Fetal weight estimation by Measurement of Soft Tissue Thigh Thickness using Ultrasound Compared to Abdominal Circumference and Femoral Length

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Abstract

Objective: To measure the value of soft tissue thigh thickness in estimating fetal weight using ultrasonography. **Design:** This study is cross-sectional and has been conducted for three months. A total of 100 clients were considered for final analysis. Subjects with no chromosomal or any major physical anomalies with a singleton pregnancy were included in this study. 2D measurement of the fetal soft tissue thigh thickness was done, the data was collected by datasheet specially designed for this study, and results were analyzed using (SPSS). **Results:** The study showed that there was a significantly strong correlation between soft tissue thigh thickness & fetal weight ($r= 0.731$, $p<0.01$) and a strong association between soft tissue thigh thickness and gestational age ($r= 0.681$, $p<0.01$). Fetal weight = 2605.4 soft tissue thickness - 899.44 ($R^2 = 0.5337$). The study found that soft tissue thigh thickness is similar to Femur Length for estimating fetal weight when used in a combination of Abdominal Circumference and Bi-Parietal Diameter ($R^2 = 0.934$). When using each of them for estimation, the standard error of an estimate is 248 .305 grams when using soft tissue thigh thickness and 249.433 grams when using femur length, as seen in the following formulae: Fetal weight /gram= 202.433 soft tissue thigh thickness + 184.734 AC -113.954 BPD -

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2366.326 (R^2= 0.934). Fetal weight /gram= 83.547 FL+ 172.603 AC -105.628 BPD -2396.056 (R^2= 0.934). **Conclusion:** soft tissue thigh thickness is a good parameter for estimating fetal weight. It is similar to femoral length for estimation when used with Bi-parietal Diameter and Abdominal Circumference.

Keywords: Fetal weight; Ultrasound; Soft Tissue Thigh thickness

Introduction

In antenatal care, as well as in the planning and management of labor and method of delivery, the accuracy of fetal weight estimation is critical. Other technologies supporting the usage standard with ultrasonography are required to get more accurate prenatal fetal weight estimations and align them with a risk-optimizing mode of delivery(1). Various morphometric equations are used to calculate fetal weight; most of these formulas include basic biometric measurements (biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL)). The Hadlock and Shepard methods are the most widely utilized. The Hadlock method has a sensitivity of 62 % and a specificity of 93 % for fetal macrosomia prediction, and the Shepard method has a sensitivity of 21 % and a specificity of 99 %. However, EFW, especially AC, has a wide range of errors (± 9%) that can affect clinical evaluation; this can be due to several factors. (2-4) Numerous studies have demonstrated the precise impact of fat and lean masses on birth weight as the primary fetal body constrictors, which may be used as fetal growth and weight markers. (5,6). Additionally, being researched is the use of fetal soft tissue measures for the diagnosis of macrosomia. STT was shown to help diagnose fetal macrosomia by Han et al., with a sensitivity and specificity of 91% and 94%, respectively. Midshaft soft tissue femur thickness is one of the valuable parameters used in previous studies for assessing fetal weight. Several studies found that fetal soft tissue thigh thickness was strongly related to GA and birth weight; it is a precise and valuable approach for determining the fetal weight(7-12).

To our knowledge, no previous studies in Sudan concerning the use of fetal soft tissue for estimation of GA and fetal weight, so the purpose of this study is to estimate fetal weight via measuring thigh soft tissue thickness in the second and 3rd trimesters using ultrasound compared to femur length.

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Methods

Cross-sectional was done on 100 pregnant women referred to a Turkish teaching hospital in Khartoum state for antenatal scanning with normal singleton pregnancy in their second and third trimesters (17-40 weeks). Any fetus with congenital anomalies, women with uncertain days of last menstrual period, multiple pregnancies, or medical conditions that affect fetal weight, including diabetic Mellitus, were excluded from the study. A SAMSUNG MEDION ultrasound machine with a curved linear transducer 3.5MHz frequency probe with a curved array was used for obstetric scanning. Data was collected using the following variables: soft tissue thickness (STT), Gestational age (using FL, LMP, BPD, AC, HC), and fetal weight. The data were analyzed by SPSS version 16; descriptive statistics was done for numeric variables, then Pearson's correlation between the study variables, and regression analysis was performed to generate formulae for prediction of fetal weight using STT then to compare with estimated fetal weight from other parameters and to assess linearity in relationship between study variables. The National University Research Committee approved the study (NU-RECPU009). Then, verbal approval was taken from Al-Turki Hospital and the Ultrasound Department in Al-Turki hospital, and written consent from the pregnant women was included in this study.

Soft tissue thigh thickness (STT) measurement:

In this study, soft tissue thigh thickness is a measure (figure 1), like Scioscia et al. (12); Soft tissue thickness of the middle thigh was measured linearly in the standard longitudinal segment that is used for femur length (FL) once the suitable image was taken, that image was frozen on the screen. Later, soft tissue thickness (STT) was measured from the exterior margin of the skin to the outer border of the femur shaft, where the femur is parallel to the ultrasound transducer, with greater and lesser trochanters rotated upward. This is the best way to view the lateral side of the femur, where vast medialis muscle fibers are visible(12).

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Figure (1) measurement of fetal weight using STT

Results

The study was conducted on 100 pregnant women aged 15-40; the mean age was 27.19. The gestational age ranged from 17-40 weeks, and the mean measurement of BPD, FL, AC, HC, and STT was 7.65 cm,5.99 cm,26.43, 28.08, and 1.05±0.26 cm, respectively. Their ranges were 3.96-9.68 cm, 2.51 -8.66 cm,11.9-36.98 cm,14.47-34.15 cm, and 0.49-1.63 cm respectively. Gestational age LMP, BPD, FL, AC, and HC ranged from 17.14- 40.86 weeks, 18-39.57 weeks, 17-40 weeks, 17.57-40 weeks, and 17.71-39.86 weeks, respectively, with mean gestational age by them were 30.36, 30.81,31.06, 30.60 and 30.99 respectively. Table (1)

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Table (1) Descriptive statistics of fetal biometry, fetal weight, and STT

Variables	Minimum	Maximum	Mean ±Std. Deviation
Age of women	15	40	27.19± 5.77
BPD (cm)	3.96	9.68	7.65±1.25
HC (cm)	14.47	34.15	28.08±4.28
AC (cm)	11.90	36.98	26.43±5.46
FL (cm)	2.51	8.66	5.99±1.20
GA LMP	17.14	40.86	30.36±5.37
GA BPD	18.00	39.57	30.81±4.89
GA HC	17.71	39.86	30.99±5.042
GA AC	17.57	40.00	30.60±5.15
GA FL	17.00	40.00	31.06±5.25
Fetal Weight (g)	336	3933	1859.18±954.26
STT (cm)	.49	1.63	1.06±.26

The study found that there was strong linear correlation between STT and gestational age LMP, BPD, HC, AC and FL respectively ($r = 0.681, 0.668, 0.661, 0.716$ and 0.696 $p < 0.001$ respectively), table2

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Table (2) Correlation between GA measured by BPD, HC, FL, AC), fetal weight, and STT.

		GA LMP	GA BPD	GA HC	GA AC	GA FL
STT (cm)	Pearson Correlation	.681**	.668**	.661**	.716**	.696**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	100	100	100	100	100

The study demonstrated that strong positive correlation between the measurement of soft tissue thickness (STT)\cm in the second and third trimesters of the pregnancy and estimated fetal weight by ultrasound ($r= 0.731$, $p<0.001$). Table (3)

Table (3) association between fetal biometry (BPD, HC, FL, AC), fetal weight and STT

Correlation		STT (cm)
EFW (g)	Pearson Correlation	.731**
	p-value	0.000
	N	100

Linear association was found between STT and fetal weight when used as a single parameter for determination, the predicted fetal weight = 2605.4STT -889.44 Gram ($R^2= 0.5337$), prediction of fetal weight depending on femur length demonstrated by: EFW= EFW\g= 739.91x – 2578 Gram ($R^2= 0.8728$), AC is the most valuable single parameter in fetal weight estimation in this study as EFW =168.21AC-2587.3 Gram ($R^2=0.9293$). figure 2,3,4

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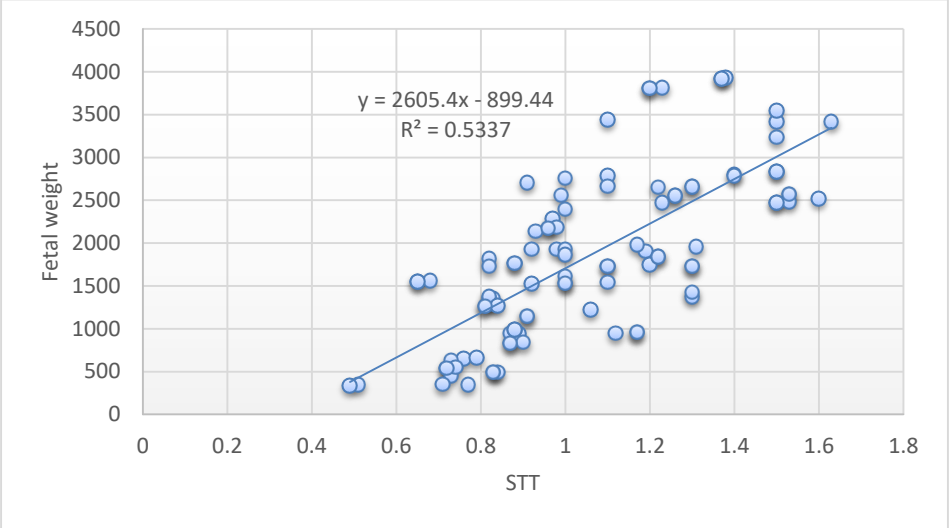

Figure (2) scatterplot shows a linear relationship between EFW and STT (R^2= 0.5337)

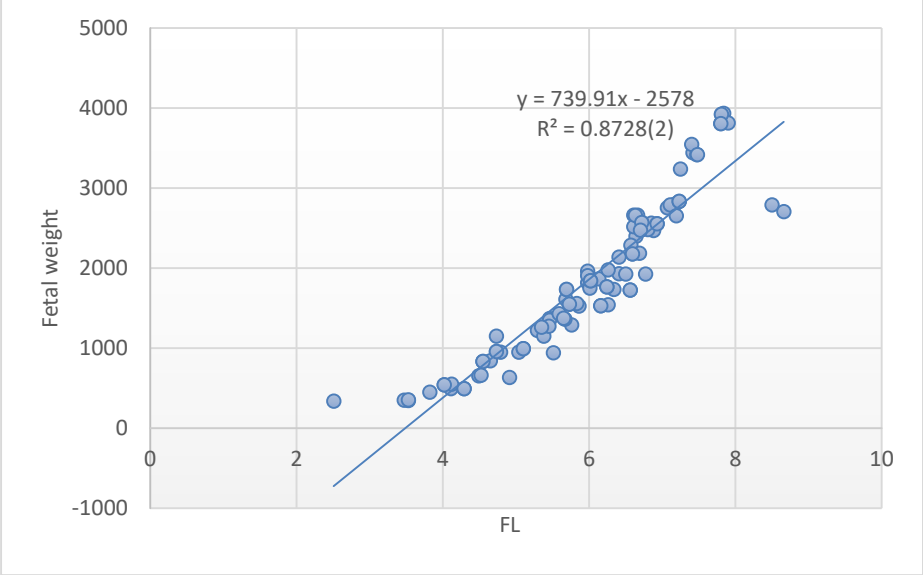

Figure (3) scatterplot shows a linear relationship between EFW and FL (R^2= 0.8728)

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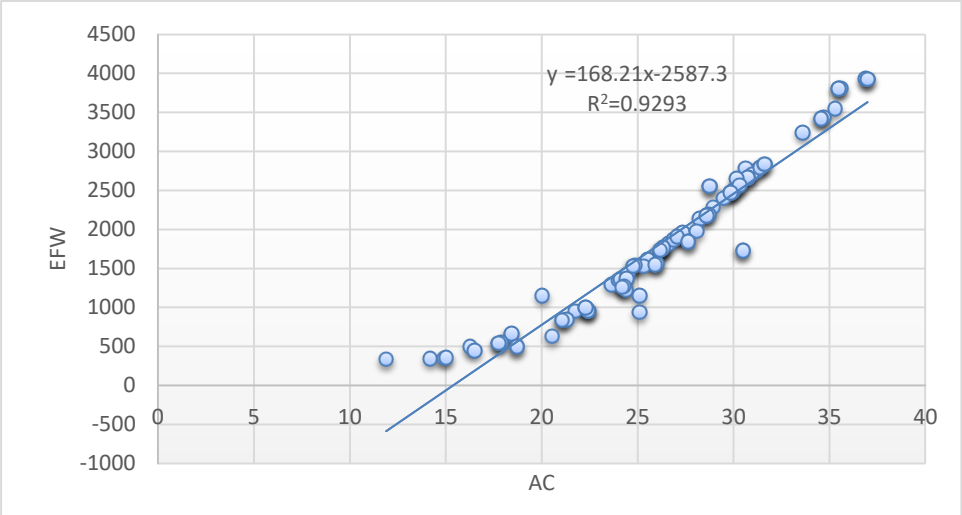

Figure (4) scatterplot shows a linear relationship between EFW and AC (R^2= 0.9293)

The study compares predicted fetal weight using BPD, FL, and AC and using BPD, AC, and STT, it was found that soft tissue thigh thickness, when used in combination with BPD and AC, is the same as femur length for fetal weight estimation, the standard error of estimate has not differed (249.4) gram for femur length and 248.30 gram for STT in combination with BPD and AC respectively, R^2= 0.934). Table 4

Table (4) Predictive formulae for estimation of fetal weight using STT, AC, and FL measurement as a single parameter and in combination with each other for an estimate of fetal weight

Variable	The predictive formula for fetal weight estimation	Predictive power (R^2)	Std. The error in the estimate	P-value
STT	2605.42STT-899.439	0.534	654.949	≤0.001
FL	739.906FL-2577.962	0.873	342.021	
AC	168.208AC-2587.269	0.929	254.976	
AC, FL	94.503FL+148.235AC-2626.041	0.930	254.217	
AC, STT	161.698AC+181.396STT-2607.269	0.931	254.110	
FL, STT	700.791STT+636.497FL-2699.827	0.894	313.281	
BPD, FL, AC	83.547 FL+ 172.603 AC -105.628 BPD -2396.056	0.934	249.433	

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BPD, FL, STT	75.721BPD+578.697FL+630.309STT-2858.104	0.897	311.507	
BPD, AC, STT	202.433 STT+184.734 AC-113.954 BPD-2366.326	0.934	248.305	
BPD, AC, FL, STT	109.542 FL+ 159.290 AC -109.990 BPD+ 243.380 STT -2424.238	0.936	246.818	

Discussion

Ultrasound is the most common method and more accurate than clinical assessment for estimating fetal weight. Different biometric variables obtained by ultrasound, such as biparietal diameter (BPD), abdominal circumference (AC), and femoral length (FL), are used in other formulas to reach estimated fetal weight (EFW). However, the Hadlock equation (based on BPD, AC, and FL) is widely used and known to have a minor error(12).

To find the impression of AC, BPD, and FL on EFW, previous Studies assessed the accuracy of EFW using these variables in different combinations. Adding AC to predict fetal weight makes all these algorithms have equivalent accuracies. Thus, AC was shown to be the best predictor of fetal weight. Correct measurement of AC depends on some strict rules, including the location of the spine at 3 or 9 o'clock of the transverse section, observing the stomach bubble at the left side, observing only one rib, and observing the junction of the umbilical segment left and right portal vein. These rules may not be achievable in all fetuses(12).

The study found a strong linear correlation between STT and gestational age LMP, BPD, HC, AC, and FL, respectively. This result is consistent with Han., et al., who stated that FTSTT was positively correlated with gestational age ($r = 0.7070$)(7).

The study found a strong significant positive correlation between STT and fetal weight ($r=0.731$, $p<0.001$) respectively, on the other hand, Scioscia M et al. and Han et al. mention that there was a significant correlation between STT and neonatal birth weight. (7,12).

A robust linear association was found between AC, FL, and STT and fetal weight ($R^2= 0.9293$, 0.8728, and 0.5337, respectively) when used as a single parameter for estimating fetal weight. These results also agreed with Scioscia M et al., who stated that linear association between STT, AC, and fetal weight ($R^2= 0.36$ and 0.46 respectively, $p <0.001$) also go online with Kalantari et al. who stated that (R^2: 0.50, for STT and fetal weight $p<0.001$)(12,13). In another single measurement regression

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comparing the mid-thigh tissue area and the EFW by AC, Larciprete et al. found a higher R square (R^2=0.59 vs. R^2=0.19). (14)

From the above regression equation, it was noted that R^2 is similar to the model of fetal weight estimation by (STT, AC, BPD), and EFW using (FL, BPD, and AC); it was 0.934 for both, with a standard error of estimation of 248 and 249 grams, respectively, and p <0.01. Also, R^2 is (0.936, and the error of estimate 246 grams) when using BPD, AC, FL, and STT in the estimation model, the association is more substantial than Kalantari et al., who stated that R square was best to fit for the model. When STT was added to AC, BPD, FL (R^2: 0.77), R square for the model using BPD, AC, FL, and model using BPD, STT, FL was the same (R^2: 0.7). Consistently, in this study R square for the model using BPD, AC, FL, and model using BPD, STT, FL was somewhat differing. It is more reliable and accurate when combined with BPD, AC, and FL than BPD, STT, and FL alone (R^2 0.934 versus 0.897, respectively). (13).

SST thigh thickness is one of the essential parameters in predicting fetal weight that may substitute femur length when combined with BPD and AC. It is an additional parameter to be considered in estimating fetal weight in the cases of short femur length.

Conclusion:

The study concluded that STT (soft tissue thickness) of the thigh added a value as additional parameters for estimating fetal weight, a significant strong positive relationship between STT and estimated fetal weight in the second and third trimesters; STT is similar to FL in assessing fetal weight when used in combination with BPD and AC.

Recommendation:

The study recommended that future studies correlate actual birth weight with estimated fetal weight to compare the accuracy of STT related to other parameters for determining fetal weight.

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