

Accuracy and reliability of ultrasound estimation of fetal weight in women with a singleton term pregnancy

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ABSTRACT

Background: Prenatal estimation of birth-weight is of utmost importance to predict the mode of delivery. This is also an important parameter of antenatal care. This study was conducted to evaluate the accuracy of estimated fetal weight by ultrasound, compared with actual birth weight.

Methods: This was a prospective and comparative study comprising 110 pregnant women at term. Patients who had their sonography done within 7 days from date of delivery were included. Fetal weight was estimated by Hadlock 2 formula, the software of which was preinstalled in ultrasound-machine. The estimated fetal weight was compared to the post-delivery birth-weight. The Pearson's correlation coefficient was used and the accuracy of sonographic fetal weight estimation was evaluated using mean error, mean absolute error, mean percentage error, mean absolute percentage error and proportion of estimates within 10% of actual birth weight.

Results: Mean estimated and actual birth weights were 3120.8±349.4 gm and 3088.2±404.5 g respectively. There was strong positive correlation between estimated fetal weight and actual birth weight ($r = 0.58$, $p < 0.001$). The mean percentage error and mean absolute percentage error of ultrasound fetal weight estimations were 1.96±11.8% and 8.7±8.2% respectively. The percentage of estimates within ±10% of the actual birth weight was found to be 67.3%. In 23% of the cases, ultrasound overestimated the birth weight. In 13% of the cases, ultrasound underestimated the birth weight.

Conclusions: There was strong positive correlation between actual and sonographically estimated fetal weight. So, ultrasonography can be considered as useful tool for estimating the fetal weight for improving the perinatal outcome.

Keywords: Actual birth weight, Hadlock's formula, Sonographically estimated fetal weight, Ultrasound

INTRODUCTION

Pre-natal fetal weight estimation, as an important aspect of routine obstetric care, helps clinicians to prepare for anticipated preterm deliveries, and to decide the optimal delivery route.¹ Birth weight is a key variable affecting fetal and neonatal morbidity, particularly in preterm and small-for-dates babies. In addition, it is of value in the management of breech presentations, diabetes mellitus, trial of labour, macrosomic fetuses and multiple births.² Both low and excessive fetal weights at delivery are

associated with an increased risk of new-born complications during labor and puerperium. For limiting the potential complications associated with the birth of both small and excessively large fetuses we requires that accurate estimation of fetal weight should be done before decision to deliver is made.³ The advantage of sonographically estimated fetal weight over clinical methods was suggested to be due to the fact that sonographic fetal weight estimation relies on objective intra-uterine linear and/or planar measurement of fetal parameters, thereby eliminating subjectivity associated

with clinical methods.⁴ At present, fetal ultrasound is extensively used to estimate the fetal weight. Multiple formulae have been developed for the estimation of birth weight using ultrasound measurement; using abdominal circumference (AC) alone, AC and biparietal diameter (BPD) and AC, BPD and femur length.⁵ The present study was conducted to evaluate the accuracy between sonographically estimated fetal weight and to compare that with actual birth weight after delivery of fetus.

Objectives

- The present study was aimed at estimation of fetal birth weight sonographically and compares them with actual birth weight after delivery of fetus
- To assess the accuracy and reliability of ultrasound estimation of fetal weight in women with a singleton term pregnancy
- To assess the outcome in term of mode of delivery, instrumental delivery and intranatal complications.

METHODS

The present study was carried out prospectively from December 2017 to June 2018 and included 110 normal antenatal women at term pregnancy (37 to 42 weeks of gestation) who were admitted and worked up at the department of obstetrics and gynaecology, SLBS GMCH Mandi and after taking consent the enrolled women sent to the department of Radiodiagnosis SLBS GMCH Mandi for ultrasonography.

Inclusion criteria

- Term pregnancies (37-42 weeks), Singleton pregnancy, vertex presentation, only those cases were included in the study in which women delivered within 7 days of sonographic weight estimation.

Exclusion criteria

- Multiple pregnancy, IUGR (intrauterine growth retardation), stillbirth, congenital fetal malformations, hydrops fetalis, diabetes mellitus in mother and delivery after seven days of ultrasonic fetal weight estimation.

Ultrasonography of each case included in the study was done using Siemens ACUSON X300 ultrasound equipment with convex probe with a frequency range of 2-9 MHz to assess fetal viability, fetal presentation, biparietal diameter, head circumference, abdominal circumference, femur length, and gestational age. Hadlock 2 equation ($\text{Log}_{10}\text{BW} = 1.304 + 0.005251(\text{AC}) + 0.01938(\text{FL}) - 0.00004(\text{Acx FL})$) was used to estimate the fetal weight, the software of which was pre-installed in the ultrasound machine. The machine calculated the fetal weight automatically after measuring the fetal growth parameters.

In this study author collected the data including demographic profile of the women, estimated fetal weight documented in ultrasonography done in the hospital, weight of fetus after delivery, mode of delivery, any instrumentation or complication faced during delivery. There will be proforma including these particulars along with consent form for women who will be enrolled in this study. It was analysed that the data both by descriptive statistics such as mean and standard deviation (SD) and inferential statistics such as Pearson's correlation (r) were used to interpret the results. Test for significance of results was set at $p \leq 0.05$. For statistical analysis different measures of accuracy were used including mean error, mean absolute error, mean percentage error, mean absolute percentage error and the proportion of estimates within $\pm 10\%$ of actual birth weight.

RESULTS

During the study period one hundred and ten pregnant women were enrolled for the study. Maximum percentage of the patients were observed in the 18-25 year age group (60.9%).

Table 1: Mode of delivery (total number of patients = 110).

Mode of delivery	Total number of patients	%
Normal vaginal delivery	85	78.2%
LSCS	24	20.9%
Instrumental delivery	1	0.9%

In this study, out of 110 women 58.2% were primigravida and 41.8% multigravidas.

A total of 78.2% of patients delivered vaginally where as 20.9% patients had undergone LSCS for various indications and 0.9% had the instrumental delivery (Table 1).

Table 2: Distribution on the basis of fetal birth weight. (Total number of patients = 110).

Fetal birth weight (grams)	Total number	%
< 2500 gm	6.0	5.5%
2500-3500 gm	91.0	82.7%
> 3500 gm	13.0	11.8%

In India, average birth weight 2500-3000 gm. We divided the cases as per the birth weight of babies into three groups. In the study, 2500-3000 gm group had maximum distribution (82.7%) of cases compared to other groups. Low birth weight was only 5.5% and 11.8% had weight >3500 gm. The maximum actual birth weight was 4000 gm (Table 2). The proportion of low birth weight (<2500 gm) was found to be higher (3.6%) with maternal weight group ranging from 40-55 kg compared to women in higher weight categories (Table 3).

In Table 4, the cases within the birth weight (<2500 gm) were observed more in primigravida (66.6%) and birth

weight (>3500 gm) were observed in second gravida (53.8%).

Table 3: Birth weight in relation to maternal weight (total number of patients = 110).

Maternal weight in kg	Fetal birth weight in grams			Percentage
	< 2500 gms	2500-3500 gms	> 3500 gms	
40-55 kg	4 (3.6%)	28 (25.5%)	2 (1.8%)	24 (30.9%)
56-70 kg	2 (1.8%)	52 (47.3%)	7 (6.4%)	61 (55.5%)
> 70 kg	0 (0.0%)	11 (10%)	4 (3.6%)	15 (13.6%)
Total	6	91	13	110

Table 4: Birth weight in relation to gravidity (total number of patients = 110).

Gravida	Fetal birth weight		
	< 2500 gms	2500-3500 gms	> 3500 gms
1 (64)	4 (66.6%)	56 (61.5%)	4 (30.7%)
2 (30)	2 (33.3%)	21 (23.0%)	7 (53.8%)
3 (11)	0 (0%)	10 (10.9%)	1 (7.6%)
4 (5)	0 (0%)	4 (4.39%)	1 (7.6%)
> 4 (0)	0 (0%)	0 (0%)	0 (0%)
Total = 110	6	91	13

Table 5: Maternal and infant demographics.

Characteristics	Mean±SD	Range	
		Maximum	Minimum
Maternal age (years)	25.1±4.3	38	19
Maternal weight (kg)	61.4±9.1	92	47
Parity	1.6±0.9	4	1
Gestational age at delivery (weeks)	39.5±1.1	41.4	37.3
Estimated birth weight (grams)	3120.8±349.4	4231	2200
Actual birth weight (grams)	3088.2±404.5	4000	2215

Table 6: Accuracy of the method.

Overall	Mean	SD
Mean error (gram)	32.6	345.5
Mean absolute error (gram)	258.5	230.1
Mean percentage error	1.96	11.8
Mean absolute percentage error	8.7	8.2
Accurate within 10% of actual birth weight	67.3%	

Maternal and infant demographics

The mean maternal age was 25.1±4.3 years (range 19 to 38 years). The mean maternal weight was 61.4±9.1 (range 92 to 47 kg) and mean parity was 1.6±0.9 (range: 4 to 1). The mean gestational age was 39.5±1.1 weeks (range: 37.3 to 41.4 weeks). The mean ultrasound estimated birth weight was 3120.8±349.4 g (range: 2200 to 4231 gm). The mean actual birth weight of new-borns was 3088.2±404.5 g (range: 2015-4000 gm) (Table 5). The mean error in the estimation of birth weight was 32.6

gm. The mean absolute error in the estimation of birth weight was 258.5 gm. The mean percentage error for ultrasound estimated fetal weight was 1.96±11.8%. This means that, in the overall study group, the ultrasonographic method slightly overestimated the actual birth weight. The mean absolute percentage error was 8.7±8.2%. In the study, the percentage of estimates within ±10% of the actual birth weight was found to be 67.3% (Table 6).

Table 7: Error estimation.

Characteristics	Number (%)
Accurate estimation	74 (67.3)
Inaccurate estimation	36 (32.7)
overestimation	23 (20.9)
underestimation	13 (11.8)

The percentage of error estimation in this study is shown in (Table 7).

The ultrasound estimated fetal weight (EFW) had a strong positive correlation with actual birth weight (ABW) of the new-borns ($r = 0.58$, $p < 0.001$). The scatter diagram of their relationship is shown in (Figure 1).

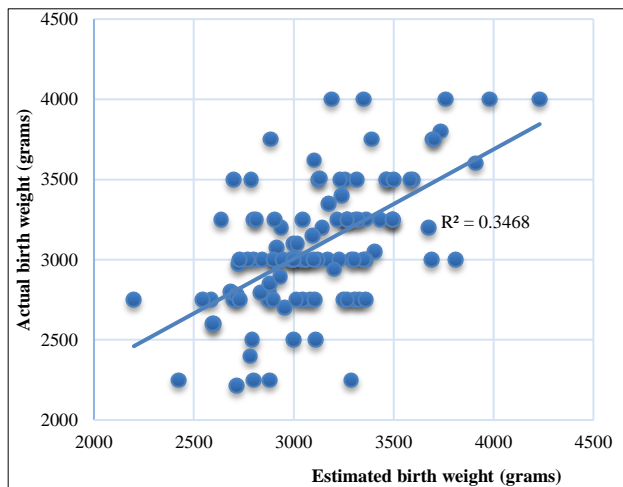


Figure 1: The relation between estimated fetal weight (EFW) and actual birth weight (ABW) (in grams) and a linear association between both variables. The continuous line is the regression line.

DISCUSSION

Birth weight of an infant is the single most important determinant of newborn survival. The assessment of fetal weight is a vital and universal part of antenatal care, not only in the management of labor and delivery but also during the management of high risk pregnancies and growth monitoring.^{6,7} Both fetal macrosomia and intrauterine growth restriction increase the risk of perinatal morbidity and mortality and of long term neurologic and developmental disorders.⁸ Limiting the potential complications associated with the birth of both small and excessively large fetuses requires that accurate estimation of fetal weight occurs before decision to deliver is made.⁹ The two main methods for predicting birth weight in current obstetrics are clinical and ultrasonographic methods.^{10,11} Ultrasound estimation of fetal weight, while being accurate to a certain degree, is associated with error ranging from ± 6 to 11% depending on parameters measured and the equation used for estimation.¹²

The majority 60.9% of the patients belonged to the age group of 18-25 years and 58.2% were primigravida. 78.2% of patients delivered vaginally where as 20.9% patients had undergone LSCS for various indications and 0.9% had the instrumental delivery. The majority 82.7% of the women had the actual fetal birth weight in 2500-3000 gm group. Low birth weight (< 2500) was found to be high in maternal weight group ranging from 40-55 kg compared to women with more weight. Low birth weight (< 2500 gm) were observed more in primigravida (66.6%) and birth weight (> 3500 gm) were commonly observed in

second gravida (53.8%). All these results were comparable with the study done by Bajaj et al.¹³

The mean ultrasound estimated birth weight was 3120.8 ± 349.4 g (range: 2200 to 4231 gm). The mean actual birth weight of new-born was 3088.2 ± 404.5 g (range: 2015-4000 gm) comparable to the mean actual birth weight of 3070 g (2110-4900 g) reported by Bajhracharya et al.¹⁴ The difference in fetal weights in different studies across the world may be due to several factors affecting birth weight such as regional and socioeconomic factors.¹²

The mean percentage error for ultrasound estimated fetal weight was $1.96 \pm 11.8\%$. The mean absolute percentage error was $8.7 \pm 8.2\%$. These results are comparable with mean percentage error and mean absolute percentage error of ultrasound fetal weight estimations were $1.9 \pm 11.4\%$ and $8.8 \pm 7.5\%$ respectively in the study done by Prasad et al.¹⁵ These results are also consistent with previously observed findings that the mean absolute percentage error of predicting birth weight varies from 6% to 12% of actual birth weight.¹²

The percentage of estimates within $\pm 10\%$ of the actual birth weight was found to be 67.3% which is comparable with the percentage of estimates within $\pm 10\%$ of the actual birth weight was found to be 65% in the study done by Prasad et al.¹⁵ These results are also consistent with what have been previously observed that 40-76% of the estimates were within 10% of actual birth weight.¹²

The ultrasound estimated fetal weight (EFW) had a strong positive correlation with actual birth weight (ABW) of the newborns ($r = 0.58$, $p < 0.001$). These results are comparable with ultrasound estimated fetal weight (EFW) had a strong positive correlation with actual birth weight (ABW) of the newborns ($r = 0.71$, $p < 0.001$) in study done by Prasad et al.

Limiting factors in this study were, no comparison had been done between Hadlock formula and other ultrasonographic formulas to compare the estimated fetal weight. Equipment and operator related errors were unavoidable. Measurements affected due to obesity, placentation and fetal position were unavoidable limitations.

CONCLUSION

This study concluded that sonographically estimated fetal weight positively and strongly correlated with the actual birth weight of fetuses. As the fetal weight is an important parameter in antenatal care and growth monitoring, it also plays an important role in deciding route of delivery. So, ultrasonography can answer all these queries of an obstetrician and can help them in managing their patients.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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