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Original Article

Estimation of Fetal Weight by Clinical Methods and Ultrasound and Correlating its Accuracy with Actual Birth Weight in Term Pregnancies

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Abstract

Objective: This study was to estimate the fetal weight in term pregnancy by clinical methods and ultrasound and to compare the results with actual birth weight (ABW).

Material and Methods: This study was conducted at a tertiary care center, Government Victoria Hospital attached to Andhra Medical College, Visakhapatnam, from January to June 2017. It was a prospective study covering 200 pregnant women at term gestation.

Results: Estimated birth weight by abdominal girth × symphysis fundal height (AG × SFH) formula was closest to the ABW (P = 0.060), as compared to the estimated birth weight by Johnson's formula (P = 0.000) and Hadlock's formula (P = 0.000). Therefore, of the three formulae studied, AG × SFH formula had better predictive value as compared to Johnson's and Hadlock's formulae. The accuracy of AG × SFH (Insler's formula) for estimating the fetal weight at term was found to be comparable to Hadlock's formula (P = 0.104).

Conclusion: Clinical estimation of birth weight definitely has a role in the management of labor and delivery. AG × SFH is a simple, easy, cost-effective, and universally applicable method to predict fetal birth weight which can be used even by paramedics like midwives and also in centers where ultrasound is not available.

Key words: Fetal birth weight, Hadlock's method, Insler's formula, Johnson's formula

INTRODUCTION

Accurate estimation of fetal weight is of paramount importance in the management of labor and in predicting the survival of the baby outside the uterus. The perinatal and maternal outcomes grossly depend on the fetal weight at term gestation[1] and management of diabetic and post-cesarean pregnancies is greatly influenced by the accurate estimation of fetal weight.[2] Different methods of estimating fetal weight have been tried in different parts of the world in search of the best method. A quick clinical method of fetal weight determination in utero will also be useful to paramedical staff working in rural areas to decide regarding referral to higher centres.[3]

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Aim

The aim of the study was to estimate fetal weight by clinical methods and ultrasound and to compare it with actual birth weight (ABW).

MATERIALS AND METHODS

This was a prospective study conducted over a period of 6 months from November 2016 to April 2017 in a tertiary care center, Government Victoria Hospital, attached to Andhra Medical College, Visakhapatnam. All term

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singleton pregnancies with cephalic presentation, intact membranes and with ultrasound sonography test (USG) examination done within a week of delivery were included in the study. Pregnancies with intrauterine fetal demise, multiple gestations, poly and oligohydramnios, pelvic or abdominal masses, and current maternal weight more than 80 kg were excluded from the study. A total of 200 mothers were included in the study after a written informed consent was sought. The Institutional Ethics Committee clearance was also obtained.

Fetal weight was assessed by –

1. Insler's formula: Fetal weight in grams = AG in centimeters × symphysis fundal height in centimeters.
2. Johnson's formula: Fetal weight in grams = (fundal height in centimeters – n) × 155
   n denotes the station of head $n = 13$ when presenting part is above ischial spines
   $n = 12$ when presenting part is at ischial spines
   $n = 11$ when presenting part is below ischial spines
3. Hadlock's formula using ultrasonographic measurements of biparietal diameter, abdominal circumference, and femur length.

The estimated fetal weights (EFW) obtained by all the three formulae were compared with the ABW and each other using paired *t*-test and Karl Pearson's correlation coefficient. $P \leq 0.05$ was considered significant.

RESULTS

In the present study, the maternal age distribution was in the range of 17–31 years, mean age being 21.84 ± 2.298 standard deviation. Maximum number of cases studied was in the age group of 21–30 years [Table 1]. Of the 200 mothers, 98 (49%) had vaginal delivery and 102 (51%) underwent cesarean section [Table 2].

Table 1: Distribution of mothers by age groups

Age groups (years)	Number of mothers (%)
≤20	63 (31.5)
21-30	136 (68.0)
31+	1 (5)
Total	200 (100.00)
Mean age±SD age	21.84±2.298

SD: Standard deviation

Table 2: Distribution of mothers by outcome

Outcome	Number of mothers (%)
FTND	98 (49.0)
LSCS	102 (51.0)
Total	200 (100.00)

FTND: Full term normal delivery, LSCS: Lower segment caesarean section

Fetal weights for all the 200 mothers were estimated clinically using abdominal girth × symphysis fundal height (AG × SFH) formula, Johnson's formula and ultrasonologically through Hadlock's formula and their respective mean values were calculated. These mean values were compared with the mean value of the ABWs and each other by paired *t*-test. Correlation of the ABWs with the estimates from all the three methods was also calculated by Karl Pearson's correlation coefficient.

The mean birth weight by AG × SFH method (2959.01 ± 331.490) when compared with mean ABW (2902 ± 412.275) by paired *t*-test, $P = 0.060$, which is statistically not significant [Table 3]. This shows that there is no statistically significant difference between the EFW by AG × SFH method and the ABW, making AG × SFH method reasonably accurate for the estimation of fetal weight in term singleton pregnancies.

Whereas the mean birth weights by Johnson's formula (3296.15 ± 404.252) and Hadlock's formula (3003.14 ± 384.897) when compared with the mean ABW (2902 ± 412.275) by paired t-test, $P = 0.00001$ for both, which is statistically significant [Tables 4 and 5]. This shows that in our study fetal weight estimates by Johnson's and Hadlock's formulae have a statistically significant difference with the ABW, hence, are not as accurate as AG × SFH formula in estimating the fetal weight at term.

When the mean EFW from both the clinical methods were compared to the mean EFW from Hadlock's method by paired *t*-test, AG × SFH was found to be statistically more comparable to ultrasound ($P = 0.104$, statistically insignificant) than Johnson's formula ($P = 0.00001$, statistically significant) in accurately estimating the fetal weight in term pregnancies [Tables 6 and 7].

Correlation analysis of the EFWs from all the three methods with the ABWs by Karl Pearson's correlation coefficient was done. As seen in Table 8, all the three methods showed a positive correlation with the ABWs. Hadlock's method showed the highest correlation ($r = 0.701$) with the ABW of the three. Among the clinical methods, AG × SFH method ($r = 0.379$) fared slightly better than Johnson's formula ($r = 0.351$). This leads to the conclusion that Hadlock's formula is more sensitive to the changes in the ABW than the clinical methods.

Correlation analysis of the clinical methods with Hadlock's formula showed positive correlation for both, but AG × SFH method showed higher correlation with Hadlock's ($r = 0.439$) than Johnson's ($r = 0.371$) leading to the inference that calculations of fetal weight using AG ×

Table 3: Comparison of AG×SFH and ABW by paired *t*-test

Procedure	Mean	Mean difference	*n*	Standard deviation	Standard error mean	*P*
AG×SFH	2959.01	56.12	200	331.490	23.440	0.060
ABW	2902.89		200	412.275	29.152	

AG: Abdominal girth, SFH: Symphysis fundal height, ABW: Actual birth weight

Table 4: Comparison of johnson's formula and ABW by paired *t*-test

Procedure	Mean	Mean difference	*n*	Standard deviation	Standard error mean	*P*
Johnsons formula	3296.15	393.26	200	404.252	28.585	0.000
ABW	2902.89		200	412.275	29.152	

ABW: Actual birth weight

Table 5: Comparison of Hadlock's formula and ABW by paired *t*-test

Procedure	Mean	Mean difference	*n*	Standard deviation	Standard error mean	*P*
Hadlock's formula	3003.14	100.245	200	384.897	27.216	0.000
ABW	2902.89		200	412.275	29.152	

ABW: Actual birth weight

Table 6: Comparison of AG×SFH and Hadlock's formula by paired *t*-test

Procedure	Mean	Mean difference	*n*	Standard deviation	Standard error mean	*P*
AG×SFH	2959.01	−44.125	200	331.490	23.440	0.104
Hadlock's formula	3003.14		200	384.897	27.216	

AG: Abdominal girth; SFH: Symphysis fundal height

Table 7: Comparison of Hadlock's formula and Johnson's formula by paired *t*-test

Procedure	Mean	Mean Difference	*n*	Standard deviation	Standard error mean	*P*
Hadlock's formula	3003.14	−293.469	200	384.897	27.216	0.000
Johnson's formula	3296.15		200	404.252	28.585	

Table 8: Correlation between ABWs with others by Karl Pearson's correlation coefficient method

Procedure compared		AG×SFH	Johnsons formula	Hadlock's formula
Correlation between ABW with	*r* value	0.379	0.351	0.701
	n	200	200	200

AG: Abdominal girth; SFH: Symphysis fundal height, ABW: Actual birth weight

Table 9: Correlation between Hadlock's formula and clinical formulae by Karl Pearson's correlation coefficient method

Procedure compared		AG×SFH	Johnson's formula	ABW
Correlation between Hadlock's formula with	*r* value	0.439	0.371	0.701
	n	200	200	200

AG: Abdominal girth, SFH: Symphysis fundal height, ABW: Actual birth weight

SFH are parallel to those of Hadlock's formula to a higher degree than Johnson's formula [Table 9].

The average error by AG × SFH formula was 56.12 g, and percentage error was 1.9 % which is the least when compared to Hadlock's formula (100.25 g and 3.5 %) and Johnson's formula (393.26 g and 13.5 %) [Table 10].

Up to an error of 5% AG × SFH method was able to accurately estimate fetal weights for 86.64% of the mothers as compared to 94.6% by Hadlock's and 66.6% by Johnson's. When the margin of error was increased to 5–10%, AG × SFH method could estimate fetal weights correctly for 97.3% as compared to 100% by Hadlock's and 91.3% by Johnson's. All the methods could accurately

Table 10: Average error and percentage error in each method

Statistic compared	SFH * AG	Johnson's	Hadlock's
Average error (g)	56.12	393.26	100.245
% error	1.9	13.5	3.5

AG: Abdominal girth, SFH: Symphysis fundal height

Table 11: Percentage error by various methods

Percentage error (%)	SFH * AG (%)	Johnson's (%)	Hadlock's (%)
Upto 5	173 (86.64)	133 (66.6)	189 (94.6)
5–10	21 (97.3)	49 (91.3)	11 (100)
11–20	6 (100)	18 (100)	0

AG: Abdominal girth, SFH: Symphysis fundal height

Table 12: Number of cases with over and underestimate of birth weight by different methods

Method	Overestimation - Number of cases (%)	Underestimation - Number of cases (%)
AG×SFH	95 (47.5)	105 (52.5)
Johnson's	158 (79)	42 (21)
Hadlock	126 (63)	74 (37)

AG: Abdominal girth, SFH: Symphysis fundal height

estimate fetal weights for all the mothers at a margin of error of 11–20% [Table 11].

When the tendency to overestimate or underestimate the fetal weight was considered, Johnson's formula had a tendency to overestimate the fetal weight in 158 (79%) of the cases, while AG × SFH formula had a tendency to underestimate in 105 (52.5%) of the cases. Hadlock's had a tendency to overestimate in 126 (63%) of the cases and underestimate in 74 (37%) of the cases [Table 12].

DISCUSSION

Information about the weight of the fetus helps the obstetrician in exercising good obstetric and perinatal management. According to Taylor and Ward,[4] the fetal weight is the greatest single factor determining the survival of the fetus. Accurate prediction of fetal weight in relation to gestational age, if applied to all pregnancies, assist in identifying wrong dates, intrauterine growth restriction, and hence, reduce the number of preterm perinatal deaths.

Several studies have been conducted in the past comparing the efficacy of various clinical methods of fetal weight estimation with ultrasound and various clinical methods among themselves. In the present study, both clinical and ultrasonographic methods of fetal weight estimation were compared [Table 13].

Dare *et al*.[5] found the percentage error between the actual and estimated weight to be 20.1% by AG × SFH method.

Table 13: Comparison of methods used for fetal weight estimation

Study	Clinical method	Ultrasonographic method
Sherman *et al*.[8]	+	+
Titapant *et al*.(2001)	+	+
Dawn *et al*.(1983)	+	-
Amritha *et al*.[6]	+	+
Shittu *et al*.[9]	+	+
Dare *et al*.[5]	+	-
HebbarShripad (2007)	+	+
Tiwari and Sood[7]	+	+
Present study (2014)	+	+

In the present study, the percentage error was 1.9% for AG × SFH method.

Amritha *et al*.[6] found the average error by AG × SFH was 224.37 g which was least when compared to Johnson's and Hadlock's method. In the present study, also the average error was least by AG × SFH formula, which was 56.12 g followed by Hadlock's formula (100.245 g) and Johnson's formula (393.26 g) [Table 14].

Tiwari and Sood[7] in their study showed an average error of 364.96 g, 327.28 g, and 198.6 g by AG × SFH, Johnson's, and Hadlock's ultrasound method, respectively.

Sherman *et al*.[8] reported that percentage of fetal weight estimates falling within 10% margin of error for clinical and USG method was 72% and 69%, respectively. Amritha *et al*.[6] reported the same to be 67% and 62% for AG × SFH method and USG method, respectively.

Table 14: Average error in grams by various studies

Study	AG×SFH method	Johnson's formula	Hadlock's formula
Tiwari *et al*.[7]	364.96	327.28	198.60
BhandaryAmritha *et al*.[6]	224.37	292.51	299.11
Present study	56.12	393.26	100.245

AG: Abdominal girth, SFH: Symphysis fundal height

Table 15: Percentage error of 10% by various methods

Study	SFH * AG (%)	Johnson's formula (%)	Hadlock's formula (%)
Sherman *et al*.[8]	72	-	69
Amritha *et al*.[6]	67	41	62
Shittu *et al*.[9]	70	-	68
Present study (2014)	97.3	91.3	100

AG: Abdominal girth, SFH: Symphysis fundal height

In the present study, when the margin of error was 10%, EFWs by AG × SFH (Insler's formula) and USG method were 97.3% and 100%, respectively [Table 15].

In this study in addition to the statistical comparison of all the methods with the ABW, we have also done a correlation analysis using Karl Pearson's correlation coefficient, which showed that both the clinical methods and ultrasound showed a positive correlation the ABW and ultrasound showing the highest correlation among the three.

CONCLUSION

Thus, based on this study, AG × SFH clinical formula can be of great value in a developing country like ours, where ultrasound is not available at many healthcare delivery systems. It is easy, cost-effective and simple and can be used even by midwives.

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