Correlation of Fetal Abdominal Subcutaneous Tissue Thickness by Ultrasound to Predict Birth Weight

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Abstract: Background: Fetal growth abnormality is correlated with the variation of the soft tissue mass, which was reduced in growth limited fetuses and improved in macrosomia. **Objective:** To correlate fetal abdominal subcutaneous tissue thickness (FASTT) measured by ultrasound at term and birth weight. **Methods:** FASTT was measured at the anterior 1/3rd of abdominal circumference by U/S after 36.0 weeks and the weight of the fetus determine after delivery. **Results:** It was found that a positive significant relation between FASTT and weight of fetus. FASTT of 8.0 mm was good cut off value to predict large for gestational age (LGA) fetus and had a reasonable negative predictive value; FASTT measurement for prediction of small fetus with birth weight less than 2500 gms was not sensitive. **Conclusion:** FASTT is a good predictor as an additional indicator to estimate large for gestational age babies along with other known birth weight parameters.

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Key words: Fetal Abdominal Subcutaneous Tissue Thickness – Ultrasound- Birth Weight

1. Introduction

Sonographic assessment of fetal growth for the estimation of fetal weight (EFW) is a regular routine in obstetrics, if respected data for planning the mode of delivery and administration of labor. The majority of the formulae were projected in the early 1980 using some combinations of standardized fetal biometric parameters, like biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length. (1)

The accuracy to predict the estimated fetal weight (EFW) during delivery could have a major influence on the appropriate obstetric organization, particularly in cases of supposed macrosomia or low birth weight. Macrosomic fetuses may causing maternal and neonatal complications during delivery (2) and low birth weight fetuses are at high risk for perinatal morbidity and mortality. (3) Thus, a acurate estimate of birth weight could done to the avoidance of some of these difficulties. (4)

Earlier studies have established that this third trimester baby weight assessment does not let us to recognize the correct quantity of neither the small fetus at term nor the large ones, rising the need to assess fetal weight nearer to birth. (5)

There was many equations obtainable for estimating fetal weight based on standard ultrasound fetal dimensions and the greatest accurate include circumferential parameters, such as head circumference and abdominal circumference. Inappropriately, these parameters are more prone to intra and inter-observer variability, particularly at term, when these measurements are technically more problematic to find. (6)

The single measurement which correlates most strongly with fetal birth weight is fetal abdominal circumference. (6) Fetal size is usually categorized on the basis of estimated fetal weight being small (<10th percentile, SGA), appropriate (10th -90th percentile, AGA), or large (>90th percentile, LGA) for gestational age.

Antenatally, several biometric parameters have been used to estimate fetal size, IUGR and macrosomia. These would include biparietal diameter, head circumference, abdominal circumference and femur length. However, fetal size has not been found to accurately identify those fetuses at nutritional risk. (7)

Fetal subcutaneous tissue thickness correlates with fetal growth and metabolic state. Several studies have shown that sonographic measurements of fetal abdominal circumference and fetal abdominal subcutaneous tissue thickness are useful for predicting fetal macrosomia. **(8)**

Aim of the Work

This study was carried out to find the correlation between fetal abdominal subcutaneous tissue thickness (FASTT) measured by ultrasound at term and birth weight measured post partum and to determine the cut-off value of FASTT for prediction of large and small for gestational age fetus in our community.

2. Patients and Methods

Study design:

A prospective observational cross-sectional study.

Study Site:

Al Hussien University Maternity Hospital.

Study population:

The study population comprises singleton term pregnancies who delivered within one week of estimation of fetal abdominal subcutaneous tissue thickness (FASTT).

Sample size:

A total number of 100 cases of singleton term pregnancies who delivered within one week of estimation of fetal abdominal subcutaneous tissue thickness (FASTT).

Inclusion criteria:

All fetuses are full term; Average for gestational age babies (AGA); Large for gestational age babies (LGA) and Small for gestational age babies (SGA).

Exclusion criteria:

All fetuses with ultrasound detected congenital anomalies; All fetuses with premature rupture of membrane; All fetuses with oligohydraminos and All fetuses of multiple pregnancies.

Approach:

The thickness of the subcutaneous fat tissue at the anterior abdominal wall was measured. The transverse section of the baby trunk on the level of the abdominal circumference was done with fetal abdomen allowed from contact with arms or legs, with amniotic fluid between the fetal trunk and the uterine wall. Once this section was acquired, a magnification of the anterior abdominal wall was obtained.

Subcutaneous fetal fat tissue was recognized as an external hyperechoic surface. The width of this layer was measured by insertion one caliper exactly between the amniotic fluid and the fetal skin and the other caliper exactly between the subcutaneous fat layer and the anterior side of the liver in contact with the anterior abdominal wall. Thickness was measured three times by the same operator.

Statistical analysis:

Data obtained from the current study will be statistically analyzed by the Statistical Analysis Software Package (SPSS) for Windows.

Study Outcome

Primary outcome:

To find a sensitive way to detect full term fetal weight.

Secondary outcome:

To decrease fetal and maternal mortality and morbidity resulting from fetal weight variations.

3. Results:

The basic clinical and demographic data show that the age was ranged from 22-35 years with a mean of 26.54±3.12 years, the parity was ranged from 0-5 with a mean of 2.1±1.23, the gestational age was ranged from 37-41 weeks with a mean of 38.56±2.40 weeks.

The patients was classified into three categories of birth weight groups 8 cases was low birth weight, 88 cases was average and 4 cases only was macrosomia the weight was ranged from 2100-4250 gm, with mean of 3033.0±470.97 gm and median weight 3000.0 gm.

The fetal abdominal subcutaneous tissue thickness of cases was ranged from 3.50-9.0 mm with a mean of 6.10 ± 1.03 mm. the median was 6.10.

The equation to predict the birth weight from Fast T.

Birth weight = 435.12 + (430.6 x Fast T)

The equation to predict the birth weight show accuracy with about 88.0% the mean errors was ±32.0 gm.

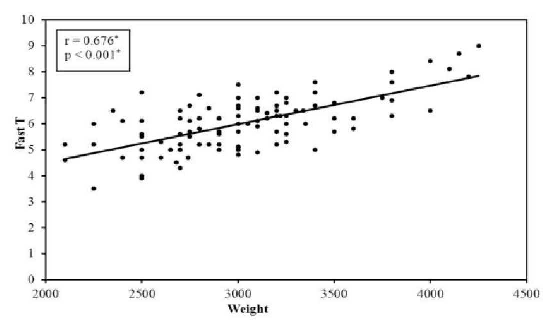

Figure (1): Correlation between Wight and Fast T

Table (1): Relation between Weight and Fast T in the three birth weight categories (n = 100)

Fast T	**Weight**			**F**	**p**
	Low (<2500) (n= 8)	**Average (2500 –4000) (n= 88)**	**Macrosmia (>4000) (n= 4)**		
Min. – Max.	3.50 – 6.50	3.90 – 8.40	7.80 – 9.0	17.391*	<0.001*
Mean ± SD.	5.23 ± 0.97	5.99 ± 0.90	8.40 ± 0.55		
Median	5.20	6.10	8.40		
Sig.bet.Grps	p_1=0.058, p_2<0.001*, p_3<0.001*				

F: F for ANOVA test, Pairwise comparison bet. each 2 groups was done using Post Hoc Test (LSD), (Tukey)

p: p value for association between Wight and Fast T

p_1: p value for comparison between Low (<2500) and Average (2500 –4000)

p_2: p value for comparison between Low (<2500) and Macro (>4000)

p_3: p value for comparison between Average (2500 –4000) and Macro (>4000)

*: Statistically significant at $p \le 0.05$

Figure (1) show that there was a positive significant correlation between fetal weight and Fast T (r = 0.676 and p <0.001).

Table (1), shows that there was a significant difference between women with different birth weight t (average, low and macrosomia) regarding the mean value of FAST, in such a way that the mean FAST was significantly higher in women who subsequently had neonates with macrosomia when compared to women who had average birth weights and in women who had neonates with average birth weights when compared to women who had neonates with low birth weights (p <0.001).

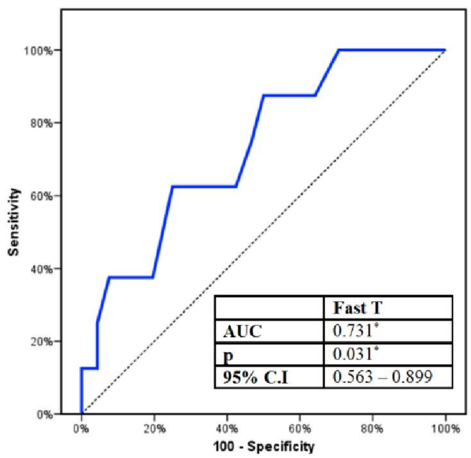

Figure (2): ROC curve for Fast T to diagnosis low weight (<2500)

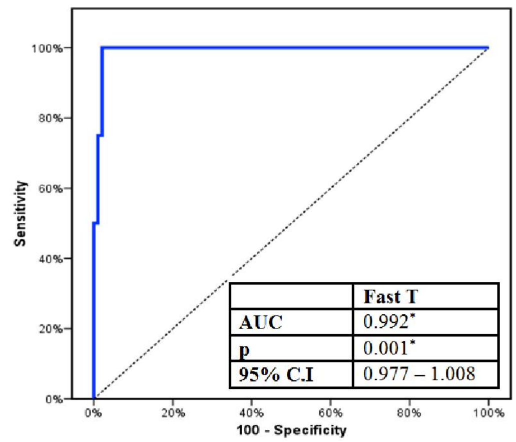

Figure (3): ROC curve for Fast T to diagnosis Macrosmia weight (>4000)

Table (2): Agreement (sensitivity, specificity) for Fast T diagnosis low and high weight.

Fast T	Cut off	Sensitivity	Specificity	PPV	NPV
Low	**≤5.2**	62.50	75.0	17.9	95.8
Macrosmia	**>8**	75.0	98.96	75.0	99.0

AUC: Area Under a CurveP value: Probability value CI: Confidence Intervals

ROC curve was constructed for FAST as predictor of low birth weight. FAST was a significant predictor of low birth weight, as indicated by the significant high area under the curve (AUC) [AUC = 0.731*, p<0.031]. The best cutoff value of FAST below which low birth weight is more likely was 5.2mm [sensitivity 62.50%, specificity 75%, PPV 17.9%, NPV 95.8%]. Receiver operator characteristics (ROC) curve was constructed for FAST as predictor of macrosomia. FAST was a significant predictor of macrosomia, as indicated by the significant large area under the (AUC) [AUC = 0.992*, p<0.001]. The best cutoff value of FAST above which macrosomia is more likely was 8 mm [sensitivity 75%, specificity 98.96%, positive predictive value (PPV) 75%, negative predictive value (NPV) 92%.

4. Discussion

In our study the age was ranged from 22-35 years with a mean of 26.54±3.12 years, the parity was ranged from 0-5 with a mean of 2.1±1.23 the gestational age was ranged from 37-41 weeks with a mean of 38.56±2.40 weeks. In agreement with our study, Bhat et al., 2014, carried out study to fid the correlation of fetal abdominal subcutaneous tissue thickness by ultrasound to predict birth weight, the study was carried out on pregnant female their age ranged from 19-33 with mean 27 years. Also the gestational age was ranged from 37-41 weeks. [9]

In our study regarding the fetal weight show 8 cases was low birth weight, 88 cases was average and 4 cases only was macrosomia the weight was ranged from 2100-4250 gm, with mean of 3033.0±470.97 gm and median weight 3000.0 gm. In agreement with our results, Abuelghar W. et al., study the Fast T to predict the fetal weight, he carried his study on 300 pregnant women, the mean fetal weight was 3065.1±87.2 gm. [10]

In this study the correlation between the Fast T and fetal weight show a strongly positive correlation, then regression model was done to predict an equation to calculate the fetal weight estimated by using Fast T. The equation to predict the birth weight show accuracy with about 88.0% the mean errors was ±32.0 gm.

In agreement with our study, Bhat et al., showed a positive correlation between FASTT and a wide range of fetal weights. Direct birth weight post partum was correlated with FASTT measured in about 11 days before delivery. Total 300 term mothers were selected. Mean birth weight of 300 newborns was 2875±564 g; out of which 6 (2%) newborns weighed more than 4000 gms and 17 babies (5.7%) weighed less than 2000 gms. The mean FASTT statistically significantly differ between normal and macrosomic fetuses (6.6 mm vs 12 mm respectively; p<0.001). [(9)]

Petrikovsky et al. measured abdominal subcutaneous tissue width in 133 full term baby of non-diabetic mothers to predict macrosomia (birth weight >4.0 kg). Birth weight was taken of those fetus delivered within 72.0 hours of measurement of FASTT. In our study there was a statistically significant difference in abdominal wall thickness between those fetuses with normal birth weight and those who were macrosomic (7 mm vs 12.4 mm, p<0.0001). The negative predictive value for a range of cut-off points between 8 and 13 mm varied between 84.3% and 100%. However, the PPV was less than 50% for cut-off values <11 mm. The Negative Predictive Value (NPV) was relatively high (≥90%) for a range of FASTT cut-off values and macrosomia prevalence rates. [(11)]

Higgins et al., found that the measurement of Anterior Abdominal Wall (AAW) in macrosomic fetuses was statistically significantly higher in comparison to those with a birth weight <90th percentile. This study also shows that a simple extra measurement, AAW, taken at time of regular measurement of Abdominal Circumference (AC), associates significantly with birth weight. A fetal AAW dimension of >5.6 mm measured at term or an abdominal circumference (AC) > 90th percentile for gestation should alert the obstetrician to the possibility of fetal macrosomia. And the sensitivity to this possibility holds good for gestation <36 weeks although sensitivity increases to almost 100% at 37-38 weeks gestation. [(12)]

In another study by Bethune et al., found that baby fat layer or subcutaneous tissue thickness >5mm was significantly important than abdominal circumference as a prediction of macrosomia in 90 pregnancies affected by gestational diabetes, but only took one measurment between 28 and 34 weeks. [(13)]

Parretti et al., investigated AAW thickness specifically in the fetuses of those with impaired glucose tolerance in pregnancy, and showed that AAW thickness increased significantly from 26 weeks compared to normal levels. [(14)]

Similar results were observed in the previous study; there was positive correlation between FASTT and birth weight. The mean FASTT increased as the birth weight increases. When we studied the difference of mean FASTT between SGA, AGA and LGA babies; the difference in mean FASTT between SGA and AGA babies and between LGA and AGA babies were statistically significant. Significance was greater for large for gestation. [(14)]

In our results the ROC curve was constructed for FAST as predictor of low birth weight. FAST was a significant predictor of low birth weight, as indicated by the significant high area under the curve (AUC) [AUC = 0.731*, p<0.031]. The best cutoff value of FAST below which low birth weight is more likely was 5.2mm [sensitivity 62.50%, specificity 75%, PPV 17.9%, NPV 95.8%].

Also, receiver operator characteristics (ROC) curve was constructed for FAST as predictor of macrosomia. FAST was a significant predictor of macrosomia, as indicated by the significant large area under the curve (AUC) [AUC = 0.992*, p<0.001]. The best cutoff value of FAST above which macrosomia is more likely was 8 mm [sensitivity 75%, specificity 98.96%, positive predictive value (PPV) 75%, negative predictive value (NPV) 92%.

Our results was agreement with Bhat et al., he obtained a cut-off value of FASTT for large babies; 6.25 mm. Sensitivity for FASTT >6.25 mm for large for gestational age babies is 79% and specificity is 70% with a Positive Predictive Value (PPV) is 24.4%and Negative Predictive Value (NPV) is 96.4%. Negative Predictive Value is high, indicating that if the FASTT is less than the cut-off value (6.25 mm in our study), baby is less likely to be large for gestational age (LGA). [(9)]

Recently, some researchers respected the sonographically measured soft tissue thickness in order to estimate fetal weight. [(15)] One study showed that measurement of the adipose tissue of the extremities has a positive predictive value of 4% in the prediction of low birth weight.10 Its sensitivity and specificity were reported 74% and 94%, respectively. In contrast, some studies have proposed that subcutaneous tissue thickness cannot be used to distinguish abnormalities of fetal growth, especially in cases of growth retardation. [(16)]Another study demonstrated that fetal thigh soft tissue thickness has a high degree of correlation with birth weight (r = 0.86); its sensitivity and speci Bcity to predict macrosomia were 91% and 94%, respectively. [(17)]

Conclusion

Fetal abdominal subcutaneous tissue thickness can serve as a useful predictor of fetal weight. Beside that FAST can be a better predictor for macrosomia than for low birth weight.

FAST can be combined with weight estimation formulas as a method to increase its accuracy especially at birth weight extremities.

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