ORIGINAL ARTICLE

Better Predictor of Fetal Weight: Mid-Thigh Soft-Tissue Thickness Versus Hadlock's Method – A Prospective Observational Study

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ABSTRACT

Introduction: Estimation of fetal weight is necessary for planning and managing labor. At term, macrosomia can be predicted by the estimation of fetal soft tissue and can be done by various ultrasonographic measurements. The correlation of estimated fetal weight (EFW) using fetal soft-tissue thickness with actual birth weight was seen in this study. **Materials and Methods**: Seventy ladies with singleton pregnancies were enrolled. The fetal weight was categorized into two groups, above and below 90th percentile respective of the gestational age. Fetal weight estimation was done using Hadlock's method, mid-thigh soft-tissue thickness (MTSTT) and was correlated with actual birth weight. Fetal abdominal subcutaneous tissue thickness (FASTT) was correlated with actual birth weight as well. **Results:** Moderate positive correlation was found between the EFW using MTSTT and Hadlock's method, and it was statistically significant ($P < 0.001$). FASTT had a mild positive correlation, which was not statistically significant. Further, MTSTT was found to be more sensitive and specific in the estimation of fetal weight with actual birth weight as a gold standard. **Conclusions:** Estimation of fetal weight using MTSTT was more superior to Hadlock's method with higher sensitivity and specificity values. There was no significant correlation observed between FASTT value and actual birth weight.

KEY WORDS: Estimation of fetal weight, Fetal abdominal subcutaneous tissue thickness, Hadlock's method, mid-thigh soft-tissue thickness.

Introduction

Ultrasonography (USG) is commonly used to assess fetal growth and further to estimate fetal weight. Estimated fetal weight (EFW) gives valuable information for planning and managing labor. This estimation is done using various formulae, the majority of them introduced in the 1980s. Various standardized fetal parameters such as biparietal diameter (BPD), head circumference (HC), femur length (FL), and abdominal circumference (AC) are used in combinations in these formulae. Among these parameters, AC is quite commonly used for estimation of fetal weight though it is quite variable. However, there is an underestimation of fetal weight as these parameters do not account for soft tissue mass. And also, at extremes of the weight spectrum, these formulae are found to be less accurate.[1]

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The abnormal fetal growths cause intra and postnatal complications, along with neonatal mortality and morbidity.[2] Macrosomia is associated with fatal perinatal complications such as cephalopelvic disproportion, shoulder dystocia, asphyxia, brachial plexus injury, injury to maternal soft tissues, and postpartum hemorrhage.[3] Hence, at term, detecting macrosomic babies plays a crucial role, as it helps in choosing the modality of delivery.

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At term, macrosomia can be predicted by soft-tissue measurement, and 75% of the body fat is found in subcutaneous tissue. The various ultrasonographic measurements such as fetal abdominal subcutaneous tissue thickness (FASTT), mid-thigh soft-tissue thickness (MTSTT), and subscapular soft-tissue thickness can be used to predict macrosomia.[4] This study was conducted with a primary objective to estimate fetal weight using MTSTT and Hadlock's method and to compare both with actual birth weight. Other objective was to measure FASTT and to find its correlation with actual birth weight.

Materials and Methods

This was a prospective observational study conducted in the Department of Radio Diagnosis of a medical college hospital of coastal Karnataka. Ladies with a singleton pregnancy who gave written informed consent were selected as study participants. A sample size of 70 was derived using the formula $4pq/d^2$. The prevalence (p) was taken from a previous similar study conducted by Banerjee *et al*.[5] and was found to be 83%, q was 100-p and was 17% and d was absolute precision of 10%. With non-response rate of 20%, the sample size was calculated to be 68, which was approximated to 70. The study was conducted for a duration of 2 months, from November 29, 2018, to January 25, 2019. Consecutive sampling was done. Ladies with a singleton pregnancy of gestational age 37–39 weeks and delivered in the same institution within 7 days of ultrasound assessment and who gave written informed consent were included in the study. Only those ladies who had similar gestational age by USG and last menstrual period (LMP) were included in the study. Ladies with maternal diabetes were also included in the study. Ladies with oligohydramnios (amniotic fluid index <7), multifetal gestation, who delivered after 7 days of the assessment and babies born with congenital anomalies, were excluded from the study.

The data regarding the hospital number, age of the pregnant lady, and gestational age according to LMP were collected.

The parameters such as BPD, AC, HC, and FL were assessed by USG. MTSTT was measured linearly in the standard longitudinal section used for FL measurement. In the middle third of the fetal thigh, with the femur lying parallel to the transducer, MTSTT was measured from the outer margin of the skin to the outer margin of the femur shaft. The measurement was taken, providing that the greater and the lesser trochanter were turned upward. This section assured the correct view of the lateral side of the femur (Image 1).[6]

Fetal abdominal subcutaneous thickness was measured at the same axial image that was used to calculate AC. A transverse section of the fetal trunk at the level of AC was obtained with the fetal abdomen, free from contact with arms or legs, and 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

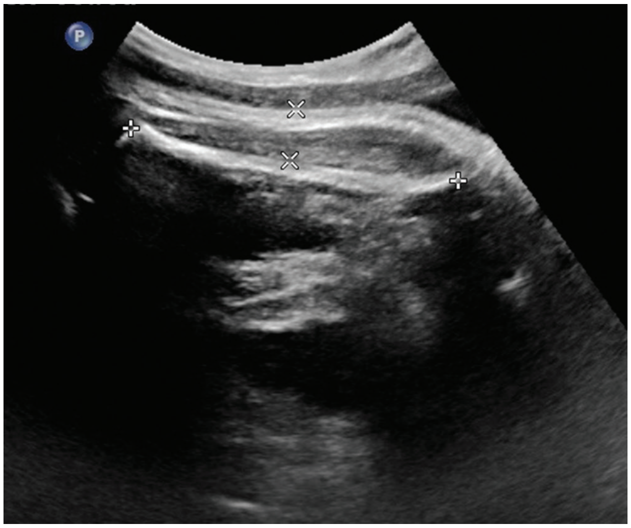

Image 1: Measurement of fetal mid thigh soft tissue thickness

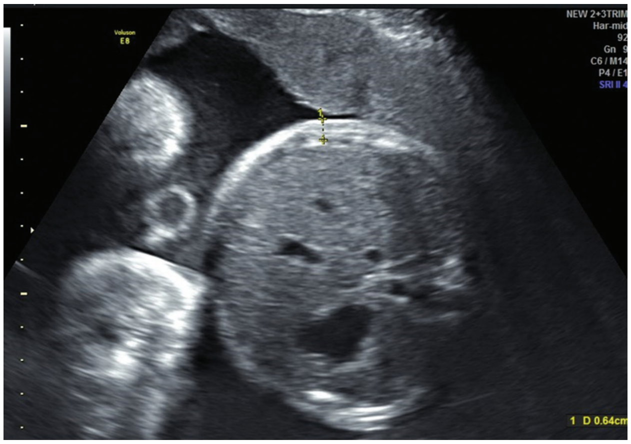

Image 2: Measurement of fetal abdominal subcutaneous tissue thickness

recognized as an external hyperechogenic surface. The thickness of this layer was measured between the fetal skin and the anterior side of the liver in contact with the anterior abdominal wall.[2,7] (Image 2)

The EFW was calculated with Hadlock's method and MTSTT using formulae 1.3596–(0.00386 [AC × FL]) + (0.0064 ×HC) +(0.00061[BPD × AC]) + (0.0424 × AC) + (0.0174 ×FL)[8] and −1687.47 + (54.1 × FL) + (76.68 × STT),[1] respectively. The EFW by Hadlock's method was calculated using the above-mentioned formula in the USG machine (automated calculation) and that of the MTSTT was calculated using Statistical Package for the Social Sciences (SPSS) software. The actual birth of the weight of the baby was collected from the labor room register in the department of obstetrics and gynecology in our hospital, where the birth weight of all the babies delivered in our hospital is recorded.

Fetal macrosomia was defined as body weight above the 90th percentile for the respective gestational age. Further, actual, and EFWs were categorized into two groups of normal and macrosomia. The 90th percentile weight for 37 and 38 weeks of gestation was 3400 g and 3600 g, respectively. The grouping was done to the fetuses of 37 and 38 completed weeks of gestational age. The sensitivity and specificity of the Hadlock's and MTSTT methods for the estimation of fetal weight were calculated, keeping actual birth weight as a gold standard. However, the estimation of fetal weight using FASTT was not done because of the unavailability of a valid, standard formula.

Institutional Ethics Committee approval was obtained before the commencement of the study (Protocol number: 2018/205).

Table 1: Descriptive statistics of ultrasonographic variables, *n*=70

Variables (in mm)	Mean	SD	Minimum	Maximum
BPD	89.52	3.32	80	98
HC	325.40	8.60	298	344
AC	333.13	13.6	295	361
FL	72.04	2.7	64	77
FASTT	6.46	1.84	4.3	13.6
MTSTT	11.69	2.6	5.9	19.1

MTSTT: Mid-thigh soft-tissue thickness, BPD: Biparietal diameter, HC: Head circumference, FL: Femur length, AC: Abdominal circumference, FASTT: Fetal abdominal subcutaneous tissue thickness

Data collected were entered in MS Excel and analyzed using SPSS (version 22.0 IBM, New York, USA). Pearson correlation test was used to find the correlation between the variables. Sensitivity, specificity, positive, and negative predictive values were calculated, keeping actual birth weight as a gold standard.

Results

The mean age of the participants was 25.41 (±4.03) years. Among the 70 participants, 41 (58.5%) had completed 38 weeks of gestation and the rest had 37 completed weeks. Table 1 depicts the descriptive statistics of the various variables assessed using USG. These variables were further used to calculate the EFW using formulae. The birth weights were further categorized as normal and macrosomia. Among the newborns, who had completed the 37 gestational weeks, 12 (17.14%) were macrosomic. Among newborns with 38 completed weeks, 8 (11.43%) were macrosomic. The correlations between the estimated birth weights using MTSTT and Hadlock's formula with actual birth weights were assessed using Pearson's correlation. The correlation between FASTT value and actual birth weight was also assessed. Fetal weight estimated using MTSTT and actual birth weight showed a moderate positive correlation (Pearson value 0.473). Fetal weight estimated using Hadlock's formula, and actual birth weight was also found to be moderately correlating (Pearson value 0.380). Both these correlations were found to be statistically significant ($P < 0.05$). The correlation between FASTT value and actual birth weight was not statistically significant (Pearson value: 0.152 and P: 0.165).

A scatter plot was constructed using actual birth weight in X-axis and EFW with MTSTT, Hadlock's formula, and FASTT in Y-axis. Figures 1-3 describe the correlation between these variables.

The sensitivity and specificity of estimating the fetal weight by MTSTT method were more compared to that of the Hadlock's method.

Discussion

The fetal ultrasound parameters were assessed in this study, along with the estimation of fetal weight. The correlations between the EFW using MTSTT and actual birth weight were tested, and moderate correlation was observed. This observed

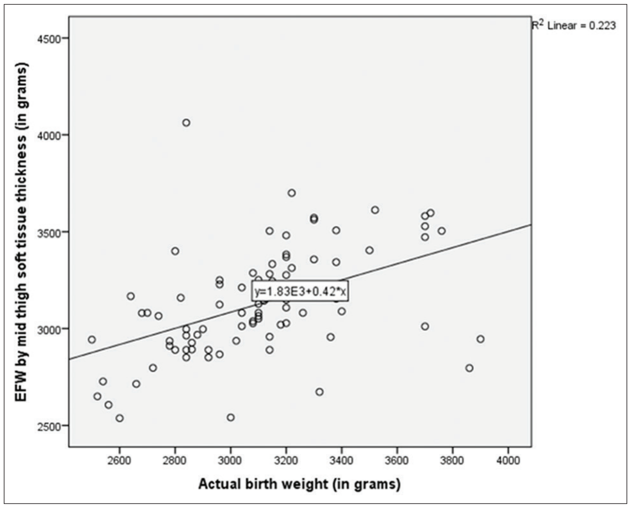

Figure 1: Scattered diagram depicting actual birth weight versus estimated fetal weight using mid-thigh soft-tissue thickness, n=70

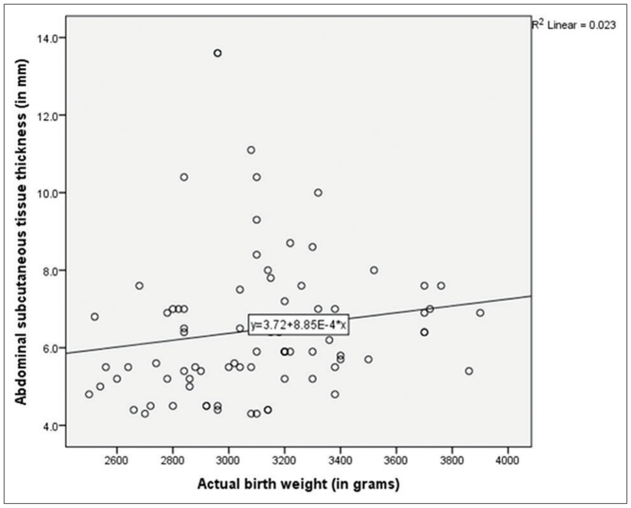

Figure 2: Scattered diagram depicting actual birth weight versus abdominal subcutaneous tissue thickness, n=70

Table 2: Correlation between the FASTT values, EFW using mid-MTSTT and EFW with Hadlock's formula with actual birth weight using Pearson correlation, *n*=70

Variables for correlation with actual birth weight (in g)	Pearson value	*P*-value
FASTT	0.152	0.165
EFW using MTSTT	0.473	<0.001*
EFW using Hadlock's formula (in g)	0.380	<0.001*

*Statistically significant correlation. FASTT: Abdominal subcutaneous soft-tissue thickness. EFW: Estimated fetal weight, MTSTT: Mid-thigh soft-tissue thickness.

correlation was statistically significant. [Table 2] The scatter plot with these variables in Y- and X-axes, respectively, also showed clustering of the values [Figure 1]. Similar findings were obtained by the study conducted by Abuelghar *et al*. where, a highly significant correlation was obtained between EFW using MTSTT and birth weight (Pearson value 0.609, $P < 0.001$).[6] Kalantari *et al*. also found a similar correlation between these values, which was highly significant (Pearson value 0.50, $P < 0.001$).[9]

Abdominal subcutaneous soft-tissue thickness was estimated, and its correlation with the birth weight was calculated using Pearson's correlation. There was no significant correlation observed between the two values [Table 2]. Further, the scatter plot with birth weight in X-axis and FASTT in Y-axis showed a scattering of values and presence of outliers [Figure 2]. However, several studies conducted show a positive correlation between the two values, and FASTT is considered to be the strongest predictor of fetal weight when measured accurately.[10] A study conducted by Forouzmehr *et al*. showed that there was a significant difference of FASTT between the normal and macrosomic babies (6.6 mm vs. 12 mm, respectively; $P < 0.001$).[11] Similar results were obtained by the study conducted by Petrikovsky *et al*. where the difference between FASTT of normal and macrosomic babies was found to be 7 mm versus 12.4 mm, $P < 0.0001$.[12] An Indian study conducted by Bhat *et al*. showed that FASTT and birth weight were having moderate correlation (Pearson value 0.418), which was highly significant (<0.001). Further, they observed that the difference in the mean FASTT values of small for gestational age (SGA), appropriate for gestational age, and large for gestational age was statistically significant. Receiver operative characteristic (ROC) curve was applied, and cutoff values for FASTT for large babies were obtained. ROC curve, when applied for SGA babies, showed that the area under the curve was not significant. Bhat *et al*. concluded that FASTT was a sensitive tool only for large for gestational weight babies and not for low birth weight babies.[13] However, various factors like observer variations while performing USG, pressure applied using the USG probe, compression due to maternal abdominal wall, quantity of the amniotic fluid, etc., play a role in the estimation of FASTT. Thus, we conclude that, though few studies show a strong correlation between the FASTT values and birth weight, the procedure is quite subjective and may not be an

Table 3: Sensitivity, specificity, positive and negative predictive values of the EFW estimation methods in the detection of macrosomia having actual birth weight as a gold standard, *n*=70

Gestational age in weeks according to LMP	Parameters	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
37 completed weeks, *n*=29	MTSTT	86.36	80	97.44	40
	Hadlock's method	84.93	50	91.18	35.29
38 completed weeks, *n*=41	Mid-thigh soft-tissue thickness	97.73	40	93.48	66.67
	Hadlock's method	93.51	25	92.31	28.57

PPV: Positive predictive value, NPV: Negative predictive value. EFW: Estimated fetal weight, MTSTT: Mid-thigh soft-tissue thickness, LMP: Last menstrual period

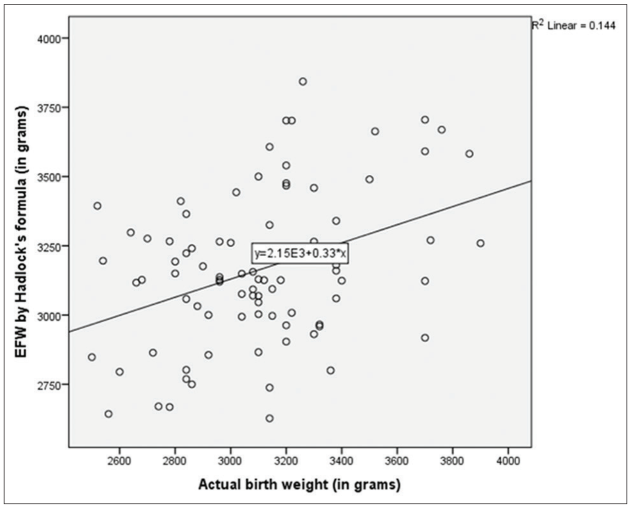

Figure 3: Scattered diagram depicting actual birth weight versus estimated fetal weight using Hadlock's formula, n=70

accurate measure for predicting the birth weight.

Hadlock's is one of the standardized methods of estimating fetal weight. In our study, EFW calculated with this method was correlated with the actual birth weight and was found to be moderately correlating [Table 2]. This correlation was statistically significant. The scatter plot further showed the clustering of values [Figure 3]. Similar results were obtained in a study conducted by Durgaprasad *et al*. where the EFW using Hadlock's formula was compared with the actual birth weight along with various other methods of fetal weight estimation. It was found that the mean difference between the EFW and actual birth weight was 100.24 g with $P < 0.001$. It was concluded by them that Hadlock's method was one of the best methods of fetal weight estimation.[14] A study conducted by Roy and Katheley found that there was a 75% agreement between the EFW by Hadlock's formula and actual birth weight, which was statistically significant.[15]

The validity of the methods of fetal weight estimation was assessed with the weights categorized above and below the 90th percentile. Actual birth weight was used as a gold standard. The gestational age in weeks was further categorized into 37 and 38 completed weeks for a better comparison of weights. At both weeks, MTSTT was found to be more sensitive and specific than the Hadlock's method. The PPV and NPV were also found to be higher [Table 3].

The strengths of this study are that we have included only term pregnancies with a singleton gestation and those who have delivered within 7 days in the same institution. Thus, discrepancy of birth weight is reduced. The low sample size of the study can be considered as a limitation. Furthermore, few technical limitations like difficulty in assessing MTSTT in breech presentations, degree of compression of the maternal abdominal wall causing inaccurate measurement of FASTT.

Conclusions

In this study, we estimated the fetal weight of term, singleton pregnancies using MTSTT and Hadlock's method. The FASTT was measured as well. These obtained values were correlated with the actual birth weight was observed. A moderate correlation was found between the EFW using MTSTT and Hadlock's method. Fetal weight estimation using MTSTT was more sensitive and specific compared to that of Hadlock's method. We thus conclude that the estimation of fetal weight using MTSTT is more superior to that of Hadlock's method.

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