postpartum hemorrhage. [13]

Strategies to Predict Fetal Macrosomia:

The three major strategies used to predict macrosomia are:

- Clinical risk factors.
- Clinical estimation by Leopold's manoeuvre: Tactile assessment of fetal dimensions through the maternal abdomen.
- Ultrasonography:

The ultrasonographic technique represents the newest and most technologically sophisticated method of obtaining birth weight estimation. [14]Different models of ultrasound estimation of fetal weight have been proposed by Hadlock 1&2 ,Birnholz, Deter et al , Jordan, Shepard, and Warsof et al , using biperietal diameter (BPD), occipitofrontal diameter (OFD), anteroposterior and transverse abdominal diameters (AD1 and AD2) and femur length (FL) in centimeters. [15]

Technical limitations of ultrasound estimation:

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 showed that fetal humeral soft tissue thickness measurement (the distance from the outer edge of the humerus to the skin surface on transverse view of the upper arm) 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 the usefulness of an objective assessment of fetal humeral soft tissue thickness in estimating birth weight in a population at risk for macrosomia. [16]

Aim of study:

To compare clinical & sonographic estimation of birth weight using Hadlock's(1) equation with a new estimation technique that involves measurement of humeral soft tissue thickness to identify newborns with excessive weight.

Patients and Methods:

This study was conducted for a period of one year, from the start of October 2003 to the end of September 2004, in the Obstetrics and Gynaecology Department of Al-Yarmook Teaching Hospital. The study included 90 pregnant women with gestational ages of 37 weeks or more who had at least one of the following risk factors for fetal macrosomia:

- Gestational diabetes.
- Pre-existing diabetes.
- Postdate pregnancy.
- Prior delivery of a macrosomic infant.

Patients either presented in early labor or for induction of labor or for caesarean section (i.e. prior to delivery). Patients included in the study met the following criteria:

1. Singleton gestation.
2. Intact fetal membranes if the patient presented in early labor.
3. The gestational age was considered to be reliable based on the last menstrual period, regarding the patient was sure of her LMP and had regular menstrual cycles, and/or on early ultrasound estimation of the gestational age.
4. No evidence of congenital abnormality by ultrasound and after delivery.

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 (screening of diabetes in pregnancy). Patients then referred for ultrasound study. Ultrasound examinations were performed using "Siemens, Sonoline Versa" ultrasound scanner. A 3.5 MHz curvilinear abdominal transducer was used to obtain morphometric measurements including the fetal abdominal circumference and femoral length. Abdominal circumference & femoral length were measured, Estimated fetal weight (EFW) was calculated using Hadlock 1 formula [40]: Log10 (BW) =1.3598 +0.051 (AC) +0.1844 (FL) _ 0.0037 (AC*FL)

The fetal humerus was visualized in a longitudinal view, and the transducer was rotated 90 then moved cephalad until the head of the humerus was found. The measurement was taken immediately below the humeral head from the outer edge of the bone to the skin surface. The humeral soft tissue thickness measurement was performed three times at the same occasion, and the average of the three values was compared with the estimated fetal weight for its ability to predict macrosomia. After delivery, the newborn's body weight was assessed.

Statistical analysis: 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:

Table (3.1) & figure (3.1) show a comparison of maternal characteristics between women who delivered macrosomic infants and those who did not. Statistically significant difference was found regarding maternal weight (87.8 kg versus 84.1 kg);

height (165.6 cm versus 163.7 cm), parity (5 versus 3) and gestational age (39.8 week versus 38.6 week).Whereas the maternal age and 2-hours postprandial blood sugar were not statistically significant.

Table (3.4) 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. Figure (3.2) shows the correlation between sonographic fetal humeral soft tissue thickness measurement and birth weight which was statistically significant (p value < 0 .001). Table (3.6) & figure (3.3) show 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.

Discussion:

In a study done by Karim et al. [17] who analysed the prevalence and outcome of macrosomia in Pakistan, he found that maternal age over 35 years, obesity, grandmultiparity, postmaturity and impaired glucose tolerance were associated with fetal macrosomia. Similar results were found by Meshari et al [18] in Saudi Arabia. However, in our study maternal age was not found to be significantly higher in the macrosomic group probably because the ages of women in our sample were not so diverse and most of their ages were around 30 years. On the other hand we did not find 2-hours postprandial blood sugar to be statistically significant as a risk factor for fetal macrosomia. We may need to do oral glucose tolerance test or even 1-hour glucose screen to detect impaired glucose tolerance in women with macrosomic fetuses. Chauhan et al (1998) [19] 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 (1997) [(20)] 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, and 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 [(16)], sonographic measurement 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:

1. The sonographic measurement of fetal humeral soft tissue thickness positively correlates with newborn birth weight.
2. The sonographic measurement of fetal humeral soft tissue thickness found to be more accurate than the clinical estimation of fetal weight in prediction of fetal macrosomia.
3. The sonographic measurement of fetal humeral soft tissue thickness found to be more sensitive but less specific than the sonographic fetal weight estimation using Hadlock's (1) equation in prediction of fetal macrosomia.

Recommendations:

1. Because of its sensitivity, we recommend sonographic measurement of fetal humeral soft tissue thickness as additional parameter to predict fetal macrosomia as it is easy to be applied.
2. Introduce a new formula for sonographic fetal weight estimation which includes fetal humeral soft tissue thickness measurement in addition to other parameters i.e. abdominal circumference and femoral length, so that the validity of sonographic prediction of fetal macrosomia can be increased.

Table (3.1). The maternal characteristics in the group under study.

characteristics	fetal weight		t test p value	Significance
	4000g Mean	<4000g Mean		
Age(year)	30.182 3.8	28.6 4.04	0.0687901	NS
Weight(Kg)	87.873 7.3	84.17 6.3	0.0132565	S
Height(cm)	165.6 1.6	163.74 2.2	0.0000078	S
Parity	5.1636 2.19	3.74 2.4	0.0063531	S
GA(week)	39.836 1.08	38.68 1.43	0.0001416	S
2-hrs postprandial BS(mg/dL)	130.98 13.9	128.45 8.51	0.2883651	NS

GA: Gestational Age
BS: Blood Sugar
S: Significant
NS: Not Significant

Figure (3.1) The maternal characteristics.

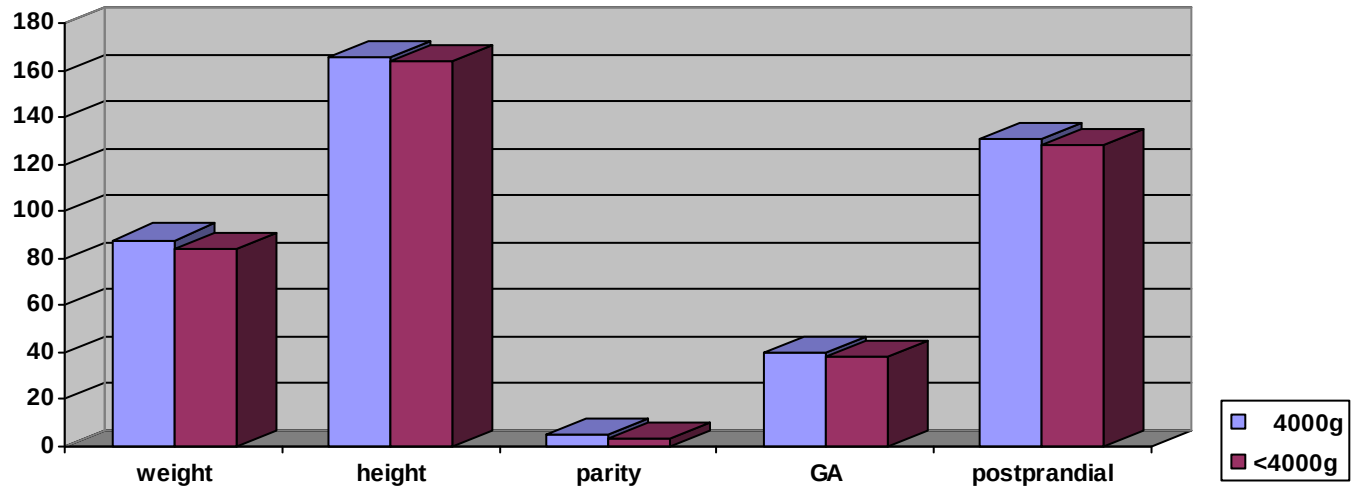


Table (3.4)
The sonographic measurement of fetal humeral soft tissue thickness

	Fetal Humeral Soft Tissue Thickness	
	Mean(mm)	±Standard deviation
All subjects	13.27	1.79
Birth weight < 4000 g	11.6	1.24
Birth weight 4000g	14.35	1.20

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

Figure (3.2) Birth weight versus sonographic fetal humeral soft tissue thickness

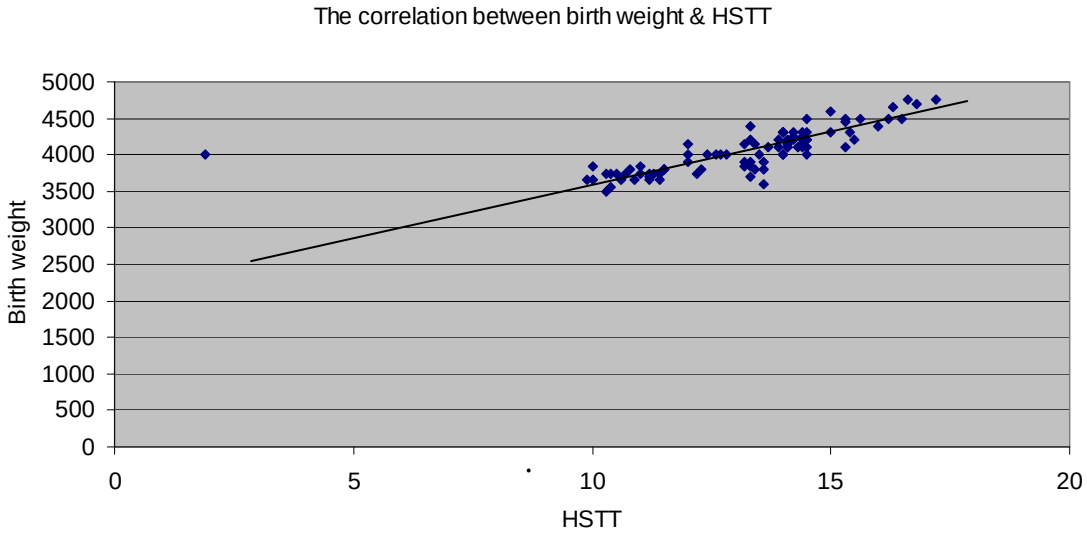
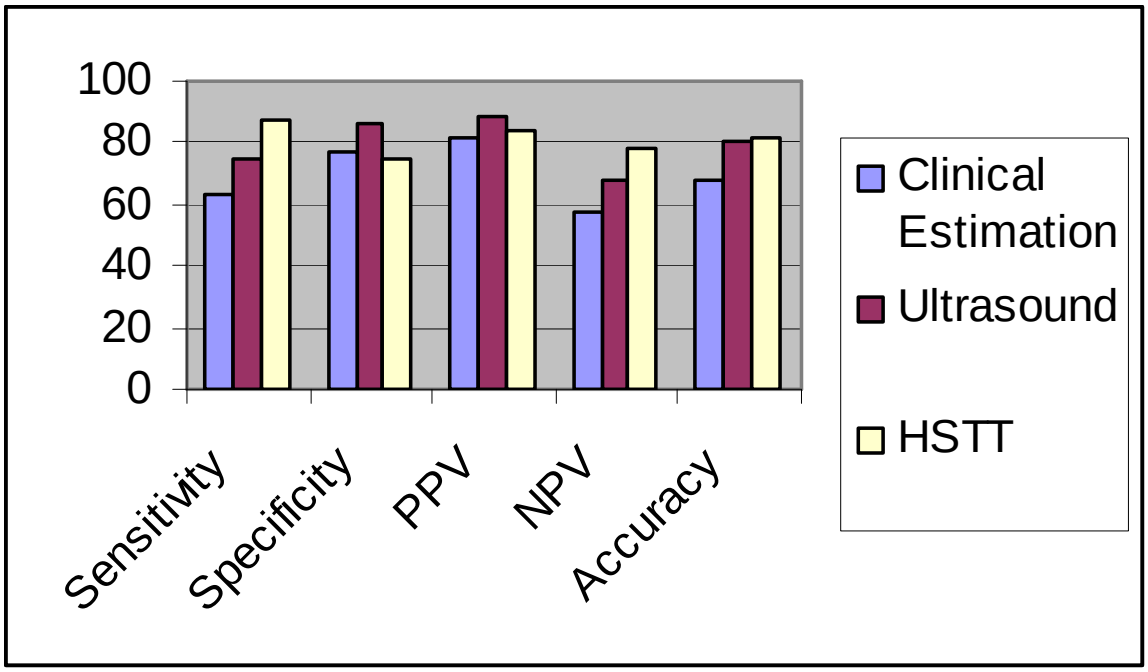


Table (3.6) Comparison of the validity of clinical estimation, sonographic fetal weight estimation & sonographic fetal HSTT in predicting fetal macrosomia

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

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

Figure (3.3) Comparison of the accuracy of clinical estimation, sonographic fetal weight estimation & sonographic fetal HSTT in predicting fetal macrosomia



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