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Original Research Article

Ultrasonographic Correlation of Fetal Thigh Circumference at 36-40 Weeks with Birth Weight

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Abstract

Estimated fetal weight has a great significance in obstetrical ultrasound, as this gives the information about fetal growth and assist in planning the mode of labour management. Various formulas are used for estimating the fetal weight. Vintzileos' formula, in which there is an addition of fetal thigh circumference along with biparietal diameter, abdominal circumference and femur length correlates well with actual birth weight however it is slightly less accurate in predicting the birth weight than Hadlock's formula. Objective: To correlate the fetal thigh circumference at 36-40 weeks ultrasonographically with birth weight. Method: A cross sectional analytical study involving 236 patients was conducting in the radiological department of Mansoorah Hospital, Lahore, Pakistan using Toshiba Nemio 30 with 2-5 MHz transducer. Results: Mean of actual birth weight is 3.3424 $\pm$ 0.42374 which is different from the mean of EFW by Vintzileos i.e. 3.4504 $\pm$ 0.08968 whereas it is similar to mean of Hadlock's formula i.e. 3.3199 $\pm$ 0.35452. Correlation between EFW by Vintzileos' formula and actual birth weight is 0.319 more significant than the correlation between EFW by Hadlock's formula and actual birth weight i.e. 0.300. ***Conclusion:*** Hadlock' formula is more accurate in predicting the actual birth weight than the Vintzileos' formula. However, due to its stronger correlation with birth weight thigh circumference can be used as an alternative parameter to biparietal diameter for estimating the birth weight at or near term when biparietal diameter becomes difficult to measure because of head positions down to pelvic bone.

Keywords: Estimated fetal weight, Fetal thigh circumference, Headlock's Formula, Vintzileos' Formula, Actual birth weight.

INTRODUCTION

Fetal weight estimation by ultrasound is an important factor in obstetrics, it is directly related to the gestational age which helps to plan the mode of delivery and labor management [1]. It gives the information about IUGR (intrauterine growth restriction) and has a significant role in the prevention of prematurity [2]. It also helps to control the rate of perinatal morbidity and mortality [3].There are many methods to find out the birth weight and many studies have been done to find out which one is more accurate. There are two main methods which include, sonographic or ultrasound method and the clinical method [4]. A clinical method includes the height of the uterus and girth of the abdomen at the level of umbilicus but this method has a major number of errors and not useful for polyhydramnios, oligohydramnios, maternal obesity, malpresentation, and multifetal pregnancy [5, 6]. In ultrasound, Head Circumference (HC), Abdominal Circumference (AC), Femur Length (FL) and Bi-parietal Diameter (BPD) are used for fetal weight estimation. These parameters are more accurate than the clinical method. These parameters are used with different formulas, either alone or in combination and provide somewhat accurate birth weight estimation [4]. In addition to these sonographical biometric parameters, a new parameter has been introduced which is the fetal thigh circumference (TC) by Hoffbauer and workers. Thigh circumference is more reliable method

for accurate fetal birth weight estimation, it also detects the changes in the soft tissue masses [7].

Vintzileos *et al.*, reported that addition of fetal thigh circumference to the other parameters (BPD, HC, AC & FL) gave more accurate results for fetal weight estimation. The mean error of this method was 6% and mean deviation was 0.3% [4]. A fetus with intrauterine growth restriction IUGR is at increased risk of hypoxia and perinatal death. Macrosomic fetus is at increased risk of cesarean section, a strong correlation of fetal thigh circumference with birth weight would be very helpful in intrauterine period for the early detection of these growth abnormalities [8]. It would also be very beneficial in the evaluation of pelvic disproportion before the induction of labor. Having all of this information decisions about the method of delivery can be easily taken, thereby minimizing the perinatal morbidity and mortality [3].

Previously very few studies have been done to prove the accuracy of this method. So, our study was designed to validate whether the addition of fetal thigh circumference has greater sensitivity and specificity in the prediction of fetal weight or not. We compared Vintzileos' method which uses the thigh circumference in addition to BPD, AC, HC and FL with Hadlock's method which includes BPD, AC and FL.

METHODS

It is a cross sectional analytical study of 236 patients. Data were collected from the Radiology Department of Mansoorah Hospital, Lahore, Pakistan in a duration of October 2018 to December 2018. The inclusion criteria was all singleton pregnant women between 36-40 weeks of gestation, sonographically normal amniotic fluid and gestational age confirmed retrospectively by recorded crown-rump length (CRL) before 12th weeks of gestation. The exclusion criteria contained congenital anomalies, polyhydramnios / oligohydramnios, intrauterine growth restriction (IUGR), maternal diabetes, hypertension, intrauterine fetal demise (IUFD). After taking the informed consent from patient, antenatal detailed history including cardiac disease, anemia, hypertension and diabetes mellitus was noted.

Patient was laid supine and a 2D ultrasonographic examination was performed with Toshiba Nemio 30 ultrasound machine using 3.5 MHZ convex transducer. Sonographic measurements of biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur length (FL) and thigh circumference (TC) were taken using calipers on screen between 36 and 40 weeks, approximately a week prior to delivery. To measure the thigh circumference the long axis of the femur was imaged first, the transducer was then rotated 90^0 to obtain a cross sectional profile of the middle of the thigh at a position that the bone profile was as round as possible and the boundary of the thigh profile was well defined. Fetal weight was then estimated using two formulae. First one was Headlock's formula;

$$\text{Log 10 (EFW)} = 1.335 - 0.0034(AC)(FL) + 0.0316(BPD+0.0457(AC) + 0.1623(FL). \quad (1)$$

This formula was incorporated in ultrasound machine and automatically calculated the estimated fetal weight.

And the second one was Vintzileos' formula;

$$\text{Log10 (BW)} = 1.897 + (0.015 \times AC) + (0.057 \times BPD) + (0.054 \times FL) + (0.011 \times TC). \quad (2)$$

This formula was not incorporated in ultrasound machine so estimated fetal weight was calculated manually. Patients were followed up till delivery and if delivery not occurred within one week of the scan, the scan was then repeated and fetal weight using two formulae was re-estimated. After delivery, the neonates' weight was measured on a weighing scale, which was compared with the sonographically estimated fetal weight.

RESULTS

Two hundred thirty six pregnant women were enrolled in this research of thigh circumference by ultrasound correlation at 36 to 40 weeks with birth weight.

Table-1: Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	EFW Vintzileos	3.4504	236	.08968	.00584
	Actual Birth Weight	3.3424	236	.42374	.02758
Pair 2	EFW Hadlock	3.3199	236	.35452	.02308
	Actual Birth Weight	3.3424	236	.42374	.02758

Table one shows the mean, standard deviation and standard error mean by pairing the actual birth weight with EFW by Vintzileos' formula and with EFW by Hadlock's formula. Mean of actual birth weight is 3.3424 $\pm$ 0.42374 which is different from the mean of EFW by Vintzileos i.e. 3.4504 $\pm$ 0.08968 whereas it is similar to mean of Hadlock's formula i.e. 3.3199 $\pm$ 0.35452. Standard error mean of EFW by Hadlock's formula is 0.02308 which is almost same to actual birth weight's standard error mean i.e. 0.02758 whereas standard error mean of EFW Vintzileos' formula is 0.00584.

Table-2: Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	EFW Vintzileos & Actual Birth Weight	236	.319	.000
Pair 2	EFW Hadlock & Actual Birth Weight	236	.300	.000

Correlation between EFW by Vintzileos' formula and actual birth weight is 0.319 which is significant and also the correlation between EFW by Hadlock's formula and actual birth weight is significant i.e. 0.300 (Table-2).

Table-3: Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	EFW Vintzileos – Actual Birth Weight	.10805	.40421	.02631	.05621	.15989	4.107	235	.000
Pair 2	EFW Hadlock – Actual Birth Weight	-.02246	.46371	.03018	-.08193	.03701	-.744	235	.458

Paired samples Test is applied by pairing the EFW by Vintzileos' formula with actual birth weight and EFW by Hadlock's formula with actual birth weight. Mean. This test shows the statistically significant difference between EFW by Vintzileos' formula and EFW by Hadlock's formula also significant between EFW by Vintzileos' formula and actual birth weight while EFW by Hadlock's formula and actual birth weight is non-significant (Table-3).

Table-4: Report

	EFW Hadlock	EFW Vintzileos	Actual Birth Weight
Mean	3.3199	3.4504	3.3424
N	236	236	236
Std. Deviation	.35452	.08968	.42374
Minimum	2.60	2.90	2.40
Maximum	4.80	4.10	4.70
Median	3.3000	3.4000	3.4000

Table-4 gives the report of EFW by Hadlock's formula, EFW by Vintzileos' formula and actual birth weight including their mean, standard deviation, minimum, maximum and median values.

DISCUSSIONS

Fetal weight estimation has been an important factor in determining the fetal growth health like intrauterine growth restriction and macrosomia both of which are at increased risk for perinatal morbidity and mortality. Assessment of fetal weight also helps in labour management. Hence, an accurate birth weight estimation is necessary to prevent complications at the time of labour management. For this purpose many clinical and sonographic methods have been used from many years [9]. In obstetrical ultrasound, fetal weight estimation is considered as a valuable source of information. However, previously very few studies have been done to improve the accuracy of fetal weight estimation [10, 11]. Various regression equations based on these parameters are used however they have not hundred percent accuracy to the actual birth weight. The most commonly used regression equation is based on biparietal diameter, abdominal circumference and femur length [12]. Vintzileos et al. devised another regression equation for birth weight estimation which is based on thigh circumference along with other parameters [13].

The present study is based on Vintzileos' formula which incorporates thigh circumference in addition to biparietal diameter, abdominal circumference and femur length. Vintzileos' formula is compared with Hadlock's formula for predicting the birth weight estimation and also to find its correlation with actual birth weight. By applying paired t test between the EFW by Vintzileos' formula with actual birth weight and EFW by Hadlock's formula with actual birth weight statistical significant difference is seen between EFW by Vintzileos' formula and EFW by Hadlock's formula. There is also a significant difference between EFW by Vintzileos' formula and actual birth weight while EFW by Hadlock's formula and actual birth weight is non-significant. P value for EFW by Vintzileos' formula is 0.001 which means there is a significant difference between EFW by

Vintzileos' formula and actual birth weight. P value for EFW by Hadlock's formula is 0.458 which means between EFW by Hadlock's formula and actual birth weight is non-significant difference. In paired statistics mean of actual birth weight is 3.3424 ± 0.42374 which is different from the mean of EFW by Vintzileos i.e. 3.4504 ± 0.08968 whereas it is similar to mean of Hadlock's formula i.e. 3.3199 ± 0.35452. Standard error mean of EFW by Hadlock's formula is 0.02308 which is almost same to actual birth weight's standard error mean i.e. 0.02758 whereas standard error mean of EFW Vintzileos' formula is 0.00584. These results show that the predictability of Hadlock's formula in estimating the birth weight is more accurate than the Vintzileos' formula. Correlation of EFW by Vintzileos formula with actual birth weight is 0.319 which is significant and the correlation of EFW by Hadlock's formula is 0.300 which is also significant however it is slightly less than the Vintzileos' formula. So Vintzileos' formula has a stronger correlation with actual birth weight than the Hadlock's formula. The results of present study indicate that for fetal weight estimation Hadlock's formula has a great accuracy in predicting estimated fetal weight than Vintzileos' formula. This study suggests to use Hadlock's formula in future for fetal weight estimation. However, due to stronger correlation between EFW by Vintzileos' formula and actual birth weight than the Hadlock's formula, Vintzileos' formula can be used as an alternative parameter to biparietal diameter or head circumference when it becomes difficult to assess the fetus head at or near term due to head position down to the pelvic bone.

By comparing the results of present study with previously done studies it can be seen that the result of present study is different from their results. Magdy Kamal *et al.*, concluded that thigh circumference has a role to play in accurately measuring fetal weight when incorporated with other fetal parameters. Vintzileos' formula would be useful in daily clinical practice for estimation of fetal weight and may prove most useful in predicting fetal weight when growth abnormalities are present. Good correlation was found between prenatal and postnatal thigh circumference estimates & ultrasound can fairly reproduce the actual thigh circumference and its inclusion in routine ultrasound is strongly recommended to improve the birth estimates [14].

Shripad and Varalaxmi reported that fetal thigh circumference measurements increase the accuracy of birth weight estimation especially in babies of <2.5 kg with 95% predictability. Different result of our study from the Shripard and Varalamxmi' s study may be due to that we studied babies with weight above 2.5 kg while their result is best for babies <2.5 kg. They also mentioned that TC provide a potentially straight forward method for assessing the deposition of muscle and fat in the growing fetus. This parameter is preferred over diameter measurements as it is less sensitive to change in shape [4].

In order to explore potential use of limb measurements, Faver *et al.*, conducted a prospective study on fetal weight estimation using TC as one of the parameters. They confirmed that the use of thigh circumference not only enhanced the detection of small for dates fetuses, but also macrosomic fetuses [15].

All these previous studies however have different result from present study as they reported that Vintzileos' formula is better in predicting the fetal weight estimation that Hadlock's formula while our result is opposite. They also confirmed that thigh circumference is an important factor for assessing the fetal growth abnormalities as such abnormalities are associated with soft tissue masses as well as Vintzileos' formula has stronger correlation with actual birth weight than Hadlock's formula which is similar to the result of our study. From all of this information we can say that thigh circumference can be used for assessing growth abnormalities as well as it can be used as an alternative parameter to biparietal diameter or head circumference when it becomes difficult to assess the fetus head at or near term due to head position down to the pelvic bone.

CONCLUSIONS

It is concluded from this study that when thigh circumference is incorporated with other sonographic parameters in estimating the fetal birth weight, does not improve the accuracy of estimated birth weight. In short Hadlock's formula has greater accuracy in predicting the actual birth weight than the Vintzileos' formula. However results of this study also show that correlation and p value of Vintzileos' formula (i.e. 0.319 and 0.0001 respectively) is more significant than the correlation and p value of Hadlock's formula (i.e. 0.300 and 0.458).So thigh circumference can be used as an alternative parameter to biparietal diameter for estimating the birth weight at or near term when biparietal diameter becomes difficult to measure because of head positions down to pelvic bone.

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