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Determination of fetal weight by ultrasonographic evaluation of fetal mid-thigh soft-tissue thickness in late third trimester

Lynn Joy[1], Anil Kumar Sakalecha[2], Rajeswari G[3], Varshitha GR[4], Surya Kanth Anne[5], Shantala Sawkar[6]

[1,5,6]Postgraduate Student, [2]Professor and Head, [3]Associate Professor, [4]Senior Resident, Department of Radio-diagnosis, Sri Devaraj Urs Medical College, Tamaka, Kolar, Karnataka, India

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ABSTRACT

Background: Estimation of fetal weight is of utmost importance in the planning and management of uneventful labor. This study was done to compare the estimated fetal weight determined by Hadlock's method and Scioscia's formula (using femur length and mid-thigh soft-tissue thickness [MTSTT]) to the actual birth weight (ABW). **Aims and Objectives:** The objectives of this study were as follows: (1) To estimate fetal weight by Hadlock's method and ultrasonographic evaluation of fetal MTSTT in late third trimester. (2) To correlate fetal weight derived by Hadlock's method and ultrasonographic evaluation of fetal MTSTT with ABW. **Materials and Methods:** The study was conducted during the period November 2022–January 2023, at Sri Devaraj Urs Medical College, Tamaka, Kolar. Seventy-six pregnant ladies at term (between 37 and 40 weeks) were included in the study. **Results:** This study assessed validity of Hadlock formulae and Scioscia's formulae for detecting fetal weight. For detection of fetal weight by Hadlock's method, area under curve (AUC) was 0.961 and according to Scioscia's formulae, AUC was 0.965. This study showed good agreement between fetal weight derived by Hadlock formulae and actual fetal weight (Kappa value – 0.725). There was also good agreement between fetal weight derived by Scioscia's formulae and actual fetal weight (Kappa value – 0.745). **Conclusion:** The fetal weight derived by Scioscia's formula was comparable to the actual fetal weight allowing us to rely on Scioscia's formulae to detect fetal weight. Calculating fetal weight by measurement of fetal MTSTT serves as an additional tool for estimation of fetal weight along with the existing parameters, thereby increasing the likelihood for accurate fetal weight estimation.

Key words: Femur length; Mid-thigh soft-tissue thickness; Fetal weight

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INTRODUCTION

For efficient obstetric care to be given, especially when macrosomia or low birth weight is suspected, it is essential to estimate the fetal weight (EFW) during labor. Low birth weight fetuses are more prone to incur perinatal morbidity and mortality, and macrosomic fetuses during labor can cause issues for both the mother and the baby.[1,2]

The most commonly used methods for estimating fetal weight are those that use circumferential measurements such as head and abdominal circumference (AC). AC is widely recognized as the most useful dimension to evaluate fetal growth, although it is subject to larger intra- and interobserver variability as compared with linear measurements.[3] None of these parameters, however, accounts for increased soft-tissue mass, which leads to an underestimation or overestimation of fetal weight.

A study published in 2008, Scioscia et al.,[4] proposed a novel approach for EFW using measurement of the femur length (FL) and mid-thigh soft-tissue thickness (MTSTT), which included assessments of adipose tissue and lean mass. The authors intended for this formula to prevent inaccurate and

Address for Correspondence:
Dr. Anil Kumar Sakalecha, Professor and Head, Department of Radiodiagnosis, Sri Devaraj Urs Medical College, Tamaka, Kolar, Karnataka, India. **Mobile:** +91-9844092448. **E-mail:** dranilsakalecha@gmail.com

time-consuming circumferential measurements, making it practical to use even during labor. The main objective of the study was to compare the actual birth weight (ABW) to the estimated fetal weight determined by Hadlock's method (using head circumference [HC], AC and FL) and Scioscia's formula (using FL and MTSTT).

Aims and objectives

The aims of this study were as follows:

- To estimate fetal weight by Hadlock's method and ultrasonographic evaluation of fetal MTSTT in late third trimester.
- To correlate fetal weight derived by Hadlock's method and ultrasonographic evaluation of fetal MTSTT with ABW.

MATERIALS AND METHODS

Study design

This study was hospital-based prospective study.

Pregnant women who met the inclusion criteria and were likely to deliver within the next 48 h following admission to the department of Gynecology and Obstetrics at 'RL Jalappa Hospital were included in this study.

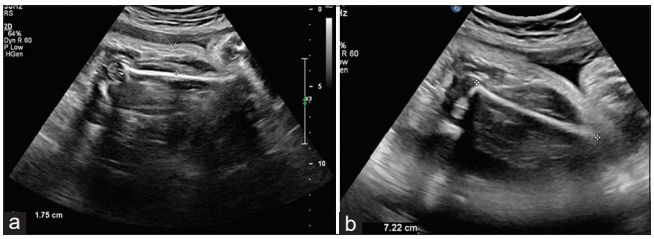

Figure 1: Sonographic measurement technique for fetal mid-thigh soft-tissue thickness. (a) The longitudinal section as used for measuring femur length is obtained. (b) Calipers are placed on the outer margin of the skin and the outer margin of the femur shaft, with the femur lying parallel to the transducer.

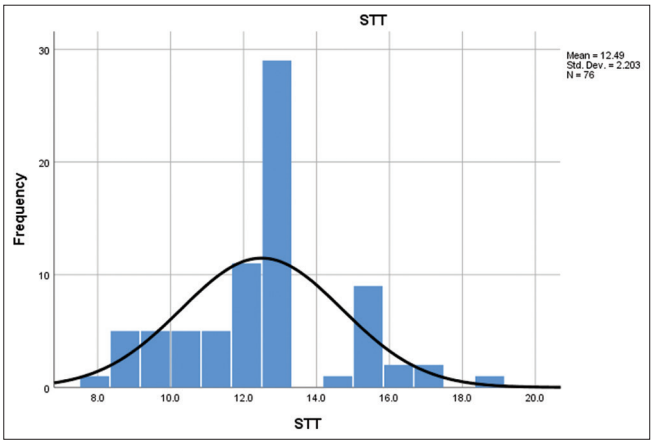

Diagram 1: Histogram and frequency polygon showing mean and standard deviations of mid-thigh soft-tissue thickness

The demographic characteristics of the mothers, including maternal age, nationality, and gestational age at the time of the examination were obtained as anamnestic data during the mothers' admission to the health facility.

Gestational age was determined from the last menstrual period and confirmed by ultrasound. All ultrasounds were performed using Philips EPIQ5, Philips Affinity 70, and Voluson GE systems. A rapid overview was performed first to confirm positive fetal life, longitudinal lie, and cephalic presentation, and then parameters such as biparietal diameter (BPD), HC AC, FL, and MTSTT was measured, respectively.

The mid-thigh STT was measured linearly from the outer edge of the skin down to the outer edge of the femur shaft using the same framed image. This measurement was taken in the middle of the fetal leg so that the upper and lower trochanters were turned upward to ensure the correct view of the lateral side of the femur (Figure 1).

The estimated fetal body weight will be calculated twice as follow:

1. Using the Hadlock formula determined by the programmed computer software.
2. Using Scioscia's formula, which will be calculated manually using FL and MTSTT as follows:

$$EFW = -1687.47 + (54.1 \times FL) + (76.68 \times MTSTT)$$

FL by millimeter, MTSTT by millimeter.

The ABW of the infant was measured immediately after delivery and after cutting of the umbilical cord and clamping it 5 cm from the fetal abdomen without any towels or clothes. All will be measured using the same calibrated scale.

This study will be analyzed and evaluated by comparing the results of estimated fetal birth weight using the previously illustrated Scioscia's formula (using FL and MTSTT) and commonly used Hadlock's formula (using BPD, HC AC, and FL) with ABW.

Inclusion criteria

The following criteria were included in the study:

1. All pregnant women at term admitted to the obstetric ward and likely to deliver within 48 h.
2. Singleton pregnancy.
3. Estimated gestational age ranging between 37 and 40 weeks gestation.

Exclusion criteria

The following criteria were excluded from the study:

1. Severe oligohydramnios.
2. Presence of congenital anomalies.
3. Diabetic and hypertensive patients

Analysis

All data for windows were collected, tabulated, and statistically analyzed using SPSS 20.0. Quantitative data were expressed as mean±SD and (minimum-maximum) and qualitative data as absolute frequencies (number) and relative frequencies (percentage) were expressed. Receiver operating characteristic and Kappa coefficient were used to compare fetal weight derived by Scioscia's formula and Hadlock's formula. Cohen suggested the Kappa result be interpreted as follows: Values ≤0 as indicating no agreement and 0.01–0.20 as none to slight, 0.21–0.40 as fair, 0.41–0.60 as moderate, 0.61–0.80 as substantial or good, and 0.81–1.00 as near perfect agreement.

RESULTS

Seventy-six pregnant women were included in the study. On analysis of results of the study, the mean age of studied group was 25.6 years (minimum age of 18 years and maximum age is 37 years) and mean gestational age of studied group was 37.6 weeks (minimum gestational age – 37 weeks and maximum – 40 weeks). Out of the 76 pregnant patients included, 34 (44.7%) patients were primigravida and 42 (55.3%) were multipara (Table 1).

Mean sonographically measured fetal Biparietal Diameter (BPD) was 9.29 ± 0.24, mean head circumference (HC) was 33.059 ± 0.49, mean fetal Abdominal Circumference (AC) was 33.14 ± 1.87 and mean Femur Length (FL) was 7.4 ± 1.6. The mean mid-thigh soft tissue thickness (MTSTT) was 12.495 cm ± 2.20 (Table 2 and Diagram 1).

The estimated fetal weight by Hadlock formulae was 3222.59 g ± 297.61 and the estimated fetal weight by Scioscia's formulae was 3284 g ± 224.62. The ABW was 3239.41 g ± 241.70 (Table 3 and Diagrams 2 and 3).

This study assessed validity of Hadlock formulae and Scioscia's formulae for detecting fetal weight. For detection of fetal weight by Hadlock's method, area under curve (AUC) for Hadlock formulae was 0.961 and according to Scioscia's formulae AUC was 0.965 (Diagram 4).

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Table 1: Mean and standard deviations of age per years, gestational age per week, and frequency distribution of parity for studied group (N=76)

Variables	Studied group (N=76)
Age per year (years)	
Mean±SD	25.6±4.41
Minimum–maximum	18–37
Gestational age per weak	
Mean±SD	37.6±0.681
Minimum–maximum	37–39
Parity	
Primigravida	N=34 (44.7%)
Multigravida	N=42 (55.3%)

SD: Standard deviation

Table 2: Mean and standard deviations of MTSTT, FL, BPD, HC, and AC (N=76)

Variables	Studied group (N=76) (Mean±SD)
Mean BPD (cm)	9.29±0.242
Mean HC (cm)	33.059±0.492
Mean AC (cm)	33.14±1.87
Mean FL (cm)	7.4±1.6
Mean MTSTT (mm)	12.495±2.20

MTSTT: Mid-thigh soft-tissue thickness, FL: Femur length, BPD: Biparietal diameter, HC: Head circumference, AC: Abdominal circumference, SD: Standard deviation

Table 3: Fetal weight by Hadlock formulae, Scioscia's formulae, and actual fetal weight per g

Variables	Studied group (N=76)
Hadlock formulae	Weight (g)
Mean±SD	3222.59±297.61
Minimum–maximum	2750–3805
Scioscia's formula	
Mean±SD	3284±224.624
Minimum–maximum	2780–3718
Actual fetal weight	
Mean±SD	3239.41±241.70
Minimum–maximum	2750–3800

SD: Standard deviation

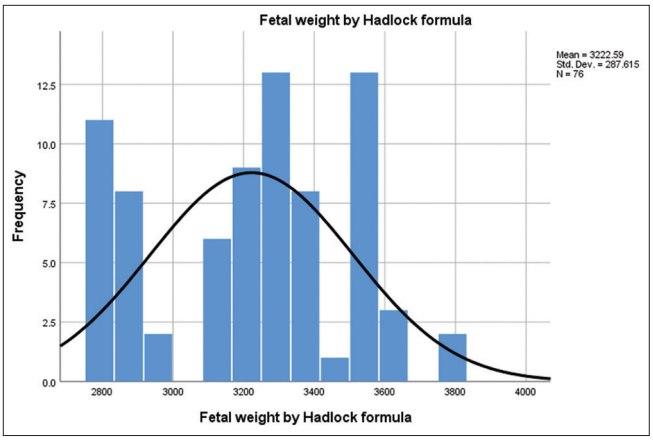

Diagram 2: Histogram and frequency polygon showing fetal weight by Hadlock formula.

agreement between fetal weight derived by Hadlock formulae and actual fetal weight (Kappa value – 0.725) (Table 5).

This study showed good agreement between fetal weight derived by Scioscia's formulae and actual fetal weight (0.745) and also showed good agreement between fetal weight derived by Hadlock formulae and actual fetal weight (Kappa value - 0.725).

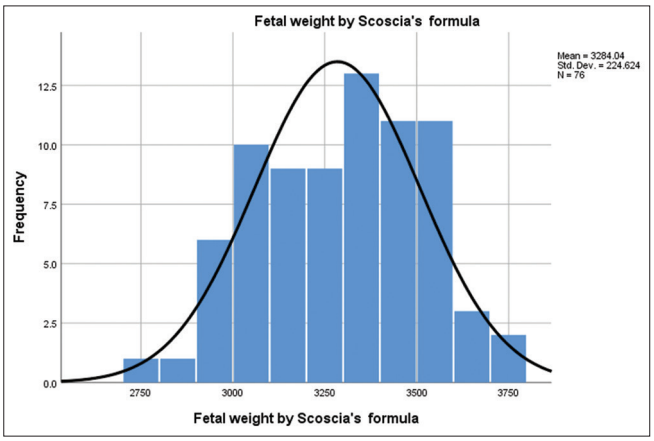

Diagram 3: Histogram and frequency polygon showing fetal weight by Scioscia's formulae (g)

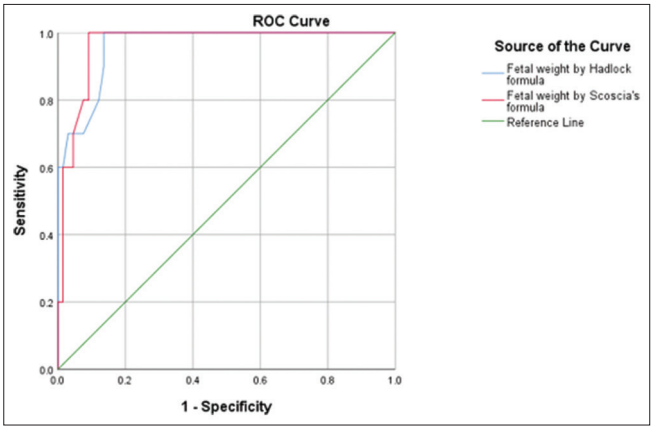

Diagram 4: Figure area under curve Hadlock formulae (0.961) and Scioscia's formulae (0.965) for detecting fetal weight among pregnant women at 37–40 weeks of gestation.

DISCUSSION

To identify any disturbances in fetal growth, such as restriction of intrauterine development and macrosomia, assessment of fetal weight is crucial. Fetal survival is determined in large part by this component. Mortality and perinatal morbidity are more likely for both. To avoid some of these difficulties in the management of labor, a reliable birth weight estimation is helpful.[5]

The most commonly used equations are based on AC, biparietal diameter, and FL. AC is sensitive to a large amount of intra- and interobserver variability as compared to linear measurements, making it the most relevant sonographic biometric parameter for estimating fetal weight.[6] Sometimes, it can be challenging to obtain images of high quality for measuring AC. The aim of this study was to evaluate usefulness of measuring FL and mid-thigh soft-tissue thickness in assessment of fetal birth weight using Scioscia's formula.

On analysis of results of the study, the mean age of studied group was 25.6 years (minimum age of 18 years and maximum age is 37 years) and mean gestational age of studied group was 38 weeks (minimum Gestational age – 37 weeks and maximum – 40 weeks). Out of the 76 pregnant patients included, 34 (44.7%) patients were primigravida and 42 (55.3%) were multipara. This result was nearly similar to the result in the study of Abuelghar et al.[7]

Where they found that the mean age of participants was 27.6±5.5 years, the mean gestational age was 38.7±1.2 weeks, and majority of patients were multiparous as compared to primigravida.

In our study, we found that there was a good correlation between ABW and estimated fetal weight using a formula based on FL and MTSTT. This was in concordance to previously published studies which reported higher correlations between estimated fetal weight and ABW, namely, Scioscia et al.,[4] who tested the original formula in 69 women and Abuelghar et

Table 4: Comparison of AUC for fetal weight by Hadlock's and Scioscia's formula

Fetal weight	Area	Standard error	P-value	Asymptomatic 95% confidence interval	
				Lower bound	Upper bound
Fetal weight by Hadlock's formula	0.961	0.022	0.001	0.918	1.001
Fetal weight by Scioscia's formula	0.965	0.019	0.001	0.927	1.001

AUC: Area under curve

Table 5: Agreement between Hadlock formulae, Scioscia's formulae, and actual fetal weight

Comparison characterizations for agree and disagree responses	Agreement N (%)	Disagreement N (%)	Kappa coefficient
Actual fetal weight versus Scioscia's formulae	63 (82.89%)	13 (17.10%)	0.745
Actual fetal weight versus Hadlock's formulae	60 (78.94%)	16 (21.05%)	0.725

al.,[7] who found a correlation in a group of 300 women, using the same formula. However, this was in contrast to a study done by Barros et al.,[8] where they found that there was a poor correlation between ABW and the estimated fetal weight using a formula based on FL and MTSTT, both linear parameters.

The linear measurement of the tissue above the external side of the fetal femur is a simple and straightforward method for assessing the fetal thigh's fat and muscular mass. The potential of linear measurement of mid-thigh STT as a useful parameter in the sonographic assessment of fetal weight is confirmed by this study. The fetal weight derived by Scioscia's formula (using FL and MTSTT]) is as reliable as Hadlock's formula, which is the most widely used formula for estimated fetal weight. The fetal weight derived by this method is also comparable to the actual fetal weight allowing us to rely on Scioscia's formulae to detect fetal weight. Hence, calculating fetal weight by measurement of fetal MTSTT serves as an additional tool for estimation of fetal weight along with the existing parameters, thereby increasing the sensitivity for fetal weight estimation.

Limitations of the study

It is important to take into account the study's limitations. Women with singleton pregnancies from 37 to 40 weeks, with normal liquor and signs of normal development made up the majority of the population. The results of this study are encouraging, but larger studies are needed to verify the validity of this unique parameter for estimation of fetal weight under various conditions, such as severe oligohydramnios and variations in fetal growth.

CONCLUSIONS

Fetal mid-thigh soft tissue thickness is a simple, useful, and easily applicable parameter for fetal weight estimation. The fetal weight derived by this method is comparable to the actual fetal weight allowing us to rely on Scioscia's formulae to detect fetal weight. Hence, calculating fetal weight by measurement of fetal MTSTT serves as an additional tool for estimation of fetal weight along with the existing parameters, thereby increasing the sensitivity for fetal weight estimation.

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Authors' Contributions:
LJ- Definition of intellectual content, Literature survey, Prepared first draft of manuscript, implementation of study protocol, data collection, data analysis, manuscript preparation and submission of article; **AKS-** Concept, design, clinical protocol, manuscript preparation, editing, and manuscript revision; **RJ-** Design of study, statistical Analysis and Interpretation; **VGR-** Review Manuscript; **SA -** Review Manuscript; **SS-** Literature survey and preparation of Figures.

Work attributed to:
Sri Devaraj Urs Medical College, Tamaka, Kolar, Karnataka, India.

Orcid ID:
Dr. Lynn Joy - https://orcid.org/0000-0002-8899-3777
Dr. Anil Kumar Sakalecha - https://orcid.org/0000-0003-2957-4908
Dr. Rajeswari - https://orcid.org/0000-0002-3014-2232
Dr. Varshitha GR - https://orcid.org/0000-0003-3511-1328
Dr. Surya Kanth Anne - https://orcid.org/0000-0001-5094-9335
Dr. Shantala Sawkar - https://orcid.org/0009-0008-8171-5118

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